Large Class Student-Centered Pharmaceutical Science Instruction: Is Classroom Attendance Necessary? Does Performance Affect Course Assessment?

Peter C. Ruenitz

ABSTRACT. Application of new instructional methods in a medicinal chemistry course offered to a class of 103 second-year pharmacy enrollees in 1995 resulted in marked improvements in rate and efficiency of content retention compared to traditional approaches. Review of student performance in and evaluation of this course suggested two matters for subsequent study: (a) the degree to which student acquisition of course content was related to regular attendance and the extent to which student course rating was affected by final exam performance. Composite data for the 1996-1998 course offerings indicated that final exam performance of students who attended class regularly was about one letter grade (9%) higher than the performance of students who attended class infrequently ($p < 0.001$), even though both groups had

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similar overall aptitude (PCAT chemistry scores) and ability (prerequisite course grades). Parameters assessing support of student learning were independent of final exam average; that which directly assessed learning exhibited some dependence on this. These results have enabled identification of significant challenges associated with further streamlining of this course by relegation of information assimilation to out-of-class assignments and suggest that, regardless of the manner of course conduct, evaluation instruments should focus on assessment of how well the course/instructor fulfilled student *needs* associated with the learning experience. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-342-9678. E-mail address: <getinfo@haworthpressinc.com> Website: <http://www.haworthpressinc.com>]*

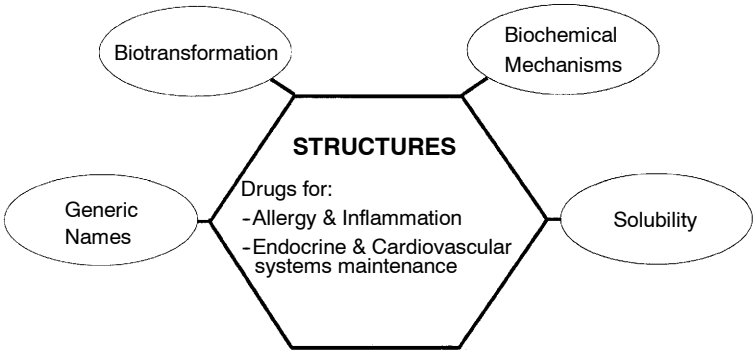
KEYWORDS. Large class instruction, performance, student assessment

INTRODUCTION

Principles of Medicinal Chemistry I is a three-credit course in the second professional year of our undergraduate semester curriculum. Classes meet for 50-75 minutes 3 times per week (or the equivalent) during the first 12 weeks of the 15-week term, with the final examination being given during week 13. This course emphasizes the relationship between chemical structures of drugs and their names (generic), biochemical mechanisms of action, biotransformation, and physicochemical properties (solubility) (Figure 1). Enrollment has ranged from 92-111 students per semester. Coverage is restricted to the most noteworthy agents in each therapeutic category; thus, students are responsible for structural knowledge of a total of about 115 drugs. The author has been the sole instructor in this course from 1995-1998.

Beginning in 1995, a novel, student-oriented approach to instruction has been used in this course (1, 2). Briefly, this approach requires students working individually or in groups of their choice to obtain, prior to class, answers to fact-oriented study questions that address, in consecutive order, fundamentals covered in assigned chapters in the textbook required for this course: W. O. Foye, T. L. Lemke, and D. A. Williams, eds., *Principles of Medicinal Chemistry*, 4th ed., Williams & Wilkins, Philadelphia, 1995. (A course packet containing a complete set of study questions for all textbook chapters to be covered during the semester is available to students before starting the course.) Class-

FIGURE 1. Course Coverage and Focus in Principles of Medicinal Chemistry I.



room coverage of each study question/answer is focused on clear, concise amplification of the particular teaching point being addressed. Five to 10 study questions are generally covered per 50-minute class period. Examples of four sets of study questions from which test questions were prepared (see below) are given in the Appendix, Section 1. At regular (unannounced) intervals, students prepare and hand in written responses to sets of review questions designed to enable self-assessment of comprehension of previously covered fundamentals (Section 1 of the Appendix).

