

THE CONSTRUCTION OF AN OBJECTIVE ACHIEVEMENT TEST
IN BIOLOGY FOR HIGH SCHOOL

A THESIS

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TEACHERS COLLEGE OF EMPORIA IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE

BY

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CHAPTER I

CONSTRUCTION OF TESTS

Purpose

The field of testing has been productive of many tests in recent years, for the measurement of both intelligence and achievement. It is commonly stated that there are fewer reliable achievement tests on the secondary level than on the elementary school level. The writer has chosen the field of Biology in the building of this group of tests for several reasons. First, his teaching experience for a number of years has been in this field. Second, the number of standardized tests in Biology is more limited than in many other subjects. Third, it was felt that a group of tests suitable primarily to Kansas conditions and Kansas teaching practice would be timely and helpful. With these reasons in mind, the writer has undertaken the construction of these tests. Future developments may indicate the need of further refinement, but the present forms have proved their merit in actual testing programs, both in classroom testing and in scholarship tests.

Method of Procedure

This series of tests consists of three groups, each group being made up of two forms. The groups are indicated in this study as Test I, Test II, and Test III. The equivalent forms of each group are indicated as Form A and

Form B. The arrangement of the series carries out the following relationships:

Test I: Forms A and B. These forms were designed to be given upon the completion of structural animal biology. Items concerning man and plant life are included only as environmental factors.

Test II: Forms A and B. These forms were designed to be given upon the completion of that portion of Biology relating especially to man, and his general relationships to animals and plants as environmental factors.

Test III: Forms A and B. These forms were designed to be given upon the completion of that portion of Biology relating especially to the structure of plants and their relations to other organisms as environmental factors.

In constructing the tests, the A forms of Tests I and II were built first, for use in the Every Pupil Scholarship Tests promoted by the Bureau of Educational Measurements of the Kansas State Teachers College of Emporia. They were used December 10, 1931, and March 25, 1932, respectively. Later, when the decision was made to use these as the basis for a thesis study, the B forms of Tests I and II were built. In constructing these, the objective was the selection of equivalent items, both as to content and as to difficul-

ty, with the hope that the B forms would equal the A forms in reliability as measuring instruments. The reliability correlations, Page 45, show the results. The B forms of Tests I and II were used in the Every Pupil Scholarship Tests of January 10, 1933, and April 5, 1933, respectively.

Test III, Forms A and B, was constructed from a large group of sample items, each test being selected by chance-half grouping. After use with a trial group, the items were rearranged and the test forms built with 80 items each. Later 20 items were added to each test for the purpose of raising the reliability. These items were selected in the same manner as the earlier body of the test.

The general policy of selecting the items from time to time during actual classroom work was followed in constructing these tests. The majority of the items were based on Biology books used as text or reference, actually considered at some time in the classroom. Some of the items were suggested by pupils in reports taken from current magazines and newspapers. Thus, the items were compiled as a result of the writer's experience over a period of years, and represent actual pupil participation.

In each case, when the tests were first compiled, they were given to selected pupils for trial. These pupils ranged from average to superior in their classroom work in Biology. In this manner, items that seemed poorly worded or invalid were detected and subjected to revision or elimination. The tests were then given to an entire class, the

results studied, and further refinement made. The final forms were then drafted.

In addition to criticism and use by pupils, the tests were also criticised by nine Biology instructors in Kansas high schools. They were: Eleanor Sirpless, Emporia; Frances Hutchison, and Pauline Eagle of El Dorado; James H. Moyer, Manhattan; Anna Belle Costin and Roy F. Metcalf, Wichita North; Carl Barnhart, Wichita East; Carl S. Brandner, Holton; E. R. Sheldon, Americus. In preparing the final forms for use in the Every Pupil Scholarship Tests conducted by the Bureau of Educational Measurements, further refinement was made as an outgrowth of suggestions received from Dr. John Breukelman, Department of Biology, and Dr. H. E. Schrammel, Director of Bureau of Educational Measurements. Test III was lengthened by the addition of twenty items with seemingly good results, as explained later in this study.

About 500 copies of each set were mimeographed and used in six representative Kansas high schools. --- Holton, Manhattan, El Dorado, Wichita North, Americus, and Emporia. Between 200 and 400 usable papers of each set were considered in making tabulations. Tabulations of Every Pupil Scholarship Test papers were also included.

