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Title: DEVELOPMENT AND EVALUATION OF A PROGRAMMED UNIT ON DIABETES MELLITUS

Abstract approved: Robert W. Sager, Ph.D.

A programmed unit on diabetes mellitus was written and tested on three groups of students. These included a class of licensed practical nurses taking a refresher course in pharmacology, a class of third year pharmacy students, and a class of first year students enrolled in a three year nursing program.

The students were administered a pre-test and the programs distributed in a class period. Students studied the material as their schedule allowed and a post-test was administered in the class period one week from the day the programs were distributed. The tests were of the multiple-choice type and the same test was used in both instances.

Analyses of the test included an item analysis and calculation of the reliability coefficient, the G-ratio, and the index of discrimination. Norms are reported for each sub-group as well as for the total group. Both the

program and test were found adequate to fulfill the goals established for teaching the subject matter and the group defined. Recommendations for minor revisions in both the program and the test are made where they are felt needed based upon data collected.

The findings of this research concur with earlier reports that programmed instruction is a proven method of learning. It is an additional tool available for classroom teaching and offers a challenge to both the student and the instructor. Perhaps the most significant outcome of the use of programmed units will be the exposure of some of the weak points in our present educational system. The tendency to insist upon high standards may bring about a re-evaluation of other methods of teaching and the establishment of new goals to raise the general level of all educational practices.

Development and Evaluation of a Programmed Unit on Diabetes Mellitus

by

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DEVELOPMENT AND EVALUATION
of a
PROGRAMMED UNIT ON DIABETES MELLITUS

I. INTRODUCTION

Programmed learning is a relatively new technique in which the individual teaches himself by following a carefully planned sequence of learning activities. Within the past decade there has been an enormous increase in the use of this method of learning. There has been considerable interest shown by educators in most fields. It is of particular importance to educators in the medical and para-medical fields, however, because of the accelerating expansion of knowledge, the increase in student enrollment, and the lack of prepared faculty. More efficient ways of collecting, organizing, disseminating, and assimilating knowledge must be found.

The concept of programmed learning dates back to 1912 when E. L. Thorndike suggested that guided experiences, broken into small steps, and followed by knowledge of results might be more effective than most lecture presentations designed to teach the same materials. (23) S. L. Pressey later developed a testing machine adding technology to the formulations of Thorndike. (16) He later developed another machine for teaching drill material that would

automatically omit a question from further presentation as soon as the subject obtained a correct answer twice in succession. (17) It was Pressey's philosophy that the teacher should be freed of much of the burdensome routine so he could be free to do more real teaching.

With a whole new area for research and the genesis of a new era in education, the early research was conducted primarily by psychologists and educational psychologists. Some work was conducted during World War II by experimental psychologists who began to apply their concepts and techniques to the problems of military training. (9)

However, it was not until 1954 that B. F. Skinner, building upon the hypothesis that learning is a rational, explainable process, suggested that we should concentrate on discovering the variables over which we can assume control in order to make warrantable predictions concerning student achievement as a result of instruction. (21) This brought a more direct educational application of learning concepts developed in the laboratores of the experimental psychologists and was the real beginning of intensive research utilizing this new instructional technique.

Under the guidance of Skinner an intensive program was pursued at Harvard University to develop and utilize the ideas he expressed. Newer optical, electronic, and electro-mechanical devices were developed and tested and considerable research was conducted on the writing of the programs. Skinner, et. al., concluded that the teaching

machine had some definite advantages over the conventional "teacher and book" method of teaching. These included the provision for immediate feedback (information as to the correctness of an answer), that they permit the student to work at his own rate so programs can be adapted to wide ranges of intelligence, that they are self-motivating, and that they offer convenient methods for providing reinforcement.

From a review of the literature to date, although there are many questions yet to be answered, the following generalizations can be made concerning programmed instruction: (1) it has demonstrated its effectiveness as a learning methodology and (2) it has demonstrated its capacity in most instances to reduce the over-all learning time required for mastery. (10, 7) Research indicates that individualized instruction through the use of a learning program can be both effective and efficient. (1) It is a proven method of learning. (11, 19, 13, 14, 5)

Lysaught states that the individual, self-instructional character of programmed learning has great significance because it can be used to learn new material of critical importance in a minimum length of time. (11) As mentioned earlier, there is concern among medical educators because of the population explosion and information explosion producing undue stress upon school facilities and faculties. It is here that many have become interested in and have used learning programs. These

programs offer flexibility so the student can study at his own rate and as his schedule allows, and are therefore a tool to afford better utilization of teachers and facilities. (8)

There has been considerable research conducted by medical schools in the development and use of programmed courses for instruction of prospective physicians. They have been used by the United States Public Health Service for training of personnel. Pfizer Laboratories, in conjunction with Basic Systems, Inc., has developed and published two programs intended for use by the practicing physician as review courses.* Programs also have been used by Pfizer in training of sales personnel. (11)

Seedor, Koehler, and Hinsvark have stated that programmed instruction is a tool well worth investigation and application to nursing to increase the efficiency of teaching and relieve busy nursing instructors of part of their routine. (19, 8, 20, 6) Relieving the instructors of routine teaching procedures would allow more time to be spent in supervision in the clinical areas.

Programs can be used for mastery of information, for supplementary education, for remedial education, and for continuation education. It is one of the professional

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* Alergy & Hypersensitivity
Current Concepts of Thyroid Disease

obligations of the well-qualified hospital pharmacist to conduct teaching and in-service training programs. (22) The educational background of the pharmacist affords him an excellent position in the education of members of paramedical fields and the use of programmed units could be of great advantage in conducting both basic learning and continuing education courses. The improvement of the hospital pharmacist's ability to conduct these training programs was a major factor in the decision to undertake the project reported in this thesis.

The success of this method of teaching depends upon the program used and it was the purpose of this study to (1) develop a unit concerned with the etiology and treatment of Diabetes mellitus, (2) develop a test adequate for measuring the knowledge gained from the program, (3) revise the program on the basis of student response, (4) revise the test questions on the basis of analysis of student response in order to increase the measurement capacity, and (5) allow time and suggest areas of clinical study and case problems for use during the class hours freed by use of the program to teach the routine material.

II. MATERIALS AND METHODS

Development of the Program

Programmed instruction is a method of organizing and presenting instructional material in small, logical,

ordered steps so that the student, working individually, may progress step to step, actively responding to each new item of learning, and by immediately being informed as to the accuracy and effectiveness of his response, may actually instruct himself in a subject matter. The single frames of learning are arranged in a logical sequence to accomplish a terminal behavior of learning by the student.

In constructing the program, the following sequence of steps developed by Lysaught and co-workers at the University of Rochester was used: (12)

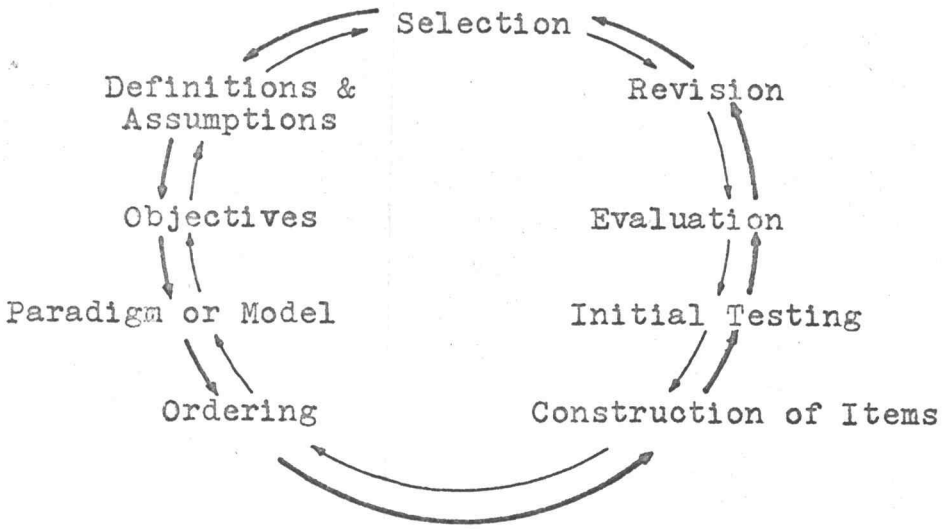

Figure 1. Schematic diagram of the auto-instructional programming process.

Diabetes mellitus was selected as the subject to be programmed because of the frequency with which medical personnel come in contact with the diabetic patient, because it is a reasonably circumscribed area of knowledge, and because of previous research in the area by the author.

Next, the group of learners for whom the program was to be written was defined. This included the educational background, vocabulary, and related conditions. It was decided to construct a basic unit suitable for use in the nurses-training curriculum, in nursing refresher courses, and pharmacy-training courses. Because of the nature of the basic design it could also be applicable in teaching the patient and teaching the employees of diabetic clinics.

Having defined the subject matter and the group of learners, objectives of the program were developed according to the guidelines set forth by Mager. (14) These are grouped as follows:

(1). To learn the basic factors of etiology of the condition.

(2). To learn the diagnostic measures employed in detection of the condition.

(3). To learn current methods of therapy including treatment by dietary measures, insulin replacement, and drug therapy.

(4). To learn to perform the diagnostic tests, to give injections in proper dosage, the design of the insulin syringe, to prepare diets, and general care of the diabetic patient.

The first three objectives as set forth above were the "content goals" of the written program and were selected to assist the student in learning the scientific knowledge. In medical education successful teaching must also attain what are termed "application goals".