The overall goal of this approach, accompanied by other procedural modifications, has been to build and sustain every student's level of self-motivation (2). Of paramount importance in pursuit of this goal was adaptation of established procedures aimed at nurturing student perception of self-control over course performance (3). These procedures included recognition and subsequent minimization of artificial barriers to learning and exploitation of pertinent pharmacy undergraduate student strengths, in particular, pattern recognition, reading comprehension, and effectiveness in responding to drill exercises.

Integration of these elements of course conduct into Principles of Medicinal Chemistry I in 1995 resulted in dramatic increases in student performance on examinations, and in most student course evaluation parameters, compared to when this course was offered in a lecture-based style. Also, the rate of content delivery was increased by about 50%.

In subsequent years (1996-1998), attention has been applied to aspects of student behavior that could guide future changes in instructional and evaluation methods used in this course. In particular, identification of student characteristics affecting exam performance and specific ways in which exam performance might affect course/instructor assessment emerged as issues worthy of systematic analysis. From an institutional perspective, the importance of student exam performance is obvious. But course/instructor evaluation is also a critical concern at this college because promotion/tenure decisions and annual merit review of faculty are based in part on such evaluations.

Regarding the first issue, review of attendance-performance data at the conclusion of the 1996 course offering revealed that some of the enrollees who rarely attended class nevertheless achieved high levels of performance. Presumably these students obtained information covered in class from selected classmates who served as proxies. In any event, it seemed that avoidance of class participation might not be due solely to naivete, confusion, and/or antisocial tendencies, but might instead reflect a perception of inefficiency regarding procedures by which didactic information was covered in class.

Alternatives to scheduled classroom instruction have recently been the subject of considerable attention (4-7). The growing availability of information technology for connecting pharmacy students to specific learning resources and for facilitating such connections might provide advantages in terms of convenience and efficiency of assimilating factual information. Indeed, the way in which such information is currently covered in Principles of Medicinal Chemistry I requires a minimal degree of instructor input and thus would not require major changes for presentation using the personal computer. Also, course packets and all examinations in this course are ready for distribution 3-6 months prior to their use, a criterion for off-site instruction (5). Accordingly, demonstration that student performance could be maintained without regular classroom attendance in this course would be a meaningful starting point for considering replacement of classroom study question coverage with out-of-class methods.

The second issue dealt with factors affecting student evaluation of course/instructor effectiveness. Qualitative observation strongly suggested that perception of such effectiveness would depend on overall student performance. On the other hand, it has recently been reported that student ratings are not unduly influenced by the grades students

receive or expect to receive (8). These apparently contradictory observations indicated the need for analysis of the effect of an isolated variable on *specific aspects* of student course evaluation. Exam performance was chosen as the isolated variable because this is of greatest concern to pharmacy enrollees at this college.

METHODS

Final exam performance results from 1995-1998 were chosen for comparison with course attendance and course evaluation data, although qualitatively similar trends to those reported below were seen in comparisons involving overall course performance results (sum of midterm and final exam scores). The comprehensive 2-hour, 50-item objective final exams given during these years addressed a random sampling of the approximately 200 study questions and 25-30 review questions relevant to the 115 specific therapeutic agents covered in 249 pages of textbook assignments throughout the semester.

Composition of Examinations

The 1995 final exam average did not provide a sufficient level of challenge to the majority of students. Thus, in each of the three subsequent years, exams were designed to be increasingly more rigorous than the previous year's. This was done in consideration of established methods, by selecting for refinement and wider application types and styles of test questions shown by item analysis to differentiate, moderately or highly, between the upper and lower quartiles of students (9). (The specific strategy and examples of how final exam questions were changed to constitute a higher degree of difficulty is presented in the Appendix, Section 2.)