Types of Questions

In the construction of the tests, four types of ques-

tions were used: 1. Multiple-response; 2. matching; 3. Unrelated word; 4. True-false. The written recall type of test was not used in order to eliminate writing and the possible introduction of duplicate answers.

The multiple-response items contain an average of about fifteen words each, and usually have five responses. Practically all responses have some degree of plausibility. This is in accordance with recognized specifications of test-building.

Matching tests are composed of ten to twenty-five pairs of statements, with several additional choices given to lessen the possibility of guessing. The elements in the second column from which selection is to be made, have been arranged in alphabetical order, a system which enables the student to find the proper statement quickly.

The unrelated-word tests usually contain five possible, numbered choices, four of which have distinct similarity. The number of the word chosen, unrelated to the others, is placed in the parenthesis before the item.

The true-false statements are, for the most part, simple direct statements. Many of them require but one line. True statements are marked plus (+) and the false statements, minus (-). This arrangement tends to increase both the speed of test-solving and the ease of comprehension on the part of the pupil.

Complete objectivity is attempted by constructing the

tests so that all answers are registered either by numerals or plus or minus (+/-) placed in the parenthesis before the number of the item. When completed, these appear as a column the length of the sheet, and at the left-hand side of the page.

No attempt was made to arrange the items in order of difficulty in the experimental forms. The error study shows a heterogeneous relationship between items in this respect. Opinion differs with respect to the desirability of arranging the items of the test in order of difficulty, especially when sufficient time is allowed pupils to complete their work. Table I indicates the number of each type of items used in the three tests. The items are balanced in amount among the various types of tests used. This benefits those pupils who believe they can answer one type of question better than another.

TABLE I
NUMBER AND TYPES OF TEST ITEMS

Type of Item	Test I		Test II		Test III	
	A	B	A	B	A	B
Total Items	100	100	110	110	100	100
True-false	35	38	33	33	30	30
Multiple Response	36	38	35	35	35	35
Matching	29	24	22	22	20	20
Unrelated-word	--	--	20	20	15	15

Read table thus: True-false items in Test I, Form A, number 35; in Form B, 38. In Test II, Form A, the items number 33; in Form B, 33, etc.

No comparison was made between the scores of this study and pupil age, or mental rating. The tests were designed for use with tenth grade pupils, and scores used were obtained mostly from pupils of that grade, although the scores of all pupils enrolled in Biology classes were used. It was presumed that the pupils would conform to the normal curve of probability in intelligence for pupils of tenth grade level.

CHAPTER II

VALIDATION OF TESTS

Importance and Meaning

Validity is defined commonly as soundness, strength, or justness. With respect to test construction, it is commonly defined as the extent to which a test measures what it is supposed to measure. The concept of soundness or justness emphasizes the trueness between the content of the measuring instrument and the content of the field it is supposed to measure. The validity, therefore, is the most important point for consideration in the construction of a test. There are many elements in validation that cannot be treated statistically. Usually validity is specific rather than general in nature.

Criteria for the validating of the tests of this study include the following:

1. A study of the content of Biology textbooks, including the balance between the various units of subject matter.
2. Comparative criteria, including studies of somewhat similar nature by other investigators.
3. A study of the content of courses of study.
4. A determination of the social utility in the terms of economic factors, health, enjoyment of life, and so on.
5. The judgments of teachers using and examining the tests.
6. Correlation with teachers' marks. Correlation values

ranging from .50 to .80 are generally considered significant.

Analysis of Textbooks

A study of five texts used in high school Biology was made to determine the distribution of content and approximate the amount of space allotted to various biological units. The texts¹ were: Smallwood, W. M., and Others, New General Biology; Gruenberg, Benjamin C., Elementary Biology; Moon, Truman J., Biology for Beginners; Hunter, G. W., New Essentials of Biology; Meier, W. H. D., Essentials of Biology.

In the intensive study made of these five texts, it was found that all material concerned with animal life (including man) , and phases of general Biology stressing facts concerning animal life not considered under any special unit, amounted to 1798 pages. The units considered were various biological divisions such as Crustacea, Orthoptera, Lepidoptera, Aves, and so forth. The number of pages of subject matter on each unit was totaled for the five books. The unit page totals were added, giving the figure 1798. The unit per cent was obtained by dividing the number of pages of each unit by the total number. Table II summarizes the totals of the principal units by page and per cent of total content concerning animal life. Table III summarizes in like manner the total content con-

cerning plant life. Table II was compiled first to validate Test I, Form A. It was also used for Test II. Table III was compiled to validate Test III and the entire series with respect to both animal and plant content. The