These guide the student in learning the application of his new knowledge while dealing with the problems of the individual patients. Objective number four falls into this category. It is the instructor's duty to attain this goal primarily by classroom demonstration and individual student participation. Dworetzky has concluded from his studies at Cornell University Medical College that programmed instruction is most worthwhile when it is used in conjunction with lecture material. (11) The lecture serves as an additional reinforcement process.

The linear model of arranging the unit was selected because of the ease in its use and because the students for whom the program is designed will all be at approximately the same level in their educational process.

The material is presented in a series of short items. The student was asked to write the answer down as a reinforcement process as this is necessary to maintain the behavior in strength. Buckland states that the physical act of writing the answer plays a dominant role in the reinforcement process and increases the behavioral learning significantly. (2) The student was also asked to review the learning steps when a wrong answer was given in an effort to discover the point where the difficulty arose.

First draft frames were reviewed by senior-year education students and pharmacists. It was discovered that item steps were too large and certain points were not clear. A second draft was pretested on a group of

nurses taking the refresher course and more problems of clarity were pointed out. A third draft of the unit was used in the research presented in this paper and a copy is included in the appendix.

Development of the Test

The test developed for use with this program was of the objective multiple choice form. This form was chosen because of the adaptability in measurement of educational outcomes: for the decreased ambiguity of true-false and completion types and for the simplicity of administering and scoring. The questions were constructed under the guidelines of Ebel. (4) Four responses to each question were listed with only one response being accepted as correct.

The organization of the program and test are presented in Figure 2:

		Program	Test
I.	Etiology	12.4%	16.2%
II.	Diagnosis	20.7%	18.9%
III.	Treatment		
	a. Diet	3.3%	2.7%
	b. Insulin	34.7%	32.4%
	c. Oral drugs	28.9%	29.7%

Figure 2. Comparison of subject content of program and test.

The unit is designed to be of high practical value concerning areas of frequently used drugs and diagnostic

measures essential to the safe care of the diabetic patient. There is considerable emphasis on treatment with insulin and the oral hypoglycemic agents because it is essential that the specific usage of these therapeutic agents be thoroughly understood in order to note signs of improvement, side effects, errors of dosage, and methods of administration.

The developmental pretesting followed the same patterns as described under the development of the program. The final draft had a mean of 86.2 percent when tested on persons who would be expected to have the knowledge the unit is designed to teach (three physicians, six pharmacists, two diabetic nurse specialists) and a mean of 34.8 percent when tested on a group having little knowledge in the area (two school teachers, two electricians, three secretaries, one insurance salesman, and two clerk-typists). These data indicate the test has relatively high concurrent validity.

Evaluation of the Program

A controlled trial program was carried out in order to test the effectiveness of the programmed unit. Three test groups were used. Group A consisted of 22 third year students of pharmacy, Group B of 21 Licensed Practical Nurses taking a refresher course in Pharmacology, and Group C of 31 first year students enrolled in a three year nursing program.

The students were administered a pre-test and the programs were distributed along with an evaluation sheet in a class period. The programs were taken home to be studied by the student for one week as his time schedule permitted. During the class period exactly one week from the time the pre-test and the materials were given to the student, the evaluation sheets were collected and the post-test administered. The same test was given in both instances. Students who did not complete the unit did not take the post-test and all data previously obtained concerning the pre-test score were deleted from the tabulations.

III. RESULTS AND DISCUSSION

All tests were hand scored. Tabulations of the frequency of choice of answers were made at the time of scoring. Grades were calculated as to percent correct. No correction for guessing was made.

The norms established for the total group and for each subgroup are reported in Table I. The report is made in percent correct.

TABLE I. NORMS ESTABLISHED FOR THE TEST

	Group A		Group B		Group C		Total	
	Pre-test	Test	Pre-test	Test	Pre-test	Test	Pre-test	Test
Mean	45.3	86.2	42.0	80.9	52.0	87.3	47.6	85.2
Median	46	89	41	78	51	86	47.5	86
Mode	41	89	38	78	51	92	46 & 51	86
Standard Deviation	7.8	7.9	9.6	10.8	6.3	7.7	8.8	7.8
Range	32-62	68-100	23-67	64-100	38-65	62-100	23-67	62-100

Question number eleven was omitted from all analyses because it was found to have two correct answers. All others have only one correct answer.

A frequency polygon showing the distribution of scores for the total group is shown in Figure 3.

An item analysis was taken of both the pre-test and the post-test on the total group as well as each sub-group tested. This indicates which items are too difficult or too easy and which may fail for other reasons to discriminate clearly between the better and the poorer examinees. The item analysis sometimes suggests why an item has not functioned effectively and how it might be changed for improvement.

The internal criterion of total test score was used as the basis and the method used was that suggested by Ebel. (4) The difficulty of each item was determined by

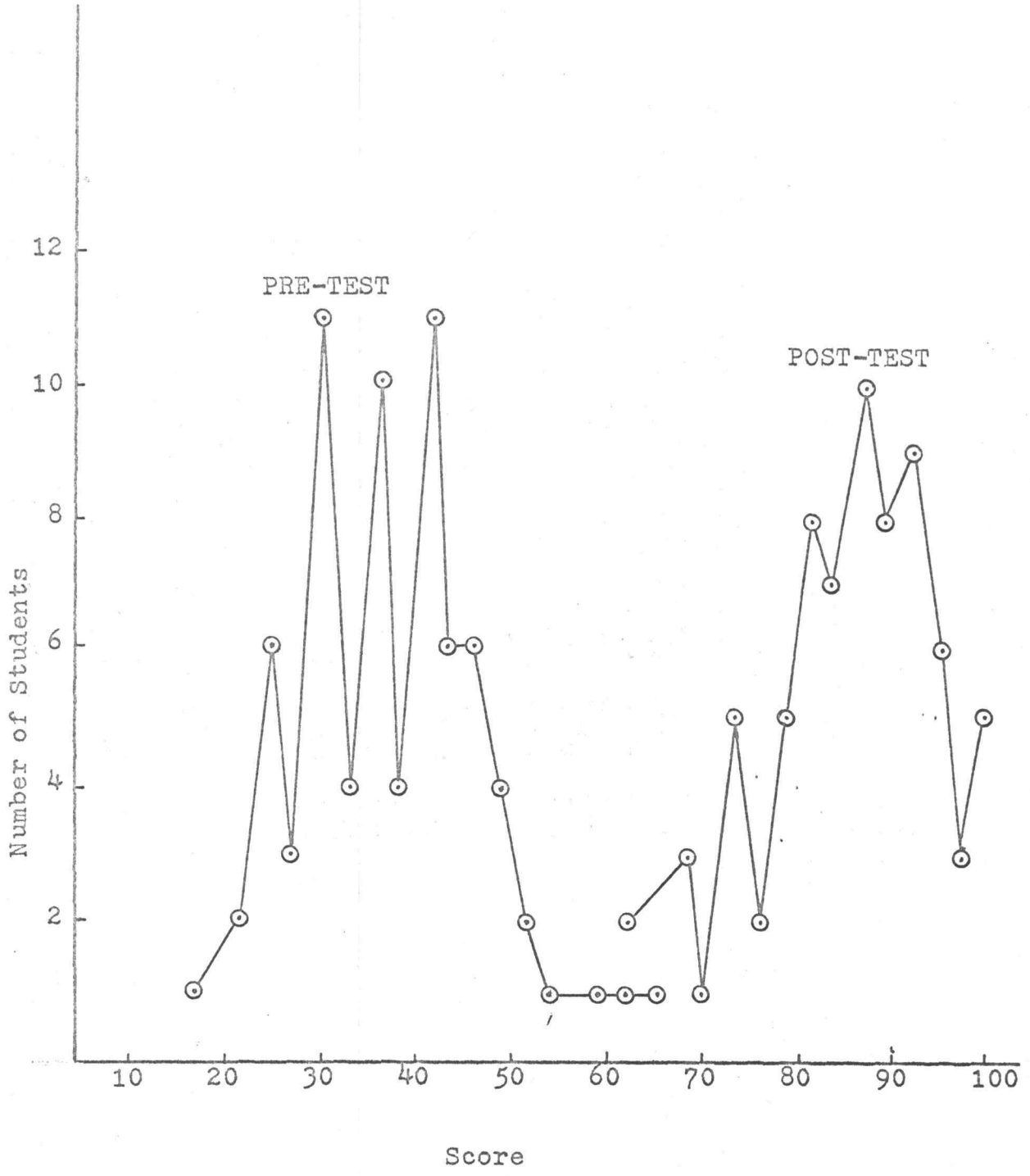

Figure 3. Frequency polygon showing distribution of pre-test and post-test scores for the total group tested.

tabulating separately the errors on the item for the entire group, the upper one-third, the middle one-third, and the lower one-third.

The item analysis indicated that in the post-test, nine of the total 37 graded items had an over-all difficulty index of less than 80 percent. Poor performance on test items can be traceable to at least two sources. The item can be intrinsically poor, due to vague instructions, unclear structure, or ambiguous wording, in which case the item requires revision; or, the material tested by the item may be inadequately taught in the program, in which case the programmer must then re-examine the program and revise it.