Monitoring Class Attendance

The in-class review process vital to student-oriented instruction provided one means of taking roll (1). Review sessions were not scheduled in advance, but were conducted during the last half of every third or fourth class period. Each student in class prepared and handed in answers, on notebook paper, to a series of 3-5 review questions

designed to (a) reinforce fundamentals recently addressed in study question coverage and clear up, as needed, misunderstandings about these and (b) clarify the level of understanding of fundamentals necessary for satisfactory exam performance. Responses to these questions were summarized during the next class meeting but were not graded, and the name of each student handing in a paper was recorded. During each of the years 1996-1998, attendance at 7-8 review sessions was determined in this way. Also during each of these three years a second, indirect way of recording attendance was to note the names on midterm examination answer sheets not retrieved on days when these were returned to the class. (There were three midterm exams given during these years.) Thus, attendance was sampled approximately once per week during the 12 weeks of classes.

Course Assessment

After completion of each year's course, each student was given the opportunity to assess Principles of Medicinal Chemistry I, in part by responding to the institutional course evaluation form which rates 6 parameters on a scale of 1-5 (5 = highest). Evaluations were conducted under the direction of the Associate Dean for Undergraduate Instruction or the Chairman of the Pharmaceutical and Biomedical Sciences Department. Evaluations were anonymous and voluntary. (See the Appendix, Section 3 for a description of the course evaluation form.) The percentages of students responding in 1995-1998 were 68%, 76%, 70%, and 32%, respectively. Assessment of class perceptions has been suggested to be representative of the class as a whole if two-thirds or more students in a given class respond (10).

Quantitation of Aptitude and Ability

For this study, each student's percentile score on the chemistry section of the Pharmacy College Admission Test (PCAT) was recorded as a proxy measure of aptitude. (The PCAT was taken by all students the year prior to entering this college. The *average* PCAT chemistry score was calculated for each student taking the PCAT more than once.) Quantitation of demonstrated relevant ability was expressed by recording in numeric form students' final grades in the prerequisite course Biochemical Basis of Disease II (PHRM 3060).

Processing of Attendance/Performance and Related Data

In each of the four years of the course, final exam scores for all students were stored on a Quattro Pro® 5.0 spreadsheet. Then, for the years 1996-1998, each student's total number of observed absences, PCAT chemistry score (percentile), and grade in the first-year prerequisite course (Biochemical Basis of Disease II) was recorded. On each of these last three spreadsheets, final exam scores, PCAT scores, and prerequisite course numerical grades were sorted with respect to number of absences. Averages and standard deviations were determined for each group with respect to number of absences. Each group with three or more absences exhibited a significantly lower final exam average than each of the groups with zero, one, or two absences. Because of their small size, the groups with three or more absences were combined and compared to the final exam averages of the combined groups with 0-2 absences, for which no differences in final exam averages were seen. Three-year averages and standard deviations for each attendance group were determined by collating and reanalyzing the sorted data for 1996-1998. These results were subjected to two-way *t* tests to determine confidence intervals. Differences were considered significant at $p < 0.05$ or greater.

RESULTS

Of the 303 students who completed Principles of Medicinal Chemistry I in 1996-1998, 205 of these (68%) had 2 or fewer absences and were combined in the regular attendance (RA) group (Table 1). The remaining 98 students (32%), each of whom missed class at least 3 times, were combined in the infrequent attendance (IA) group.

Performance differences between 1996-1998 composite RA and IA groups were associated with attendance, but not with aptitude or ability. As indicated in Table 1, the RA group achieved a significantly different ($p < 0.001$) and higher (9%) final exam average than the IA group for the three-year period studied. Similar intergroup differences were seen in individual years 1997 and 1998. No intergroup variations ($p < 0.05$) were seen in PCAT chemistry averages or in the first-year prerequisite course averages for the three-year composites.

Composite final exam score distribution differences were associated

TABLE 1. Performance Characteristics of Students in Two Attendance Categories in Principles of Medicinal Chemistry I.