TABLE II
DISTRIBUTION OF ANIMAL BIOLOGICAL UNITS
IN FIVE TEXTBOOKS

Name of Unit	No. Pages	Percent
Animal Biology:		
Aves (Wild and Tame Birds)	136.89	7.61 %
Pisces (All Fish)	57.83	3.21 %
Batrachians (Frog, Toad, Salamander)	54.56	3.13 %
Crustacea (Lobster, Crayfish, Shrimp, Crab, etc.)	49.82	2.77 %
Mammalia (General Facts)	45.50	2.53 %
Orthoptera (Locust, Cricket, etc.)	40.07	2.23 %
Protozoa (Total)	32.16	1.78 %
Reptilia (Turtle, Snake, Lizard, etc.)	28.38	1.57 %
Insecta (General Facts)	26.96	1.50 %
Lepidoptera (Moths)	26.50	1.47 %
Hymenoptera (Bees)	25.50	1.42 %
Lepidoptera (Butterflies)	21.78	1.21 %
Diptera (Mosquitoes)	19.83	1.10 %
Diptera (House fly)	18.16	1.01 %
Annelida (Earthworms)	18.24	1.01 %
Coelenterata (Hydra, Jellyfish, etc.)	16.46	.92 %
Ungulata (Tame Cattle, Horses, etc.)	15.82	.88 %
Ungulata (Wild Deer, Bison, etc.)	15.03	.83 %
All Other Animals	136.48	7.59 %
Human:		
Man - Structural	276.36	15.37 %
Man - Health, Food, etc.	233.00	12.96 %
General (Facts pertaining to all animals equally well)	502.67	27.95 %
Total	1798.00	100.00 %

Read table thus: The amount of space devoted to Aves totals 136.89 pages in the five texts examined, or 7.61 % of the total pages concerning animal biology.

TABLE III
DISTRIBUTION OF PLANT BIOLOGICAL UNITS
IN FIVE TEXTBOOKS

Name of Unit	No. Pages	Percent
Plant Biology:		
Life Function - Adaptations.	29.0	3.14 %
Composition of Living Things, Chem. etc.	72.5	7.88 %
Photosynthesis - Food Manufacture.	47.5	5.14 %
General - Structural and interrelations.	127.5	13.83 %
General - Mendel, Burbank, Plant improvement.	38.5	4.17 %
Bacteria.	66.0	7.63 %
Fungi - Rust, Smut, etc.	47.5	5.15 %
Algae - Spirogyra, etc.	1.0	.10 %
Bryophytes - Moss, Liverworts.	8.3	.90 %
Pteridophytes - Fern, Horsetails.	14.0	1.52 %
Gymnosperms - Pines, Other Evergreens	10.0	1.08 %
Angiosperms - Seed plants discussed as general class.	8.0	.86 %
Roots.	54.0	5.84 %
Stems.	55.0	5.97 %
Leaves.	58.0	6.29 %
Flowers.	71.5	7.76 %
Fruits and Seeds.	84.0	9.11 %
Economic Uses - Food, herbs, fiber, pulp, etc.	41.5	4.50 %
Forestry.	87.5	9.50 %
Total	921.3	100.00 %

Read table thus; Under Plant Biology, life functions and adaptations total 29 pages in the five texts examined, or 3.14 % of the total pages on plant life.

percentage of each item was compiled separately in the tables. The total number of pages in both tables amounted to 2719. In this count of pages, neither the appendix nor the bibliography was included for any of the books.

The inspection of the Biology texts, and a summary of teaching practice, which would be based on these texts to a considerable extent, indicate that high school Biology is commonly divided into three general divisions. These are:

1. General Animal Biology, including structure, life history, economic value and interrelationships due to environment. Little attention is commonly given to plant life or to man, except as environmental factors.
2. Human Biology, including health, structure, and function of the various parts and organs of the human body, and environmental interrelationships of man with both plants and animals. Here the comparative and economic relationships of man with the lower animals seems to be emphasized to a greater degree than are the relationships of man with plant life.
3. Plant Biology, including structure, life history, economic value, and interrelationships of man with general animal life. Little attention is commonly given to animal life or to man, except as environmental factors.

In accordance with these facts, it was decided to formulate three sets of tests, emphasizing respectively, General Animal Biology, Human Biology, and Plant Biology.

Each set was to be composed of equivalent A and B forms.