The Index of Discrimination was calculated for each item tested according to the following formula: (4)

$$I_D = \frac{\text{(number correct in upper group) - (number correct in lower group)}}{\text{(number of papers in each group)}}$$

As noted in Table II, all values for the Index of Discrimination for the pre-test are positive for the total group tested and all except one (question number 24) are positive for the post-test. Items of medium to hard difficulty have greater discriminating powers. In the correlation of item difficulty and index of discrimination as reported in Tables III and IV, the nine items showing the most difficulty all had high discriminating power between the better and the poorer students, so it was

TABLE II. INDEX OF DISCRIMINATION

	Pre-Test				Post-Test			
Item	Group A	Group B	Group C	Total	Group A	Group B	Group C	Total
1	0.63	0.14	0	0.24	-0.13	0	0	0.04
2	0.13	0.29	0	0.12	0	0	0	0
3	0.25	0.43	0	0.20	0	0	0	0
4	0.50	0.14	0.10	0.24	0	0	0	0
5	0	0	0.30	0.12	0	0.43	0.10	0.16
6	0	0.43	0.10	0.16	0	0.29	0.10	0.12
7	0.50	-0.14	0.30	0.24	0.13	0.29	0.10	0.16
8	-0.25	0.43	0	0.04	0	0	0	0
9	-0.13	0	0.30	0.08	0.13	0	0	0.04
10	0	0.29	0	0.08	0.13	0.57	0.10	0.24
11	-----omitted from all analyses-----							
12	0	0.14	0.10	0.08	0	0	0	0
13	0.25	0.14	0.50	0.32	0.13	-0.14	0.10	0.04
14	0.38	-0.29	0.30	0.16	0	0.29	0.10	0.12
15	0.13	0.57	0.30	0.32	0.13	0	0	0.04
16	0.13	0.29	0.30	0.24	0.13	0.29	0	0.12
17	0.25	0	0.20	0.16	0.25	0.14	0.40	0.24
18	0.25	0.57	0.20	0.32	0.13	0.14	0.20	0.16
19	0.50	0.57	0.30	0.44	0	0	0.10	0.04
20	0.38	0	0.40	0.28	0.13	0.14	0.20	0.16
21	0.38	0.57	0	0.28	0.25	0.14	0.	0.12
22	0	0.14	0	0.04	0.13	0.29	0.30	0.24
23	0.25	0.29	0.40	0.24	0	0.43	0.20	0.20
24	0.13	0.14	0	0.08	-0.13	0	0	-0.04
25	0.50	0.57	0.70	0.52	0	0.57	0.20	0.24
26	0.50	0	0.50	0.36	0.13	0.43	0.50	0.36
27	0.38	0.14	0.20	0.24	0.25	0.86	0.40	0.48
28	0.25	0	-0.10	0	0.50	0.57	0	0.32
29	-0.13	0.57	0.10	0.16	0.50	0.57	0.30	0.44
30	0.13	0.29	-0.10	0.08	0.50	0.57	0.30	0.44
31	0	0.29	0.40	0.24	0.13	0.43	0.30	0.28
32	0.50	-0.14	0	0.12	0	0.14	0.10	0.08
33	0.63	0.14	0.60	0.48	0.13	0.29	0.30	0.24
34	0	0	0	0	0.13	0.14	0	0.08
35	0.13	0.29	-0.20	0.04	0.50	0.86	0.50	0.60
36	0.25	0.14	-0.10	0.08	0.50	0.71	0.50	0.56
37	-0.25	0.29	0.10	0.04	0.25	0	0.10	0.12
38	-0.13	0	0.10	0	0.75	0	0.40	0.40

concluded by the programmer that neither the program nor the test were intrinsically deficient. The material was covered and the questions were of sufficient clarity for more than 80 percent of the students and when a question was answered incorrectly by less than this 80 percent, it always had significantly high discriminating powers between the better and the poorer students.

Data on the usefulness of the distractors are reported in Appendix B. For the test these are analyzed on the basis of being confusing or misleading to the student. Considered were the Index of Discrimination and the relative difficulty of the item. In all cases with the exception of Question number 28, the majority answered the question correctly. None of the distractors were used to the extent that the question of the program could be considered misleading, unclear, or ineffective. In the analysis of the usefulness of the distractors in the pre-test, only seven were found to be completely ineffective.

Based upon the analysis data presented, changes recommended in the use of the distractors are minor and are suggested where it is felt there could be improvement. These appear in Appendix B. Also based upon these data, it is felt by the programmer that the program is intrinsically sufficient to teach that for which it was constructed.

Reliability coefficients were calculated for each

TABLE III.

ITEM DIFFICULTY vs. INDEX OF DISCRIMINATION--PRETEST

Group A			Group B			Group C			Total		
Item	%	Index of D	Item	%	Index of D	Item	%	Index of D	Item	%	Index of D
6	100	0	34	100	0	2	100	0	34	100	0
34	100	0	24	95	0.14	8	100	0	12	96	0.08
2	95	0.13	12	95	0.14	21	100	0	2	95	0.12
12	95	0	2	86	0.29	24	100	0	8	86	0.04
3	86	0.25	1	81	0.14	34	100	0	24	86	0.08
8	77	-0.25	8	76	0.43	12	97	0.10	3	86	0.20
10	73	0	31	76	0.29	1	94	0	1	82	0.24
14	73	0.38	32	76	-0.14	3	94	0	21	70	0.28
1	68	0.63	3	71	0.43	4	74	0.10	32	66	0.12
5	68	0	19	71	0.57	23	68	0.40	7	66	0.24
7	68	0.50	25	71	0.57	7	65	0.30	19	64	0.44
25	68	0.50	7	62	-0.14	14	65	0.30	25	62	0.52
19	64	0.50	21	62	0.57	32	65	0	14	62	0.16
26	64	0.50	22	57	0.14	13	58	0.50	6	58	0.16
24	59	0.13	23	52	0.29	19	58	0.30	23	58	0.24
32	59	0.50	26	52	0	20	58	0.40	31	58	0.24
23	50	0.25	14	43	-0.29	25	52	0.70	26	55	0.36
31	50	0	38	43	0	26	52	0.50	22	47	0.04
9	45	-0.13	29	38	0.57	30	52	-0.10	20	45	0.28
37	45	-0.25	6	33	0.43	31	52	0.40	37	39	0.04
20	41	0.38	15	33	0.57	6	48	0.10	4	39	0.24
21	36	0.38	16	29	0.29	22	48	0	13	35	0.32
22	36	0	18	29	0.57	33	45	0.60	30	35	0.08
16	32	0.13	20	29	0	15	42	0.30	10	32	0.08
33	27	0.63	37	29	0.29	37	42	0.10	15	32	0.32
4	23	0.50	30	24	0.29	18	32	0.20	5	32	0.12
17	23	0.25	5	19	0	9	29	0.30	38	30	0
30	23	0.13	10	19	0.29	17	26	0.20	9	28	0.08
38	23	-0.13	13	19	0.14	38	26	0.10	33	28	0.48
13	18	0.25	35	19	0.29	28	16	-0.10	18	28	0.32
15	18	0.13	28	14	0	5	13	0.30	16	22	0.24
18	18	0.25	9	10	0	10	13	0	17	19	0.16
27	18	0.38	27	10	0.14	35	13	-0.20	29	19	0.16
28	14	0.25	36	10	0.14	16	10	0.30	28	15	0
29	14	-0.13	4	5	0.14	29	10	0.10	35	12	0.04
36	9	0.25	17	5	0	27	7	0.20	27	12	0.24
35	5	0.13	33	5	0.14	36	7	0	36	8	0.08

TABLE IV.

ITEM DIFFICULTY vs. INDEX OF DISCRIMINATION--TEST

Group A			Group B			Group C			Total		
Item	%	Index of D	Item	%	Index of D	Item	%	Index of D	Item	%	Index of D
2	100	0	1	100	0	1	100	0	2	100	0
3	100	0	2	100	0	2	100	0	4	100	0
4	100	0	4	100	0	3	100	0	8	100	0
5	100	0	8	100	0	4	100	0	12	100	0
6	100	0	15	100	0	8	100	0	24	99	-0.04
8	100	0	24	100	0	9	100	0	1	99	0.04
12	100	0	12	100	0	12	100	0	34	97	0.08
23	100	0	20	95	0.14	16	100	0	15	97	0
32	100	0	21	95	0.14	21	100	0	6	96	0.12
1	95	-0.13	18	95	0.14	24	100	0	9	96	0.04
7	95	0.13	34	95	0.14	34	100	0	20	96	0.16
9	95	0.13	6	90	0.29	6	97	0.10	21	96	0.12
14	95	0	17	90	0	7	97	0.10	3	96	0.12
15	95	0.13	19	90	0.14	15	97	0	16	93	0
19	95	0	9	90	0	20	97	0.20	7	92	0.16
20	95	0.13	32	90	0.14	32	97	0.10	18	92	0.16
22	95	0.13	16	86	0	5	94	0.10	19	92	0.04
24	95	-0.13	3	86	0.29	10	94	0.10	23	92	0.20
26	95	0.13	13	81	0.29	13	94	0.10	5	91	0.16
31	95	0.13	23	81	-0.14	14	94	0.10	14	89	0.12
34	95	0.13	33	81	0.43	23	94	0.20	26	89	0.36
10	91	0.13	7	81	0.29	18	90	0.20	13	88	0.04
16	91	0.13	5	76	0.43	19	90	0.10	17	88	0.24
17	91	0.25	14	76	0.29	31	90	0.30	10	86	0.24
18	91	0.13	38	76	0	27	87	0.40	31	86	0.28
21	91	0.25	10	71	0.57	17	84	0.40	33	84	0.24
13	86	0.13	30	71	0.57	33	84	0.30	32	82	0.08
25	86	0	31	71	0.43	35	84	0.50	22	80	0.24
27	86	0.25	22	62	0.29	22	81	0.30	27	78	0.48
33	86	0.13	26	62	0.42	25	77	0.20	35	77	0.60
35	82	0.50	29	62	0.57	29	77	0.30	25	74	0.24
30	73	0.50	35	62	0.86	26	71	0.50	30	72	0.44
37	68	0.25	37	62	0	30	71	0.30	29	69	0.44
28	64	0.50	25	57	0.57	37	71	0.10	37	68	0.12
29	64	0.50	27	57	0.86	36	65	0.50	36	53	0.56
36	54	0.50	28	43	0.57	28	42	0	28	49	0.32
28	27	0.75	36	33	0.71	38	29	0.40	38	42	0.40

sub-group as well as the total group for both the pre-test and the post-test according to the split-halves method. (4) The formula for calculating this is:

$$r = \frac{(n\ Exy) - (Ex)\ (Ey)}{\sqrt{nEx^2 - (Ex^2)} \times \sqrt{nEy^2 - (Ey)^2}}$$

E - the sum of
x - odd numbered questions
y - even numbered questions

A split halves correlation coefficient of 0.5 was found for the pre-test and of 0.47 for the post-test.