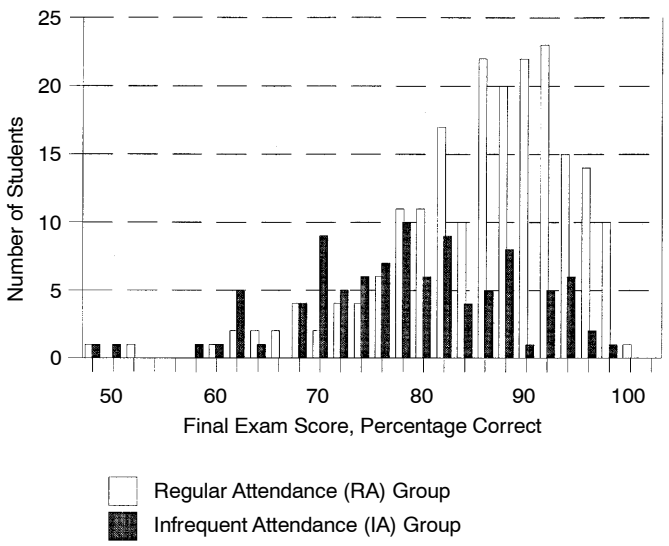
			Final Exam Score, %[a]	PCAT Chemistry[b]	PHRM 3060 Grade[c]
Year	Number of Absences	*N*[d]	**Average** (Standard Deviation)		
1996	0-2	81	**87.0** (8.2)	**77.8** (15.3)	**2.6** (0.8)
	≥ 3	19	**82.0** (9.2)	**75.6** (17.2)	**2.8** (0.7)
1997	0-2	72	**84.9** (9.7)	**78.9** (17.1)	**2.9** (1.0)
	≥ 3	39	**78.7**[e] (11.8)	**85.5** (14.3)	**2.6** (0.8)
1998	0-2	52	**84.5** (9.1)	**82.9** (14.0)	**3.2** (0.8)
	≥ 3	40	**76.8**[e] (8.5)	**78.3** (18.0)	**2.7**[e] (0.8)
1996-98	0-2	205	**85.7** (9.0)	**79.5** (15.8)	**2.9** (0.9)
Composite	≥ 3	98	**78.6**[f] (10.2)	**80.7** (16.9)	**2.7** (0.8)

[a] Examinations contained 50 objective (multiple choice and matching) questions.
[b] Pharmacy College Admission Test (PCAT): average percentile score of the group.
[c] Course grades for students in the prerequisite course, PHRM 3060 (Biochemical Basis of Disease II) were converted to numeric values (A = 4, B = 3, C = 2, D = 1) to calculate group averages.
[d] *N* = number of students missing the indicated number of classes, e.g., Fall Semester 1996, 81 students missed 0-2 classs.
[e] [(f)] Significantly different from respective 0-2 absence group averages at $p < 0.05$ ($p < 0.001$).

with attendance. The 205-member RA group score distribution approximated a parabolic curve which was skewed slightly to the right and tailed to the left (Figure 2). In contrast, the parabolic score distribution for the 98-member IA group was symmetric.

Performance differences were accompanied by little change in the six course evaluation parameters. The approach used to increase the rigor of final exams in years subsequent to 1995 was accompanied by respective 6.2 and 7.8 percentage point reductions in final exam averages in 1997 and 1998 relative to that seen in 1995 ($p < 0.05$) (Table 2). These performance differences were not, however, accompanied by differences in course evaluation parameters in which organization, coherence, motivation, empathy, and fairness were rated (cf. 1997, 1998 with 1995 or 1996). The learning parameter was lower ($p < 0.05$) in 1997 compared to that seen in 1996 but not 1995. Evaluation data

FIGURE 2. Composite Final Exam Score Distribution, 1996-1998.



for 1998 are included in Table 2 but were not compared statistically to data for previous years due to an insufficient number of student responses.