From Tables II and III, the various units were consolidated under four heads, by pages and percentages. These data are found in Table IV. It will be noted that the combined subject matter of the five textbooks is distributed thus: Animal Biology, 28.90 %; Human Biology, 18.74 %; General Biology, 18.48 %; and Plant Biology, 33.88 %. In building the tests with which this study deals, the writer used the foregoing percentages as partial guides for determining the relative proportion of items for each of the major divisions of subject matter.

TABLE IV
SUMMARY OF TEXTBOOK MATERIAL BY PAGES AND PERCENTAGES

Division.	Pages.	Percent.
Animal Biology	785.97	28.90 %
Human Biology	509.36	18.74 %
General Biology	502.67	18.48 %
Plant Biology	921.30	33.88 %
Total	2719.30	100.00 %

Read table thus: In the five textbooks analyzed, the space devoted to Animal Biology totaled 785.97 pages, or 28.9 % of the total.

Comparison of Test Content with Textbook Content

A study was next made to discover to what extent the distribution of test items of the combined forms of the tests, agrees with the textbook criterion, namely the num-

ber of pages devoted to each of the four major divisions of Biology. These data are tabulated in Table V. It will be noted that a very close relationship exists between the per cent of space devoted to the divisions by the texts, and the per cent of items devoted to each division of the test.

TABLE V

COMPARISON OF THE DISTRIBUTION OF TEST ITEMS WITH THE DISTRIBUTION OF SUBJECT MATTER BY TEXTBOOKS

Divisions of Biology	Test Percentage	Text Percentage
Animal Biology	29.84 %	28.90 %
Human Biology	19.20 %	18.74 %
General Biology	17.42 %	18.48 %
Plant Biology	33.54 %	33.88 %
Total	100.00 %	100.00 %

Read table thus: The Animal Biology content of the tests amounts to 29.84 % of the whole, as compared with 28.9 % in the analysis of textbooks.

In addition to the balance of subject matter for the entire series, an attempt was made to preserve a proper balance and emphasis within each group of tests. This emphasis was to be: Test I, General Animal Biology; Test II, Human Biology; Test III, Plant Biology. The material in Table II was condensed under the headings, Animal Biology, Human Biology, and General Biology, to determine the proportion of each. It will be observed from Table VI

that 43.72 % of the total material of this type is devoted to Animal Biology, 28.33 % to Human Biology, 27.95 % to General Biology. Two factors influenced the writer in the distribution of the test items, first, the distribution of content in the text books, and second, the common practice of emphasizing a study of Animal Biology, other than Human Biology, during the earlier portion of the year's work. The study of Human Biology commonly follows, with the study of Plant Biology concluding the course.

TABLE VI

DISTRIBUTION OF ANIMAL BIOLOGICAL MATERIAL
ACCORDING TO ANIMAL BIOLOGY, HUMAN BIOLOGY
AND GENERAL BIOLOGY.

Division of Biology	Pages	Per Cent
Animal Biology	785.97	43.72 %
Human Biology	509.36	28.33 %
General Biology	502.67	27.95 %
Total	1798.00	100.00 %

Read table thus: Of the total number of pages devoted to Biology of Animals, 785.97 pages, or 43.72 % concern other animals than man.

In view of these facts, Forms A and B of Test I were built with a greater proportion of items concerning Animal Biology and a lesser proportion of the other phases. Forms A and B of Test II likewise were built with a predominance of items on Human Biology. A greater

number of items on Plant Biology was included because of the economic relation of Plant Biology to man.

The content of Forms A and B of Test III places basic emphasis on Plant Biology. The data in Table III were used as a basis for this test, which covers fully the entire range of plant life and plant interrelationships.

In Table VII are listed the data which show the balance between the biological divisions within each series of tests, and also for the entire six forms. In the two columns at the right of the table, are the total number of items composing each division of the test, and the percentage of each. The test items, were distributed as follows: Animal Biology, 185 items, or 29.84 %; Human Biology, 119 items, or 19.20 %; General Biology, 108 items, or 17.42 %; and Plant Biology, 208 items, or 33.54 %.

Further inspection of Table VII will show that the general specifications for the distribution of test items among the various divisions of subject matter has been maintained not only for the entire series of tests, but also for each test of the group. The 137 items of Animal Biology comprising Test I amount to 68.5 % of the whole, and indicate the special emphasis assigned to this part of the content. The fact that General Biology ranks second in this test, making up 25 % of the whole, shows the emphasis upon general biological facts necessary in the successful introduction of the subject.