The Spearman-Brown formula is used to predict the increase in the reliability resulting from lengthening a test by the addition of items like those in the original test. (4) It is as follows:

$$r_n = \frac{nr_s}{(n-1)r_s + 1}$$

r_n = reliability of a test n times as long

r_s = known reliability

For this test projected to one twice as long, the reliability was raised to 0.67 and 0.64 for the pre-test and post-test, respectively. This indicates the items in this test have a relatively high discriminating power as shown by the item analysis data. With the recommended changes in distractors, the correlation coefficient might improve. On this premise, it is felt by the programmer

that this is sufficient in discriminating power, difficulty, and reliability to recommend for use.

It is stated by McGuigan and Peters (15) that the single best index by which to assess a program is the G-ratio. G is defined as the ratio between the amount learned and the amount that could possibly be learned. It is derived as follows:

$$G = \frac{T_2 - T_1}{r - T_1}$$

r -- possible score
T_1-- Pre-test score
T_2-- Post-test score
$T_2 - T_1$--Gain
$r - T_1$--Possible Gain

G-ratios derived from this research are reported in Table V.

TABLE V. G-RATIOS DERIVED FROM THIS RESEARCH

	G-Ratio
Group A	0.75
Group B	0.67
Group C	0.74
Total Group	0.72

G values vary from 0 to 1.0. McGuigan (15) picked the arbitrary value of 0.5 and said any programs yielding G values below this number would not be recommended for use. The G-ratio varies with the quality of the test and the correlation of the test and the program. The

correlation of the test and the program is self-explanatory. As for the quality of the test, should the test contain a number of "bad" items (items which are poorly written and are ambiguous, misleading, etc.) and are missed by a large percentage of the "good" students, G is artifically depressed. As noted from the Index of Discrimination for the test developed for use with this program, no questions fall into this category. Removing excessively easy items from the test does not affect the G score; therefore, the values obtained in this research can be considered valid, accurate, and reasonably good for a programmed unit.

Recommended Revisions

The recommended revisions for the test have already been discussed and are reported in Appendix B.

A section on glucagon was inadvertantly omitted from the program during the writing. This section has now been written and is included with the copy of the program in Appendix A, and questions covering this section have been added to the test.

Recommendations for Use of the Unit

It is recommended that this unit with the revisions recommended in this paper be used for teaching. Comments by the students were overwhelmingly in favor of the programmed method of teaching. It was highly accepted

by all groups used in this experiment, the general feeling being it was more efficient both in time required and in teaching capacity. Perhaps this feeling can be summarized by Garcia's statements concerning the advantages of programmed learning for the student: (1) the brighter and more advanced students do not have to sit in a classroom lecture and hear unnecessary repetition and (2) the average and slower students have a better opportunity to learn the subject matter. (11)

Garcia also states that another advantage is more efficient utilization of lecture time. In the conventional lecture method, not all students arrive in class sufficiently interested or prepared to listen profitably. With the use of a program, students could study the basic standardized knowledge before the lecture and then arrive in class prepared to ask intelligent questions and to receive further in-depth material concerning the subject from the instructor. This was observed by the programmer in the group of refresher-course nurses (Group B). Students spent an average of two hours and fifteen minutes studying the program outside class hours. The in-class presentation consisted of about one hour answering questions and clarifying points of the program. Two additional hours were utilized for practical clinical application including performance of the tests the diabetic uses for ketones and for sugars, observations of

medications and equipment used by the diabetic, viewing actual sample diets and weighing some foods to relate quantity and portion. This included a review of nutritional requirements and calorie values.

As stated earlier, this method of teaching is most worthwhile when it is used in conjunction with the lecture material. It is estimated by the programmer that it would take approximately three hours to present the material covered in the program by the conventional lecture method and an equal time outside class for the student to study his notes. By use of the program, the student spent an average of two hours and fifteen minutes to cover this material and one-half hour in taking the test. However, he also received three hours of classroom instruction in material of which he would not have been able to take advantage had the same amount of time been utilized by the conventional method of teaching.

III. CONCLUSIONS

Programmed learning is a proven method of learning accepted and used by many leaders of the education field. However, perhaps of more significance than its value as a teaching tool, it has exposed some weak points in our educational system. Indirectly it has exposed the delinquency and obsolescence of the traditional method of writing textbooks. It has stimulated a re-analysis of

our entire educational enterprise. The tendency to insist upon high standards may spread to other methods of teaching and raise the general level of educational practices. The detailed specification of goals may refine the goals for other methods of education, and finally, the total curriculum may be streamlined as irrelevant information is screened out.

There are limitations to the programmed approach. These include the amount and types of material which can be programmed, the limitations placed upon the programmer by the method and those placed upon the program by the programmer, and the lack of trained personnel to write the programs. Another important limitation, not to be taken lightly, is the importance which the personality of the lecturer plays in the role of stimulating student interest.

Therefore, it is concluded that programmed learning is a proven method of teaching, that it does offer another tool for use by the medical educator, and that it is the responsibility of the user to overcome the limitations. The instructor takes the additional responsibilities upon himself; those of selecting or writing programs that have proven valuable and reliable, of keeping these programs current, and of presenting supplemental material on the subject. (18) This is the challenge. Present-day education requires this and educators must meet the challenge.

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APPENDICES

APPENDIX A

COPY OF THE PROGRAM WITH SUGGESTED REVISIONS

To The Student

Programmed learning is designed so the student builds a structure of knowledge in small steps. These individual steps are called "frames" and in this course each item is one frame. Each frame asks you to answer a question, fill in a blank space or complete a chart. After writing your answer, you are able to compare it with the correct response, which is given to the right of the page.

If your answer was right, your response is immediately confirmed and the point you just learned is reinforced. If your answer was wrong, you can determine immediately why you are wrong and prevent building further knowledge of a wrong premise. To gain maximum benefit from the course, you must not look at the response until after you have done what the frame asks. You might find it helpful to use the mask that accompanies the program. Lay it on the page so that it exposes the frame you are studying, but covers the response. When you slide the mask down to the next frame, you can then compare your previous response with the correct answer.

Do not try to figure out an answer the easy way by referring back to a previous frame. Look back only when

you must. This should be necessary only after you have made an incorrect response and cannot determine why.

Write the answer whenever possible. Doing it "in your head" weakens the impression-reinforcing pattern that is built into the program. WRITE DOWN ALL ANSWERS.

It is possible to complete the course in a single long session, but is desirable to go through the program in several sessions of shorter time span.

There are review questions spaced throughout the course and it is advisable to seek the correct answer back through the learning steps when any of these cannot be answered. Upon completion of the course, the student should again go through all the review questions to test his retention of the knowledge.

Diabetes mellitus

1. Diabetes mellitus is a chronic disease in which there is a relative or complete lack of insulin, the hormone produced by the beta-cells of the Islets of Langerhans of the pancreas. Insulin is necessary for the metabolism of carbohydrates. Diabetes mellitus is a disease caused by the malfunction of the endocrine gland, the _____.	Pancreas
2. In diabetes there is a lack of the hormone, _____.	Insulin
3. This hormone is produced by the beta-cells of the _____ of the pancreas.	Islets of Langerhans
4. This hormone, insulin, is produced by the pancreas and is concerned with the metabolism of _____.	Carbohydrates
5. Carbohydrate is the principle source of energy for the tissue cells and is utilized by the body chiefly in the form of glucose. The hormone necessary to utilize glucose as a source of energy for the cell is _____.	Insulin
6. Carbohydrates are broken down in the body to the final end-product, _____, the form in which they are utilized to produce energy.	Glucose

7. The failure of the pancreas to supply the body with insulin results in a disease called _____.

Diabetes mellitus

8. Diabetes mellitus is a disease in which the _____, an endocrine gland, fails to produce the hormone, _____, so tissue cells cannot utilize _____ as a source of energy.

Pancreas
Insulin
Glucose

REVIEW QUESTIONS

1. What endocrine gland is afflicted in diabetes mellitus?

Pancreas

2. What hormone is absent in diabetes?

Insulin

3. What is the function of glucose metabolism?

To produce energy

4. Where is insulin produced in the body?

The beta-cells of The Islets of Langerhans in the pancreas

5. Name the sugar that is the end-product of carbohydrate metabolism.

Glucose

9. Limits of blood glucose level normally range from 60-160 milligrams (mg) per 100 cubic centimeters (cc) of blood. This level is controlled principally by the kidney and when the resorption capacity of the kidney tubules is overtaxed glycosuria results.