DISCUSSION AND CONCLUSIONS

Two aspects of the present results extend earlier findings which suggested a positive relationship between attendance and final exam performance in the 1996 offering of this course and in an introductory medicinal chemistry course taught in the same manner to first-year undergraduates (2). First, the negative (rightward) skew of the RA performance distribution chart (Figure 2) suggests a greater mastery of course content compared to the IA group, whose performance distribution charted as a regular parabola (3).

Second, students in the RA group had a composite "B" average on the final exam, but those in the IA group had a composite "C+" average (Table 1). Furthermore, Table 1 shows these intergroup performance differences (1996-1998 composite) to be independent of differences in aptitude or ability.

TABLE 2. Final Exam Performance and Course Assessment in Principles of Medicinal Chemistry I.

Fall Semester of:	1995	1996	1997	1998
Final Exam Average, % (Standard Deviation)	89.0 (6.4)	86.1 (8.6)	82.8 (10.9)	81.2 (9.6)
Number of Students	103	100	111	92
Statistical Range, $p < 0.05$	87.8-90.3	84.1-88.1	80.7-84.9	79.2-83.2
Evaluation Parameter:				
Organization	4.81 (0.44)	4.83 (0.41)	4.74 (0.52)	4.86 (0.34)
Coherence	4.83 (0.38)	4.89 (0.35)	4.58 (0.67)	4.67 (0.37)
Learning	4.55 (0.60)	4.74 (0.57)	4.32 (0.91)[a]	4.36 (0.60)
Motivation	4.47 (0.70)	4.57 (0.85)	4.33 (0.91)	4.59 (0.56)
Empathy	4.75 (0.58)	4.75 (0.63)	4.78 (0.55)	4.76 (0.43)
Fairness	4.79 (0.45)	4.91 (0.36)	4.82 (0.45)	4.83 (0.25)
% Students Responding	68	76	70	32[b]

[a] Lower than respective Fall 1996 parameter, $p < 0.05$.
[b] Evaluation parameter results for 1998 were not compared statistically with those of previous years due to an insufficient number of student responses in 1998.

As described above, attendance was recorded discretely for about one-third of the class periods in each of the years 1996-1998 and mainly for classes in which review questions were covered. There are two potential problems with this approach. First, observed performance differences might reflect primarily the importance of exposure to review question coverage as opposed to attendance at sessions concerned only with study question coverage. However, observation (quantitative) of *overall* attendance in all class sessions over the past three years suggested no substantial differences in numbers of students in attendance based on whether or not review questions would be covered. Second, there might be ''compliance'' problems associated with handing in written responses to discussion questions or picking up exam answer sheets on the day they're returned. These could conceivably have resulted in overestimation of number of absences of some students. However, it seems likely that *any* method of attendance checking would be prone to assessment errors, unless student com-

pliance with regimented attendance checking protocols was consistently enforced. Resorting to such an approach, even if not implemented during each class session, would probably have a negative impact on the very student behavioral attributes that this course seeks to build and sustain (2, 11). Thus the present sampling method of attendance assessment, although not without its shortcomings, is believed to afford the most meaningful estimates of student class attendance without compromising self-motivation. An earlier study of the effect of attendance on exam performance has been reported based on attendance sampling of less than 20% of total class sessions (12).

A troubling aspect of the final exam score distribution data (Figure 2) is that a significant percentage of RA group members received scores below the 70% ''pass line.'' In the composite 1996-1998 RA group, no correlation was found between exam performance and PCAT chemistry score; however, a correlation of +0.41 ($p < 0.001$) was found between final exam performance and prerequisite course grade (resorted data not shown). Thus, deficiencies in ability but not aptitude, as defined in this study, might account for the marginal performance of some RA group members. Specifically, shortcomings in pattern (drug structure) recognition ability could be responsible, but this possibility has not been studied comprehensively.