TABLE VII

SUMMARY OF TYPE OF TEST ITEMS OF ENTIRE SERIES OF TESTS

Division of Biology	Test I A and B Combined	Test II A and B Combined	Test III A and B Combined	Test I-II-III	
				Total Items	Average Per Cent
Animal Biology	137 Items 68.5 %	43 Items 19.54 %	5 Items 2.5 %	185	29.84 %
Human Biology	11 Items 5.5 %	99 Items 45.00 %	9 Items 4.5 %	119	19.20 %
General Biology	50 Items 25 %	42 Items 19.09 %	16 Items 8 %	108	17.42 %
Plant Biology	2 Items 1.00 %	36 Items 16.37 %	170 Items 85.00 %	208	33.54 %
Total Items	200.	220.	200.	620	
Total Per Cents	100. %	100. %	100. %		100. %

Read table thus: Forms A and B of Test I, when combined, contain 137 items on Animal Biology, amounting to 68.5 % of Test I; Test II, 43 items on Animal Biology, amounting to 19.54 % of Test II; Test III, 5 items on Animal Biology, amounting to 2.5 % of Test III. Of the total items included in the three sets of tests, 185 or 30% of the entire group, are based on Animal Biology.

Specifications for Test II call for emphasis upon Human Biology. Table VII shows that there are 99 items with direct bearing upon the human side of the subject matter. Because of the interrelations between plants and animals with respect to man, there is an increase in the proportion of items covering plant and animal life used, animal life making up 19.54 % of Test II and plant life, 16.37 %.

Test III is devoted largely to plant life, 170 items, or 85 % of the total number being based upon that phase of the work. The ratio of items covering plant life to those based upon animal life is 208 to 304. This is the ratio which is necessary to maintain the balance among the four divisions as originally planned. Thus, the analysis of the three tests of the series, taken separately, shows that the balance originally designed for the entire group has been maintained to a high degree.

Comparative Criteria

In addition to textbooks in Biology, it was felt that there are other basic sources of material useful in determining validity. The three used here include, first, a study of the biological material found in current magazines; second, a comparison with a standardized informational test in Biology and, third, a consideration of several General Science Tests with respect to their content devoted to animal and plant life.

The first of these concerned a comparison made by Hill,² of the biological content of current literature and the Kansas Course of Study. This material was used as a basis for comparing the tests of the present study with current literature content. Hill concluded that if pupils are taught only that which is contained in the Kansas Course of Study for high schools, they are prepared to read easily about 89 % of the Biology found in current magazines.

His analysis of a large and representative group of magazine articles indicated a somewhat one-sided distribution among the various phases of biological content. Table VIII shows in parallel columns the percentage distribution of magazine content, textbook content as listed

2. Harry A. Hill. "A Comparison between the Biological Content of Certain Periodical Literature and the Kansas High School Course of Study". Thesis Study, University of Kansas, Lawrence.

in Table IV, and the test items of this study. It will be seen that the test parallels much more closely the textbook content than the magazine content, but that considerable agreement, nevertheless, exists between magazine content and either of the others.

TABLE VIII

COMPARISON OF THE DISTRIBUTION OF MAGAZINE CONTENT, TEXTBOOK CONTENT, AND TEST ITEMS

Divisions of Biology	Magazine Content	Textbook Content	Test Items
Animal Biology	52.40 %	28.90 %	29.84 %
Human Biology	28.82 %	18.74 %	19.20 %
General Biology	12.69 %	18.48 %	17.42 %
Plant Biology	6.09 %	33.88 %	33.54 %
Total	100.00 %	100.00 %	100.00 %

Read table thus: The ratio of Animal Biology between the Magazine Content, Textbook Content, and Test Items, is 52.4 % : 28.9 % : 29.84 %.

The following conclusions may be drawn from the data of Table VIII:

1. Magazines tend to cater to human interest in animals rather than to a well balanced biological "diet".
2. The textbooks contain a better balanced ratio between plants and animals.
3. The tests of this study stress plant biology as much as animal biology, and emphasize a phase of the subject not commonly obtained in current reading; namely, the

information obtained from the magazine study should be regarded as sufficient reason for additional emphasis upon instruction regarding plant life.

A short comparison was made between the content of the tests of this study and the Coopriider³ Biology Information Exercises. The percentage distribution for both are listed in Table IX. It will be noted that there exists considerable agreement between these two sets of tests in this respect.