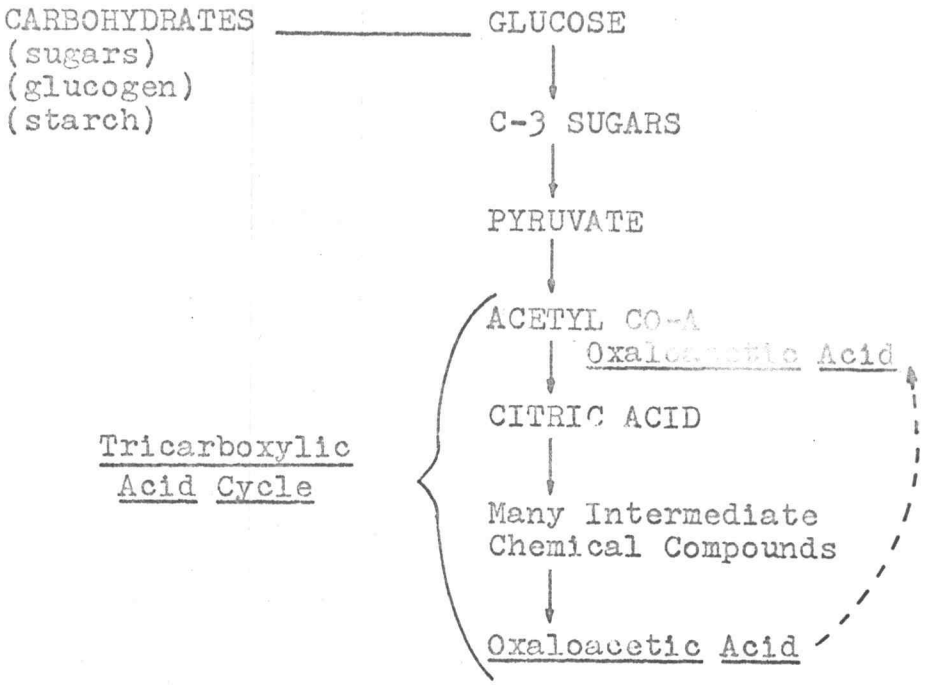
Glycosuria is a condition characterized by the presence of sugar (glucose) in the _____.

Urine

10. Normal blood sugar is considered to be 100 mg/100 cc also denoted as 100 mg percent (%). This varies with time of last meal, constituents of the meal, etc. Normal range limits are _____.

60-160 mg/100 cc

11. 60 mg/100 cc could also be denoted as _____.	60 mg%
12. 160 mg/100 cc could also be denoted as _____.	160 mg%
13. The normal blood sugar level is around _____.	100 mg%
14. Hypoglycemia is the term used to describe the condition of low blood sugar. This would mean a blood glucose level of less than _____.	60 mg%
15. A blood sugar level of 50 mg% would be indicative of _____.	Hypoglycemia
16. Hyperglycemia is the term used to describe the condition of higher than normal blood sugar. This would mean a blood glucose level of more than _____.	160 mg%
17. A blood sugar level of 180 mg% would be indicative of _____.	Hyperglycemia
18. The presence of sugar in the urine is called _____.	Glycosuria
19. In the diabetic there is a reduced oxidation of glucose by the tissue cells to produce energy and metabolic compounds. This results in _____, sugar in the urine, and _____, high blood sugar.	Glycosuria Hyperglycemia



20. This chart is a simplified version of glucose metabolism which produces the energy within our bodies. The end-product of the tricarboxylic acid (TCA) cycle is oxaloacetic acid. As shown in the chart this acid has to be present to combine with the Acetyl Co-A to regenerate and continue the TCA cycle.

The key end-product of glucose metabolism that must be present to re-generate the metabolic cycle is _____.

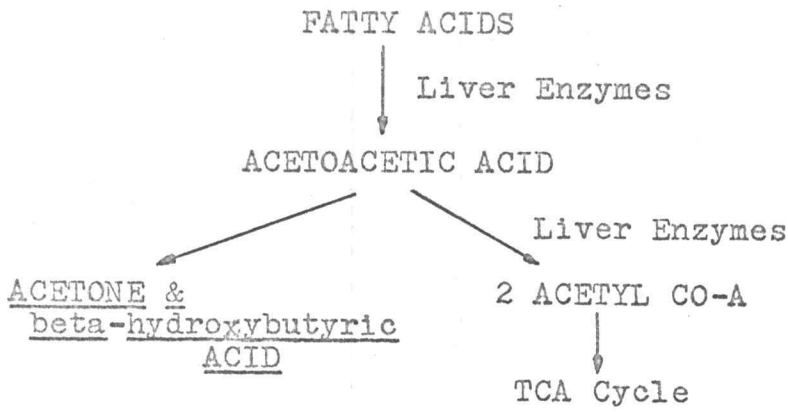
Oxaloacetic Acid

21. When oxaloacetic acid is not present, there has to be another means to produce energy. So in starvation and diabetes mellitus, fatty acids are used as the source of energy.

When oxaloacetic acid is not present and glucose metabolism is virtually stopped, what is used as the source for producing energy?

Fatty Acids

22. The liver cannot oxidize all the products of the metabolism of fatty acids so when there is a condition where large amounts of fatty acids are being used as the source of energy (as in diabetes) there is an accumulation of these end products. This altered condition is shown in the diagram below:



_____ ABNORMAL PATHWAY
_____ Normal Pathway

The acetone and beta-hydroxybutyric acid soon accumulate and are detected in the urine and breath. Normally fatty acids are broken down so they are metabolized in the TCA Cycle but when there is an excess of them to be metabolized and the liver does not have sufficient enzymes to metabolize them, the end-products are _____, and _____.

Acetone
beta-hydroxybutyric Acid

23. These are detected in the _____ and _____.

Urine and Breath

24. Beta-hydroxybutyric acid is an acid and the accumulation of this substance in the blood causes the acidity of the blood to rise and produces a condition known as acidosis. This abnormal condition results because the fatty acids

are used in large amounts as a source of energy due to the absence of the key end-product of glucose metabolism, _____.	Oxaloacetic Acid
25. The presence of beta-hydroxybutyric acid and acetoacetic acid (the precursor of acetone) and acetone in the urine can be detected by chemical tests. The test for the beta-hydroxybutyric acid is simply a measure of the acidity of the urine. In the presence of beta-hydroxybutyric acid, the acidity of the urine would be _____ than normal.	Higher
26. Ketostix is a commercially available preparation. It is a paper strip for use in the colorimetric "dip and read" test for the detection of acetoacetic acid in the urine. Ketostix are used to determine the presence of _____ in the urine.	Acetoacetic Acid
27. Another commercially available preparation is Acetest, a tablet, used to detect both acetoacetic acid and acetone in the urine. The "dip and read" test for acetoacetic acid is done with _____.	Ketostix
28. The two products available for determining the presence of the products of increased fatty acid metabolism are _____ and _____.	Ketostix & Acetest
29. Excess glucose in the urine is termed _____.	Glycosuria

30. In diabetes this occurs when glucose is not being metabolized. Glucose in the urine can be detected by the "dip and read" test using Clinistix or Testape or with Clinitest tablets. Acetest tablets are used to test for _____ and _____.

Acetoacetic Acid & Acetone

31. The commercially available products used to test for glycosuria are _____, _____ and _____.

Clinistix
Clinitest
Testape

32. The diagnostic measures in determining diabetes mellitus are concerned with blood and urine glucose levels. What is the upper limit of normal blood glucose?

160 mg%

33. The oral glucose tolerance test is one diagnostic tool used. In this test fasting blood and urine sugars are determined and the patient is given a pre-determined amount of glucose. Tests for blood and urine glucose are done 1/2, 1, 2, and 3 hours later. If the blood glucose level rises above 170 mg% and fails to return to fasting levels (100 mg%) or below by the end of the three hours, diagnosis of diabetes is presumed.

This test is called the _____ _____.

Glucose Tolerance Test

REVIEW QUESTIONS

1. What is glycosuria?

Excess sugar in the urine

2. What are the limits of normal blood sugar?

60-160 mg%

3. Normal blood sugar would be around _____.	100 mg%
4. What is the term used to describe high blood sugar?	Hyperglycemia
5. What is the term used to describe low blood sugar?	Hypoglycemia
6. What is the key end-product of glucose metabolism needed to regenerate the TCA Cycle?	Oxaloacetic Acid
7. When glucose is not used as a source of energy, what is used by the body?	Fatty Acids
8. Why is excess fatty acid metabolism undesirable?	The liver can't metabolize all the end-products and they accumulate to form acetone and beta-hydroxy-butyric acid
9. What is used to detect acetone in the urine?	Acetest
10. What are Ketostix used for?	To detect urine ace-toacetic acid
11. What would you be testing for if you used Clinitest, Clinistex, or testape?	Urine glucose
12. Explain the glucose tolerance test.	Patient is administered a measured amount of glucose & urine & blood samples are taken at specified intervals. If the body does not utilize this glucose (i.e. it is still in the urine or blood) the patient is considered to be diabetic

34. The primary objective in treatment of diabetes mellitus is to restore the patient's metabolism and maintain his general health and nutritious state. Therapy consists of dietary management and, when indicated, administration of insulin or one of the oral hypoglycemic agents.

The primary consideration in treatment of the diabetic is proper management of the _____.

Diet

---

35. Adjunctive therapy consists of administration of _____ or one of the _____.

Insulin
Oral Hypoglycemic Agents

---

36. The diabetic diet is a measured but normal diet the exception that the more rapidly absorbed carbohydrates and foods containing them in large amounts must be eaten sparingly.

This is in order to maintain normal blood _____ values and prevent _____.

Sugar
Glycosuria

---

37. The amount of insulin necessary to control diabetes varies greatly. The factors on which it depends are listed below:

1. Carbohydrate content of the food
2. Total caloric intake
3. Body mass
4. Exercise (amount of)
5. Fever, infection, trauma
6. Other endocrine gland malfunctions

The dose of insulin is determined to bring the _____ and _____ glucose concentrations to normal limits.