Taken together, the above results indicate that relegation of study question coverage (information assimilation) in Principles of Medicinal Chemistry I to out-of-classroom assignments would present several major challenges. First, IA group students generally did not master the course content as effectively as RA group students. Future students prone to nonattendance, given additional freedom/responsibility for working study questions, might be even less likely to pursue such assignments with the necessary vigor. A mechanism to obviate this scenario is needed. Second, and even more importantly, out-of-class assimilation procedures must demonstrate maintenance of performance levels among the majority of students who would perceive the benefit of classroom instruction. Third, their implementation must result in no deterioration of course evaluation ratings for those parameters associated with *support* of student learning (see below). From an overall perspective, concern has been expressed that computer-assisted and off-site learning alternatives to scheduled classroom instruction fail to cultivate intangible aspects of professional education,

which are believed to be enabled primarily by direct student-instructor and student-student interactions (5, 6).

This concern, and the challenges expressed above, might be approached successfully by increasing the amount of class time dedicated to review sessions and alerting students on the first day of classes to the necessity of regular attendance, with occasional absence permissible, using the composite 1995-1998 findings summarized in Table 1 for illustration. These measures could increase the percentage of students who attend class regularly. Also, some of the review questions could be presented in ways designed to make students aware of specific challenges inherent in this course, such as the need for immediate recognition of drug structures on exams, that might not have been encountered previously.

Several consequences can be envisioned to arise from adaptation of computer-supported or other self-directed coverage replacing and augmenting classroom study question coverage of course fundamentals, together with more intensive in-class review processes. Exam performance of a small percentage of regular attendees, who (like their counterparts in 1996-1998) could otherwise experience difficulty mastering the course material (Figure 2), might improve if problems such as that referred to above could be preempted by implementation of appropriate measures during review sessions. Additionally, students who formerly stayed away from class would be more likely to participate effectively in classes in which the focus was primarily on information not directly available to them, and this would result in higher exam scores for these students than those achievable using current procedures.

Regardless of what measures are taken to address the challenges of off-site assimilation of course fundamentals, the need for lessening our dependence on specific times and places for delivery of didactic instruction has become indelibly clear in an era where classroom space and time is becoming more and more constrained relative to the growing abundance of other learning options.

Many factors besides quality of instruction have been shown to exert a significant influence on student course evaluation. These include class size, student interest in the subject matter, total academic workload of the students, experience/maturity level of the students, and degree of difficulty of the course (10). The classes of students which were the subject of this analysis were of approximately equal

size (Table 2), educational experience, workload, and aptitude and ability (Table 1). This enabled isolation of course difficulty, as measured by final exam performance, as a variable with which to compare course evaluation results. Sufficient differences were observed in the degree of final exam difficulty in the four years of this study to allow comparison of performance with evaluation.

It has been suggested that, all other things being equal, student course evaluation is independent of performance (8, 10). The present results are in general agreement with this suggestion. Only learning, the parameter most closely related to exam score, was suggested to be performance-dependent (Table 2), although the trend was only significant in comparing 1997 results with those of 1996. Otherwise, for example, none of the 1997 evaluation parameters differed from those of 1995 despite a 7.5% difference in final exam averages for these years.

These findings tentatively suggest that survey questions used in teaching evaluation instruments should address primarily those issues that relate only indirectly to student learning. Specifically, the focus should be on items assessing how well student needs are being fulfilled. Ratings on items that assess issues relating directly to student learning might need to be interpreted in relation to exam performance.

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APPENDIX

Supplementary Information

SECTION 1. Study and review questions upon which the test items in Section 2 were based. Students use the textbook to obtain answers to the STUDY QUESTIONS (S) in sets W-Z below, and subsequently compose responses in class to REVIEW QUESTIONS (R), in preparation for corresponding EXAM QUESTIONS W-Z in Section 2.

SET W:

S1. Describe how activated prothrombin is converted to thrombin (how do these proteins DIFFER, what coagulation factor is required).

S2. What's the physiologic role of thrombin?

S3. How does heparin reduce thrombin blood levels?