TABLE IX

COMPARISON BETWEEN DISTRIBUTION OF TEST ITEMS ACCORDING TO CONTENT OF COOPRIDER BIOLOGY INFORMATION EXERCISES AND STUDY TESTS IN BIOLOGY

Divisions of Biology	Coopriider Information Ex.	Study Test in Biology
Animal Biology	38 %	29.84 %
Human Biology	18 %	19.20 %
General Biology	17 %	17.42 %
Plant Biology	27 %	33.54 %
Total	100 %	100.00 %

Read table thus: On animal biological content, the tests of this study compare with Coopriider's Information Exercises in the ratio of 29.84 % : 38 %.

³. J. L. Coopriider. "Information Exercises in Biology", SCHOOL SCIENCE AND MATHEMATICS, Vol. XXV, No. 8. (November, 1925) pp. 807 - 813.

A study was also made of five standardized General Science⁴ tests with reference to biological content. They were the Powers General Science Test, Iowa High School Content Examination by Ruch and Stoddard, General Science Test by Ruch and Popence, General Science Test by Toops, and the General Science Scale by Dvorak. Table X shows the percentage distribution among the four major divisions in comparison with the distribution of items in the several forms of the present study.

TABLE X

GENERAL SCIENCE TESTS COMPARED WITH THE
TEST OF THIS STUDY

Divisions of Biology	General Science	Study Test in Biology
Animal Biology	23.7 %	29.84 %
Human Biology	27.3 %	19.20 %
General Biology	17.1 %	17.42 %
Plant Biology	31.6 %	33.54 %
Total	100.0 %	100.00 %

Read table thus: The per cent of animal biological content in the group of General Science tests is 23.7 % compared with 29.84 % in test used in this study.

While the purpose of the study was to ascertain the amount of biological information which these authors expected pupils of the eighth and ninth grades to possess, data were also available to determine the balance between animal and plant life, and man. It was found that the

4. See Appendix

distribution of the content compared favorably with the distribution in the other investigations cited. Items concerning the human phase of the subject were somewhat in excess of the others, but this is in keeping with the objectives of General Science.

Content of Courses of Study

As another measure of the validity of the tests of this study, an examination was made of the courses of study of Kansas, of Missouri, and of the Denver Public Schools. The purpose was to determine the nature and extent of biological units considered. The Kansas course of study was used as a basis upon which to formulate the method of procedure for two reasons: first, because it is formulated for the immediate territory for which these tests are being constructed; and second, because it divides the year's course into a greater number of teaching units. These units are units of Biology content, as, for example, Mosquito, Mollusk, Birds, Roots, Flowers, Forestry, and Health. The material taken from the three sources was tallied on work-sheets and summarized under the four general divisions of Animal, Human, General, and Plant Biology. The criteria were considered along with that secured by the study of the various textbooks, in constructing the tests.

While the units from the three sources above named were being summarized several interesting points were observed. Seven units of subject matter appeared in only one of the three courses of study; twenty-four units of subject matter appeared in only two, and twenty-seven units of subject matter appeared in all three courses. There seemed to be greater agreement on items concerning plant life than on those concerning animal life, sixteen of the twenty-seven appearing in all three courses, dealing with plants. Items about human structure and function appeared with about equal frequency in all three courses. The Kansas and Missouri courses were in high agreement concerning units of animal life.

When the tallies of the various units were grouped under the four general classifications, the results were: Animal, 47; Human, 45; General, (applying more or less to both plants and animals), 19; and Plant Life, 37. These indicate about equal emphasis upon Animal, Human, and Plant Biology in the three courses inspected.

Table XI shows the percentage distribution of these units, compared with the textbook distribution and test item distribution. Here again it will be noted that marked agreement exists. Based on this consideration, two points are evident: first, that courses of study tend to follow the same general trend that textbooks in Biology follow; and second, that this series of tests under

consideration tend to follow the same pattern.

TABLE XI

COMPARISON OF DISTRIBUTION OF TEST ITEMS
ACCORDING TO BIOLOGICAL DIVISIONS AND
DISTRIBUTION OF UNITS OF COURSES OF
STUDY

Divisions of Biology	Test Study Per Cent	Courses of Study	Textbook Per Cent
Animal Biology	29.84 %	31.76 %	28.90 %
Human Biology	19.20 %	30.40 %	18.74 %
General Biology	17.42 %	12.84 %	18.48 %
Plant Biology	33.54 %	25.00 %	33.88 %
Total	100.00 %	100.00 %	100.00 %

Read table thus: 29.84 % of the Test Study is Animal Biology, compared with 31.76 % found in the examination of courses of study, and 28.9 % found in the examination of textbooks on Biology.