Blood
Urine

---

38. Probably the most important factor in dietary regulation is the proper management of _____ intake.

Carbohydrate

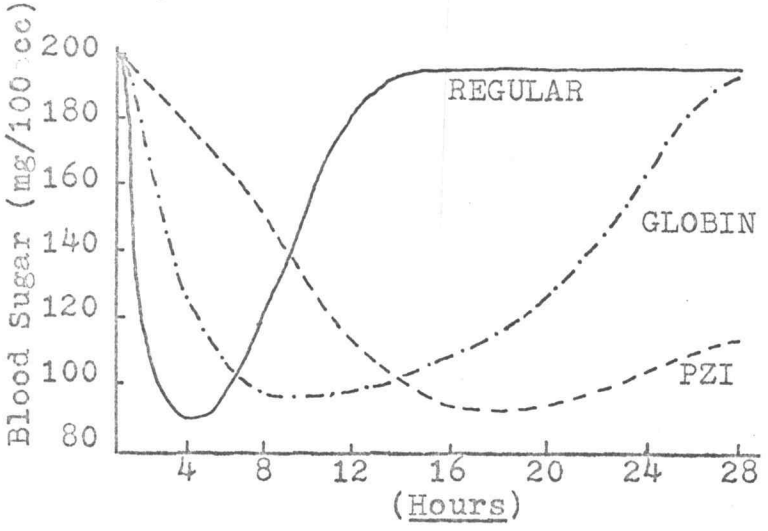
---

39. The desired normal blood sugar is _____.

100 mg%

---

40. Study the chart below:



Classified according to onset of action, insulins are divided into two groups--rapid-acting and slow-acting.

According to the chart, regular insulin is classified as _____ acting.

Rapid

---

41. The two slow-acting insulins shown on the chart are _____ and _____.

Globin
Protamine Zinc

---

42. Maximum effect of the regular insulin (also known as crystalline insulin) is _____.

3-5 hours

---

43. Duration of effect of regular insulin is about _____. — 6-8 hours

44. The only rapid-acting insulin is _____. — Regular Insulin

45. Regular insulin is generally administered subcutaneously (SubQ) but may be given intravenously (IV) or intramuscularly (IM). The first effects of a dose of regular insulin could be expected within one hour, as shown by the chart, and peak effect would be shown at _____. — 3-5 hours

46. A second dose of regular insulin would need to be given after _____. — 6-8 hours

47. Regular insulin is the only _____ -acting insulin. — Rapid

48. Regular insulin is seldom used alone except in cases of acidosis, unstable diabetes, during medical or surgical complications, and in some cases during the initial stages of standardization. The route of administration is generally _____, but it may be given _____ or _____. — SubQ IV IM

49. Insulin is generally given 15 to 20 minutes before the meal (breakfast when a single daily dose is given). Regular insulin would have a duration of action of _____. — 6-8 hours

50. An insulin syringe especially calibrated for unit dosage is used for the injection. Insulin is available in the concentrations of 40, 80, 100, and 500 units/cc and it is generally injected _____.

SubQ

---

51. Since it is given SubQ, the needle used for the syringe is 1/2" x 28 gauge. To give 20 units of Regular Insulin U40, one would use _____cc.

1/2 cc

---

52. The dose of 20 units from the concentration of 80 units/cc would be _____.

1/4 cc

---

53. Disposable needles and syringes are available for diabetic's use. They are convenient because they do not have to be sterilized and the needles are always sharp. What size and gauge of needle would you advise a patient to buy?

1/2" x 28 gauge

---

54. The slow-acting insulins include protamine zinc insulin (PZI), NPH, Globin Zinc Insulin, and the Lente group of insulins. These are all suspensions and must be shaken before injected. They are to be administered SubQ only. Regular insulin, in contrast, is a solution and is generally given SubQ but can also be given _____ or _____.

IV or IM

---

55. Ultralente Insulis is the slowest-acting of the insulins with maximum effect noted at 18-24 hours. This is in contrast to the most rapid-acting insulin, _____.

Regular Insulin

---

56. Other insulins and their onset and duration of action are classified below:

	Onset	Duration
Regular	1 hr	6-8 hrs
Semilente	1 hr	12-16 hrs
Globin	2-4 hrs	18-24 hrs
NPH	2 hrs	28-30 hrs
Lente (similar to NPH)	2 hrs	28-30 hrs
PZI	5 hrs	24-36 hrs
Ultralente (similar to PZI)	8 hrs	36 hrs plus

Mixtures of these are sometimes used to obtain a rapid onset with a prolonged duration of action. An example of this would be _____.

Regular & Ultralente
Regular & PZI
Semilente & Ultralente
Semilente & PZI

---

57. Proper adjustment could be expected to be maintained with a single daily dosage of which insulins?

NPH
Lente
Ultralente
PZI

---

58. When a single daily dose is given, it is usually given at what time of day?

1/2 hour before breakfast

---

59. The size and gauge of the needle suggested is _____.

1/2" x 28 gauge

---

60. In emergencies insulin may be given by the _____ or _____ route but it is generally given _____.

IV or IM
SubQ

61. Hypoglycemia (insulin "shock") may occur if too much insulin or too little food is taken. The level of blood sugar in this condition is _____.	Low
62. Hypoglycemia is treated with carbohydrate ingestion in mild cases or administration of IV solution of 25% dextrose in severe conditions. Blood sugar in severe cases would be less than _____.	60 mg%
63. Symptoms of a hypoglycemic reaction are blurred vision, sudden weakness or dizziness. A good source of carbohydrate to treat this condition is _____.	Candy
64. Severe hypoglycemia is also called _____.	Insulin shock
65. Two states which may lead to insulin shock are _____ and _____.	When too much insulin is taken and when too little food is taken
Items number 66-76 are added with the revision to include the section on glucagon).	
66. Glucagon is a crystalline polypeptide extracted from the pancreas, that when administered parentarally, causes an increase in blood glucose concentration. It would therefore be used to treat _____.	Severe hypoglycemia of insulin shock
67. Administration of glucagon would _____ the blood sugar level.	elevate

68. Glucagon exerts its effect by liberating endogenous glucose from hepatic glycogen. No evidence of toxicity has been reported with the use of this drug. What is the source of this drug?

Extract of the pancreas

---

69. Severe hypoglycemia leading to insulin shock may occur as a result of insulin overdosage, inadequate food intake, inability to utilize food, or strenuous exercise. Glucagon can be administered IM, SubQ, or IV. The blood glucose in hypoglycemia is _____.

low

---

70. Because of the varied routes of administration of glucagon, it is easier and more convenient than the administration of glucose in the unconscious or uncooperative patient suffering from insulin shock. Glucagon can be administered _____, _____, or _____.

IM, IV, or SubQ

---

71. The use of glucagon makes management of insulin shock outside the hospital easier. The family of a diabetic can be taught to use glucagon and this reduces the dangers of brain damage caused by prolonged hypoglycemic reactions. What other method to treat insulin shock has been studied?

25% solution of IV dextrose

---

72. Glucagon usually produces a slow, gradual, and smooth termination of coma as compared with the sudden awakening which follows administration of IV glucose. Response usually occurs within 5-20 minutes. The response to IV glucose is _____.

immediate

---

73. The usual does of glucagon is 0.5 to 1 mg. It is not effective orally so it is administered _____, _____, or _____.

IM, IV, or SubQ

---

74. IV glucose can be administered if the patient does not respond to glucagon therapy. What is the usual dosage of glucagon?

0.5 to 1 mg

75. Within what length of time would you expect the patient to respond?

5 to 20 minutes

76. When insulin shock has progressed to where the patient is unable to swallow, it is treated with _____.

IV injection of 25% dextrose or glucagon

77. Aside from insulin shock, other untoward effects caused by insulin can include a local urticarial swelling at the site of injection, local allergic reactions, and symptoms of electrolyte imbalance including edema and changes in vision. Continued injection into the same site can cause local tissue atrophy and absorption of the insulin is poor. This can be prevented by continually _____ the site of injection.

Varying or changing

78. Protamine Zinc Insulin is the most common offender in allergic reactions. These are sometimes treated with the antihistaminic drugs but it is more desirable to find an insulin to which the patient is not sensitive. This sensitivity is caused by the protein onto which the insulin is absorbed to increase its duration of action. There is no protein in rapid-acting _____ insulin so it could be an alternative choice of therapy.

Regular

79. The duration of action of Lente, Semilente, and Ultralente insulin is determined by particle size and contain no modifying protein, so they are less apt to produce an allergic reaction. Insulins containing a modifying protein are _____, _____ and _____.