S4. Describe the structure of heparin

S5. How does the structure of warfarin compare to vitamin K?

S6. How does warfarin reduce prothrombin blood levels?

R1. How do the structures and mechanisms of anticoagulant action of warfarin and heparin differ?

SET X:

S1. What are the major physiologic effects of histamine? Where is histamine stored in the body?

S2. What are the THREE receptors, through which these effects are mediated, called? Which of the above EFFECTS are mediated by H1 receptors?

S3. What TWO things happen when histamine free base is added to excess dilute HCl?

S4. What effects of histamine are antagonized by diphenhydramine? Which ones are not? What is the significance of this differential antagonism?

S5. What are the structural requirements for antagonism of histamine at receptors which mediate allergic responses?

R1. How does diphenhydramine differ structurally and pharmacologically from cimetidine?

R2. How and why are diphenhydramine and histamine ionized at physiologic pH?

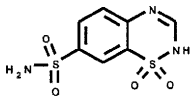
SET Y:

S1. Diagram (sketch) a nephron unit and indicate the location of the glomerulus, proximal convoluted tubule, Henle's loop, distal convoluted tubule, and collecting tubule.

S2. (a) What are the FOUR sites (regions) in the nephron responsible for sodium resorption? (b) What percent of sodium is resorbed at each of these sites?

S3. At what nephron site do thiazide diuretics act?

S4. What CHANGES need to be made in the thiazide (right) in order to improve diuretic POTENCY? Look at hydrochlorothiazide, bendroflumethiazide, and methyclothiazide



S5. Why are carbonic anhydrase inhibitors of limited value in inhibiting sodium resorption?

S6. What is the major side effect to long-term thiazide use?

R1. How does hydrochlorothiazide produce diuresis?

R2. What structural changes to hydrochlorothiazide will make it more/less potent?

SET Z:

S1. What ENZYME catalyzes the conversion of arachidonic acid to PGH_2? Name TWO inflammation-causing prostaglandins produced from PGH_2?

S2. What enzyme do phenylbutazone and oxyphenbutazone INHIBIT, which is responsible for their anti-inflammatory effects?

S3. How is phenylbutazone metabolized OXIDATIVELY (two metabolites)?

S4. How does oxyphenbutazone differ structurally, but compare therapeutically, to phenylbutazone?

R1. How does phenylbutazone combat inflammation?

R2. How is phenylbutazone metabolized to inactive, and active, metabolites?

APPENDIX (continued)

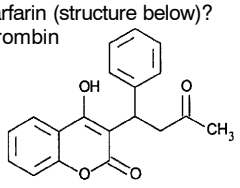
SECTION 2. Composition of final examinations.

Each multiple choice and matching item from final examinations given in 1995-1998 was analyzed with respect to its *difficulty factor* (DF) and the *discrimination index* (DI) associated with its correct answer. DF is the fraction of the total number of student responses to an item which were correct. DI is calculated by dividing the difference in the number of correct responses in the upper quartile of students less that in the lower quartile of students by quartile size. Thus, for an item on an exam completed by 100 students on which 80 students chose the correct answer, the DF is 0.80. Furthermore, if all 25 students in the upper quartile chose the correct answer but only 16 students in the lower quartile chose the correct answer, DI = (25 − 16)/25 = 0.36.

Too many items on the 1995 final exam had DFs of > 0.90 and DIs of < 0.10, judged to be suggestive of an insufficient degree of overall challenge. It was hypothesized that inclusion of more items with DFs ranging from 0.60-0.90 and DIs ranging from 0.20-0.60 would be necessary to optimize rigor. Therefore, increasing percentages of items on subsequent final examinations were prepared based on elements of style and focus associated with items having DFs and DIs in these ranges. Thus, although only 12% of the test items on the 1995 final were within the above specified ranges, the percentages of such items on the 1996-1998 final exams were, in turn, 32%, 56%, and 64%.