Social Utility of the Test

The social utility value of tests depends upon the nature of the subject matter. The lack of agreement concerning the content of the secondary school course of study in Biology, and the difference in emphasis placed upon the several divisions of the subject, tend to confuse utility values. The chief difficulty lies in the determination of the ratio between factual information which should be taught, and the social content such as health, economic factors, enjoyment of life, and so forth. The

controversy centers about the question of how much of the "what" should be emphasized, or how much of the "why" and "how" should be included.

The tests were divided as to utility into three groups in order to attempt to determine the appropriate distribution of purely informational items, and those having a social utility value. The data given in Table XII show a slightly larger per cent of items purely informational but the difference is relatively small.

TABLE XII
SOCIAL UTILITY ITEMS COMPARED WITH
INFORMATIONAL ITEMS

Utility Value	Test I		Test II		Test III	
	A	B	A	B	A	B
Informational	52	54	65	69	58	60
Mixed	9	8	3	3	5	5
Social	39	38	42	38	37	35
Total	100	100	110	110	100	100

Read table thus: In Test I, Form A, 52 items were informational, 9 items were mixed, and 39 had social utility value.

Until a more nearly unified agreement upon biological content and pedagogical procedure is formulated, it would seem desirable to stress the informational content on the secondary level, to a somewhat greater degree than the social.

Judgments of Teachers

Judgment of teachers concerning testing items and the apparent value of tests are likely to vary to the same degree that the judgments of any group will vary in respect to factors which are more or less subjective. However the judgments of experienced teachers concerning a test must necessarily bear some weight in determining the validity of the instrument. Teachers' judgments are often pooled concerning the various items included in a test at the time it is being constructed. This method was not used in the selection of items for this test, except by way of refinement after the main body of the test had been built.

After the tests had been administered in the several schools, a method was devised to obtain judgments concerning their validity. The teachers were asked to estimate: first, the fairness of the items composing the test; second, the extent to which the entire test covered the work commonly taught during the year; and third, the extent to which the test really measured the knowledge of the pupils concerning the subject matter. This method of validation rests upon the theory that common sense suggests that a test which contains items recognized as worth while by several teachers (the more the better, of course) must bear some validity as a measure. When objective data are not available, collective judgments will, of necessity, provide the selective criterion.

The following excerpts are taken from letters received from teachers that assisted the writer by administering the series of tests.

Frances S. Hutchison: "As to the tests covering the material which I wish to cover in a year's work, yes. I feel that they do that very thoroughly, as nearly so as any could do.

Yes, I believe that the tests did measure the knowledge of the students concerning the subject matter. -----I feel that the tests were very good ones. As far as the pupils' reaction goes, that varied with variance of ability. My better pupils always were pleasant about the tests for they liked to see where they would rank. They, as well as the poorer students, usually thought that they were pretty hard. Some of them would often wonder where you found some of the questions, but could usually find out as they attempted to look up those missed."

Eleanor A. Sirpless: "These tests are fair and comprehensive, covering the subject matter satisfactorily. They are definitely and clearly stated. The various types of questions are well proportioned and arranged. I consider the series very satisfactory.

Roy F. Metcalf: "I consider the tests which you sent out, very good. They, however, did not fit our situation so well because we do not stick to one textbook. We use several reference books and outline our course somewhat similar to the Denver plan. I am sure they were of considerable value to our students in that they afforded a review, and taught them many new facts."

James H. Moyer: "The test itself is a very fair sampling of the material usually stressed in Biology. In my opinion, your practical applications were good, but it seems in some cases, the information could not be found in the text.

As is my custom in giving such tests, I never looked at the test until they were in the hands of the pupils. We, as a result, were a little surprised at the small amount of material on human physiology contained in the test."

It may be noted that one teacher mentions the Denver plan. Another mentions material not in the state text. As to difficulty, source books and so forth, it has been noted elsewhere that several texts and curricula, including the Denver course of study, were used in preparing the specifications for the test. Statistical measures of scores received from these schools show rather close conformity. Table XIII shows the medians and ranges of these schools on Test III, Forms A and B.