NPH
Protamine Zinc
Globin Zinc

80. All of the insulins listed in Item 69 are given _____ and never _____.

SubQ
IV

81. The only insulin that can be given IV is _____.

Regular

82. This is done under what condition?

Emergency of diabetic coma

83. At what level would the blood sugar be when this is done?

Hyperglycemia (Above 160 mg%)

84. The diabetic coma is of gradual onset and the significant diagnostic differences from insulin shock are:

	Diabetic Coma	Insulin Shock
Skin	Dry & Flushed	Moist & Pale
Mouth	Dry	Drooling
Thirst	Intense	Absent
Hunger	Absent	Occasional
Vomiting	Common	Rare
Pain, Abdominal	Frequent	Absent

	Diabetic Coma	Insulin Shock
Respiration	Exaggerated	Normal or Shallow
Breath	Acetone Odor	Acetone Odor Rare
Blood Pressure	Low	Normal
Pulse	Weak & Rapid	Full & Bounding
Tremor	Absent	Frequent
Lab Findings		
Urine Sugar	High	Absent
Blood Sugar	High	Less than 60 mg%
Response to Treatment	Gradual	Rapid

85. The treatment for the diabetic coma is _____. IV Insulin

86. The treatment for insulin shock is _____. Carbohydrate Administration Administration

87. If a patient has low blood pressure, high urine and blood sugar, exaggerated breathing, acetone breath, dry mouth, and intensive thirst, you would suspect _____. Diabetic Coma

88. IV Insulin is used to treat _____. Diabetic Coma

89. The only insulin that can be given IV is _____. Regular

90.	Oranges, hard candy, chocolate, and soda pop are good sources for obtaining glucose quickly so could be used to treat _____.	Insulin Shock
91.	The blood sugar in insulin shock would be _____.	Less than 60 mg%

REVIEW QUESTIONS

1.	What is the primary consideration in treating diabetes mellitus?	Proper dietary management
2.	What is used as theprimary indicator in adjusting the dosage of insulin?	Blood & Urine Glucose
3.	What is the normal blood sugar level?	100 mg%
4.	Can Protamine Zinc Insulin be given IV?	No
5.	Which insulin has the most rapid onset of action?	Regular
6.	What is the duration of action of regular insulin?	6-8 hours
7.	How many cc would you give to administer a dose of 50 units of NPH U80?	5/8 cc
8.	How many cc would you give to administer a dose of 60 units of Regular U40?	1.5 cc
9.	What size and gauge of needle would you use?	1/2" x 28 gauge
10.	What are the indications for use of regular insulin?	Coma & for adjustment of dosage
11.	Name four insulins that could be used on a once-a-day basis.	NPH Lente Ultralente PZI

12. Is the patient hypoglycemic or hyperglycemic in insulin shock?

Hypoglycemic

13. The treatment of insulin shock is _____.

To give carbohydrate

---

92. The oral hypoglycemic agents used to treat diabetes mellitus are of two chemical classifications--the sulfanylureas (closely related to the sulfonamides) and the guanidine drugs. Below is a list of these drugs.

Sulfanylureas
Tolbutamide--ORINASE 500 mg
Chlorpropamide--DIABENESE 100 mg, 250 mg
Acetohexamide--DYMELOR 250 mg, 500 mg
Tolazamide--TOLINASE 100 mg, 250 mg

Guanidine
Phenformin--DBI 25 mg
Phenformin (timed disintegration) --DBI-TD 50 mg

The chemical classifications of the oral hypoglycemics are _____ and _____.

Sulfanylureas
Guanidine

---

93. Chemically Diabenese and Orinase belong to the _____.

Sulfanylureas

---

94. Chemically Phenformin is a _____ derivative.

Guanidine

---

95. Dymelor and Tolinase are chemically classified as _____.

Sulfanylureas

---

96. The sulfanylureas are believed to act by causing the beta-cells of the pancreas to release endogenous insulin. The trade names of the sulfanylureas are _____, _____, _____, and _____.

Diabenese
Dymelor
Orinase
Tolinase

---

97. The sulfanylureas are recommended for diabetes mellitus of the stable maturity-onset type. They act by _____.

Causing the beta-cells of the pancreas to release endogenous insulin

---

98. Insulin is a _____.

Hormone

---

99. Patients with brittle or juvenile diabetes usually do not respond well to the sulfanylureas but some show partial benefit from the guanidine drugs. The trade name for the guanidine drug on the market tday is _____.

DBI

---

100. DBI is available as the 25 mg tablet. It is also available in a 50 mg capsule. This is DBI-TD (TD means timed disintegration and is long-acting). DBI is the trade name for the guanidine derivative _____.

Phenformin

---

101. Phenformin (DBI and DBI-TD) can be used alone or in combination with insulin. The usual dose is one tablet or capsule daily in the morning. If higher doses are needed, a second capsule is added in the evening. The "TD" in DBI-TD stands for _____.

Timed-disintegration

---

102. Chemically DBI (Phenformin) is a _____ derivative.

Guanidine

---

103. The guanidine derivatives can sometimes be used with success for the brittle, juvenile diabetic while the sulfanylureas are recommended only for _____.

Stable adult diabetics

---

104. The mechanism of action of Phenformin (DBI) is unknown but it is believed in some way to affect the entry of glucose into the cell where it is metabolized. The usual dose of DBI is _____ _____.

25 mg daily or bid

---

105. As the dosage of DBI increases, so do the side effects. These side effects are generally of the gastro-intestinal nature and include anorexia, nausea, vomiting, diarrhea, dizziness and headache. The usual dose of DBI-TD is _____.

50 mg daily or bid

---

106. The guanidine derivatives (Phenformin--DBI) can be used with some success where the sulfanylureas fail. This is for the _____.

Brittle juvenile diabetic

---

107. Side effects to watch for with DBI are generally of the _____ nature.

Gastro-intestinal

---

108. The oral hypoglycemic agents are sometimes combined with insulin therapy to reduce the dosage of insulin. The insulin with the most rapid onset of action is _____.

Regular Insulin

---

109. Name two insulins which have a long duration of action.

NPH
Globin
PZI

---

110. The size and gauge of the needle suggested for giving insulin is _____.	1/2" x 28 gauge
111. Which insulin can be given IV?	Regular
112. Orinase (Tolbutamide) is a sulfanylurea derivative. The usual maintenance dose is 1 Gram (2 tablets) daily. The dosage is adjusted by urine sugar levels. Excess sugar in the urine is termed _____.	Glycosurea
113. Name three commercially available products that can be used to detect glycosurea.	Testape Clinistix Clinitest Tablets
114. The side effects of Orinase (Tolbutamide) therapy are almost insignificant but as with Phenformin there is some incidence of _____.	Gastro-intestinal Upset
115. Chlorpropamide (Diabenese) is supplied in 100 mg and 250 mg tablets. The usual dose is one tablet daily. It is a sulfanylurea derivative. Describe the mechanism of action.	To release endogenous insulin from the beta-cells of the pancreas
116. What is the usual dosage of Diabenese?	100 mg or 250 mg daily (1 tablet daily)
117. Compare this with the dosage of Orinase.	Diabenese 100-250 mg daily Orinase 1 Gram daily

118. Diabenese has a higher incidence of side effects than Orinase. These include dermatological side effects, jaundice due to liver involvement, and some central nervous system involvement. The main side effect with Orinase therapy is _____.

Gastro-intestinal Upset

---

119. The most noted side effects of Diabenese therapy are _____, _____ and _____.

Dermatological conditions
CNA Involvement
Jaundice due to liver involvement

---

120. The usual dose of Diabenese is _____.

100-250 mg daily (1 tablet daily)

---

121. Dymelor is the trade name of Acetohexamide, another sulfanylurea oral hypoglycemic agents. What is the trade name for each of the following?

Phenformin

Tolbutamide

Chlorpropamide

Acetohexamide

Tolazamide

Phenformin (DBI & DBI-TD)
Tolbutamide (Orinase)
Chlorpropamide (Diabenese)
Acetohexamide (Dymelor)
Tolazamide (Tolinase)

---

122. Dymelor is supplied in 250 mg and 500 mg tablets. The usual dosage is 500 mg to 1 Gram daily. This is comparable to what other drug already studied?

Orinase

---

123. The side effects of Dymelor therapy are also essentially the same as those of Orinase. This would be _____ _____.

Gastro-intestinal Upset

124. Like all sulfanylurea derivatives, Tolinase is effective in the mild to moderately-severe maturity-onset type of diabetes. Name the sulfanylurea derivatives.

Diabenese
Dymelor
Orinase
Tolinase

125. The guanidine derivatives are effective in some cases of juvenile, brittle diabetes. The guanidine derivatives currently on the market are _____ and _____.

DBI and DBI-TD

126. Tolinase has been found effective in approximately one-third of the failures where the other oral hypoglycemic agents have been used. An overdose would result in _____ blood sugar.

Low

127. One single daily dose of Tolinase (Tolazamide) is recommended. The dosage would be adjusted according to the patient's _____ and _____ sugar.

Urine
Blood

128. Tablets of Tolinase are supplied in 100 mg and 250 mg. This is recommended to be given _____ daily.

Once

129. What is the mechanism of action of the sulfanylurea derivatives?

To cause the release of endogenous insulin

130. What is the mechanism of action of the guanidine derivatives?

Effect the entry of glucose into the cell where it is metabolized

131. Complete the following chart:

Generic Name	Trade Name
Tolbutamide	Tolbutamide (Orinase)
	Diabenese — Chlorpropamide (Diabenese)
Tolazamide	Tolazamide (Tolinase)
Phenformin	Phenformin (DBI & DBI-TD)
	Dymelor — Acetohexamide (Dymelor)

REVIEW QUESTIONS

1. What is the main side effect of Orinase, DBI, Dymelor and Tolinase?

Gastro-intestinal Upset

2. The side effects of Diabenese are _____, _____ and _____.

Dermatological Involvement
CNA Involvement
Jaundice

3. The usual dose of Orinase is _____.

1 Gram daily (2 tablets)

4. To what chemical classification does Phenformin (DBI) belong?

Guanidine

5.	What is the mechanism of action of the sulfanylureas?	Release endogenous insulin from the beta-cells of the pancreas
6.	When the sulfanylureas indicated?	Stable adult diabetes
7.	When are the guanidine derivatives indicated?	Stable adult diabetes Brittle juvenile diabetes
8.	How are the dosages of the oral hypoglycemics adjusted?	By urine glucose and acetone determinations
9.	What is the usual dose of Diabenese?	100-250 mg daily (1 tablet daily)
10.	Name the sulfanylurea derivatives.	Diabenese Orinase Dymelor Tolinase
11.	What is the usual dose of Tolinase?	100-250 mg daily (1 tablet daily)

APPENDIX B

COPY OF THE TEST WITH KEY, SUGGESTED REVISIONS, AND DATA ON FREQUENCY OF CHOICE OF ANSWERS

Name_____
Date_____

Test (Diabetes mellitus)

Multiple Choice -- Place an "X" before the number of the best answer presented.