Examples of how DF and DI can be changed by refocussing exam items are shown below. Generic names of the indicated drug structures are included in sample test items for convenience. In practice, these are omitted from most test items because students in this course are required to know the generic name of each drug structure covered. Correct responses are indicated by asterisks.

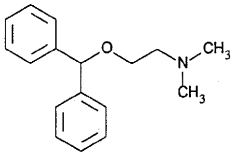
W. Which of the following describes the mechanism of action of warfarin (structure below)?



*A. Inhibitor of vitamin K dependent carboxylation of preprothrombin
B. Interferes with calcium uptake by coronary blood vessels
C. Reduces levels of thromboxane A2 in blood platelets
D. Modulates electrical conductivity of ventricles
DF = 0.92 DI = 0.15

W'. Which of the following is correct about the structure and function of thrombin?
A. An enzyme which binds to the thrombin receptor to initiate the clotting of blood
B. A lipoprotein which interacts with warfarin to inhibit biosynthesis of clot dissolving factors
C. A sulfonated/sulfated polysaccharide which inactivates coagulation factor Xa
*D. A proteolytic enzyme that hydrolyzes fibrinogen
DF = 0.72 DI = 0.35

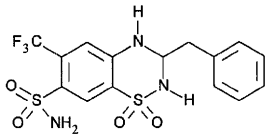
X. Diphenhydramine (below) is categorized therapeutically as a _____ drug.



A. Antithyroid
*B. H1 Antihistamine
C. Anti-inflammatory
D. Hypoglycemic
DF = 1.00 DI = 0.00

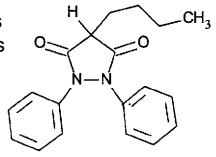
X'. Diphenhydramine is poorly soluble in water, but its solubility is increased by adding an aqueous solution of which of the following?
A. Glucosamine
B. Sodium hydroxide
C. Ammonia
*D. Hydrochloric acid
DF = 0.72 DI = 0.29

Y. Which of the following is correct concerning bendroflumethiazide (below)?
*A. It acts mainly at distal convoluted regions of renal tubules
B. An example of a potassium sparing diuretic
C. Its effect is due mainly to its ability to inhibit carbonic anhydrase
D. It counteracts the effect of cortisol on blood glucose levels
DF = 1.00 DI = 0.00



Y'. The therapeutic effect of bendroflumethiazide will be ELIMINATED by which of the following structural changes?
A. Replace the phenylmethyl group with a hydrogen atom
B. Replace the -CF_3 group with a -Cl group
*C. Replace the -SO_2NH_2 group with a -COOH group
D. Replace the hydrogen on the ring sulfamyl group with a methyl group
DF = 0.62 DI = 0.41

Z. Phenylbutazone (structure below) interferes with the physiologic function of which of the following?
*A. Prostaglandin cycloöxygenase B. Histamine H1 receptors
C. Anabolic receptors D. Thromboxane receptors
DF = 0.96 DI = 0.11



Z'. Phenylbutazone is converted to an active metabolite by which of the following routes?
A. Hydrolysis of its five-membered ring
*B. *p*-Hydroxylation of one of its phenyl rings
C. Hydrolysis of its *n*-butyl side chain
D. □ - 1 hydroxylation of its *n*-butyl side chain
DF = 0.78 DI = 0.34

SECTION 3. Course evaluation questions.

Evaluations were administered after completion of the course and submission of final course grades by the instructor. The instructor did not participate in the evaluation process. Anonymous, voluntary student responses to the six questions (A-F) below were collected and tabulated. Each item was rated on a 1-5 scale: 1 = almost never, 2 = seldom, 3 = sometimes, 4 = often, 5 = almost always.

A. The course was well **organized** and carefully prepared.
B. Course material was presented in an **understandable** manner.
C. I **learned** a lot from this course.
D. The conduct of this course **motivated** me to do my best.
E. Students were treated in an **empathetic** manner in this course.
F. Course grades were assigned **fairly** and impartially.