		Frequency of Choice of Answers	
		Pre-test	Post-test
1.	Diabetes mellitus results from a malfunction of the		
	_____a. Adrenal gland	11	0
	_____b. Kidneys	2	0
	__X__c. Pancreas	59	73
	_____d. Anterior pituitary gland	2	1
2.	Insulin is involved in the metabolism of		
	_____a. Fats	1	0
	_____b. Protein	0	0
	__X__c. Carbohydrates	70	74
	_____c. Fatty acids	3	0
3.	The basic compound of body metabolism utilized to produce energy is		
	__X__a. Glucose	64	71
	_____b. A fatty acid	3	3
	_____c. An amino acid	3	0
	_____d. Dextrose	4	0
4.	Insulin is produced by one		
	_____a. Alpha cells	18	0
	_____b. Body metabolism	12	0
	_____c. Adrenal gland	15	0
	__X__d. Beta cells	29	74
5.	Normal blood glucose is		
	_____a. 60 mg/100 cc	57	7
	__X__b. 100 mg/100 cc	13	67
	_____c. 160 mg/100 cc	3	0
	_____d. 100 mg/10 cc	1	0

Name_____

6.	60 mg/100 cc can also be designated as		
	X a. 60 mg%	44	71
	___ b. 60 mg/liter	6	0
	___ c. 60 mg/100 mg	11	2
	___ d. None of these (100 mg/1000 cc)*	13	1
7.	Blood glucose ranging from 60 mg/100 cc to 160 mg/100 cc is		
	___ a. Definitely indicative of diabetes	23	5
	___ b. A laboratory error (indicative of latent diabetes)*	0	0
	X c. The normal range	47	68
	___ d. Impossible	4	1
8.	A blood sugar level of 180 mg/100 is indicative of		
	X a. Hyperglycemia	64	74
	___ b. Glycosuria	6	0
	___ c. Hypoglycemia	3	0
	___ d. Tetany	1	0
9.	The key end-product of glucose metabolism which must be present to regenerate the cycle is		
	___ a. Aminoacetic acid	21	2
	___ b. Acetyl Coenzyme A	8	0
	___ c. Pyruvic Acid	24	1
	X d. Oxaloacetic Acid	21	71
10.	When glucose is not available for metabolism, what is used to produce energy?		
	X a. Fatty acids	24	64
	___ b. Amino acids	9	2
	___ c. Carbohydrates	24	7
	___ d. Protein	17	1
11.	Acetest tablets detect _____ in the urine.		
	___ a. Acetic acid		
	X b. Acetone		
	X c. Acetoacetic acid		
	___ d. Acetate		

---

* Suggested revisions

Name_____

12.	Clinitest tablets are used to detect _____ in the urine.		
	____a. Acetone	2	0
	____b. Acetoacetic acid (sugars)*	0	0
	__X__c. Glucose	71	74
	____d. Betahydroxybutyric acid (dextrose)*	1	0
13.	What is the primary indicator in adjusting the dosage of insulin?		
	____a. Blood glucose	18	1
	____b. Urine glucose	16	3
	____c. Urine acetone and glucose	12	5
	__X__d. Blood and urine glucose	28	65
14.	In dietary management of diabetes mellitus, the intake of _____ is probably the most important.		
	__X__a. Carbohydrates	44	66
	____b. Fats	3	1
	____c. Proteins	1	0
	____d. All of these	26	7
15.	The most rapid-acting insulin is		
	____a. Protamine Zinc	9	1
	____b. NPH	29	1
	____c. Lente	12	0
	__X__d. Regular	24	72
16.	Which of the following can be administered intravenously?		
	__X__a. Regular Insulin	16	69
	____b. NPH Insulin	14	0
	____c. Globin Insulin	33	4
	____d. Ultralente Insulin	11	1
17.	The duration of action of one dose of regular insulin is about		
	____a. 2-4 hours	19	3
	____b. 3-5 hours	15	6
	__X__c. 6-8 hours	12	65
	____d. 8-10 hours	28	0
18.	Which insulin would be used to treat diabetic coma?		
	____a. NPH Insulin	21	3
	____b. Semilente Insulin	15	0
	__X__c. Regular Insulin	20	68
	____d. Protamine Zinc Insulin	18	3

---

* Suggested revisions

Name_____

19.	What would you use to treat insulin shock?		
	____a. Insulin	2	1
	__X__b. Carbohydrate	47	68
	____c. Orinase	5	0
	____d. None of these	20	5
20.	What size needle would you select for administering insulin?		
	____a. 20 x 1/2"	24	2
	____b. 26 x 3/4"	16	1
	__X__c. 28 x 1/2"	32	71
	____d. 28 x 3/4"	2	0
21.	Normally insulin is given		
	____a. Intramuscularly	14	3
	____b. Intravenously	6	0
	__X__c. Subcutaneously	51	71
	____d. Intradermally	3	0
22.	To give 50 units of PZI U40, you would give		
	____a. 4/5 cc	13	4
	____b. 5/8 cc	10	4
	____c. 1 1/5 cc	17	7
	__X__d. 1 1/4 cc	34	59
23.	One single daily dose would not maintain a diabetic using		
	__X__a. Regular Insulin	43	68
	____b. NPH Insulin	10	2
	____c. Protamine Zinc Insulin	10	2
	____d. Lente Insulin	11	2
24.	When a single daily dose is given what time of day is it given? (of insulin)		
	____a. At bedtime	1	0
	____b. Before lunch (Just after breakfast)*	0	0
	____c. About 10 AM	9	1
	__X__d. Before breakfast	64	73
25.	In diabetic coma, the blood sugar would be		
	__X__a. Higher than normal	46	55
	____b. Lower than normal	26	18
	____c. 60 mg/100 cc	0	1
	____d. 100 mg/100 cc	2	0

---

* Suggested revisions

Name_____

26.	An injection of 25% dextrose might be used to treat		
	_____a. Diabetic coma	15	12
	_____b. Insulin reaction	17	5
	__X__c. Insulin shock	41	56
	_____d. Hyperglycemia	1	1
27.	Phenformin is		
	_____a. An oral insulin	21	4
	__X__b. A guanidine derivative	8	58
	_____c. A sulfanylurea derivative	10	6
	_____d. The generic name of Orinase	35	6
28.	Which of the following dosages would you question?		
	_____a. Orinase 1 Gram daily	22	4
	_____b. NPH Insulin 80 units daily	20	20
	__X__c. DBI-TD 500 mg daily	11	36
	_____d. Regular Insulin 20 units, NPH Insulin 45 units daily	21	14
29.	The most outstanding side effect of DBI therapy is		
	__X__a. Gastrointestinal involvement	14	51
	_____b. Liver Involvement	24	9
	_____c. Frequent hypoglycemia	21	4
	_____d. Dermatological manifestations	15	10
30.	Patients with brittle or juvenile diabetes would preferably be treated with		
	_____a. Orinase	19	9
	_____b. Dymelor	10	4
	_____c. Diabenese	19	8
	__X__d. DBI	26	53
31.	Stable, adult diabetics could possibly be managed with		
	_____a. Orinase	22	9
	_____b. Tolinase	2	0
	_____c. Diabenese	7	1
	__X__d. All of these	43	64
32.	The usual dose of Orinase is		
	_____a. 1 Gram q other day	9	0
	__X__b. 1 Gram daily	49	71
	_____c. 1 Gram tid	15	2
	_____d. 1 Gram qid	1	1

Name_____

33.	The mechanism of action of the sulfanylureas is to		
	_____a. Release insulin intracellularly	6	6
	_____b. Release insulin from the alpha-cells	18	0
	__X__c. Release insulin from the beta-cells	21	62
	_____d. Stimulate the adrenals to produce insulin	29	6
34.	To test for urine glucose, you might use		
	_____a. Ketostix	0	0
	__X__b. Clinitest	74	72
	_____c. Acetest	0	2
	_____d. Ictotest	0	0
35.	Phenformin is the generic name for		
	_____a. Orinase	47	9
	_____b. Tolinase	6	4
	__X__c. DBI	9	57
	_____d. Diabenese	12	4
36.	Tolbutamide is the generic name for		
	_____a. Tolinase	51	27
	__X__b. Orinase	6	36
	_____c. Dymelor	5	7
	_____d. Diabenese	12	4
37.	A dose of Dymelor 500 mg daily is		
	_____a. Questionable	29	10
	__X__b. Correct	29	50
	_____c. An overdose	8	12
	_____d. Incorrect	8	2
38.	It is recommended that Tolinase be given		
	__X__a. 1 x daily	22	31
	_____b. 2 x daily	24	37
	_____c. 3 x daily	24	4
	_____d. 4 x daily	4	2

Name_____

*39. Glucagon can be used to treat
_____a. Hyperglycemia
__X__b. Hypoglycemia
_____c. Diabetic Coma
_____d. Insulin Sensitivity

*40. The usual dose of glucagon is
_____a. 0.05 to 1.0 mg
_____b. 0.5 to 10 mg
__X__c. 0.5 to 1.0 mg
_____d. 5 to 10 mg

---

* These questions are added with the revisions suggested to cover the section on glucagon.