TABLE XIII

COMPARISON OF MEDIANS AND RANGES, TEST III,
FORMS A AND B OF FOUR SCHOOLS

School	Median		Range	
	A	B	A	B
Manhattan	50	47	34 - 65	32 - 67
El Dorado	47	47	29 - 64	30 - 68
Wichita No.	44.4	42	28 - 60	20 - 62
Emporia	44	47	31 - 58	38 - 61
Possible Score - 80 points.				

Read table thus: ^{the}Median of Manhattan on Test A ^{was} 50; El Dorado's median was 47; Wichita North's median was 44.4; Emporia's median was 44.

The scores made by the pupils of the Manhattan High School did not coincide with the impressions of the instructor concerning the field of information covered by the tests. Table XIV shows how well the test scores made by the Manhattan pupils compare with their semes-

ter grades. The correlations of .64 on Form A and .735 on Form B indicate high validity. The two forms of Test III were used.

TABLE XIV

CORRELATIONS BETWEEN TEST III SCORES AND SEMESTER GRADES MADE BY MANHATTAN PUPILS

Factor Considered	Form A	Form B
Number of Scores	93	93
Correlation	.64 ± .04	.735 ± .03
Mean	48.2	49.7

Read table thus: The correlation coefficient between the scores of Test III, Form A of the Biology test and the semester grades of the 93 Manhattan High School pupils was .64.

Tabulations revealed that the correlations for more than three hundred papers of Test III, Forms A and B with semester grades were $.49 \pm .022$, and $.545 \pm .024$, respectively. This would indicate that the tests given were valid measuring instruments of these pupils in Manhattan, and that the seeming fact that there was considerable material not included in the text did not prove detrimental. The same results in general hold in the analysis of the scores of the other high schools. The conclusion is that when the judgments of teachers, as revealed through school marks, were treated statistically in comparison with the scores made by their pupils, their judgments hold a high degree of validity.

Correlation with Teachers' Marks

Some idea of the validity of a test may be gained by ascertaining the relationship between the scores made by the pupils on the test and their marks measuring achievement over a period of time, such as a semester. It is generally recognized that a correlation between test scores and teachers' markings will be rather low, ranging from .40 to .80. The Barret-Ryan⁵ English Test given to 127 college freshmen and correlated with semester grades resulted in a correlation of .66. The Iowa Elementary Language Tests reported by Ballinger⁶, when correlated with teachers' marks ranged from .196 to .555 for 12 tests. The average of the twelve was .40.

In this study all forms of the test were correlated with teachers' marks for the semester. The number of scores used in each case varied but was large enough to yield a reliable measure. These data are tabulated in Table XV. It will be noted that the range of coefficients was between .457 and .677. This validity is higher than that of many reputable standardized tests. The index of reliability was also computed for each test and ranks comparatively high.

5. E. R. Barrett, Teresa M. Ryan, and E. R. Wood. "Barrett-Ryan English Test", MANUAL OF DIRECTIONS, Bureau of Educational Measurements, Kansas State Teachers College, Emporia.
6. Harvey L. Ballinger. "The Validation of the Iowa Elementary Language Tests", UNIVERSITY OF IOWA STUDIES IN EDUCATION, Volume VI, Number 3.

TABLE XV

TEST SCORES COMPARED WITH TEACHERS' SEMESTER GRADES

Tabulation Item	Test I	Test II	Test III
Number Scores - A r Form A vs. Sem. Grade	314 .603	391 .677	393 .492
Number Scores - B r Form B vs. Sem. Grade	316 .637	237 .457	359 .545

Read table thus: 314 scores made by pupils on Test I, Form A, when correlated with their semester grades, had a correlation of .603.

Summary of Validity

Considering the field of criteria presented, the tests forming the basis for this study conform closely to the requirements for validation. The salient facts are given in summary:

1. The balance between the tests and the subject matter of the textbooks is in close correspondence.
2. The trends revealed by a study of this test were similar to the results obtained by other investigators in the same field.
3. Courses of study tend to follow the content of textbooks. The tests were so constructed that they harmonize with both.
4. The tests are well balanced as to the use of informa-

tional items, and items of social utility.

5. Teachers using the tests have expressed satisfaction with them as measuring instruments.

6. Correlations with teachers' marks compare well with other tests widely used. The correlations between pupils' scores and semester grades range between .49 and .67, with an average of .57 for the six forms.

RELIABILITY OF TEST

Importance and Meaning

The second important consideration in the building of a standardized test is its reliability. By reliability of a test is meant the accuracy with which the test measures what it is supposed to measure. Stated in another way,¹ it means the degree to which an individual in a group taking a test or a number of comparable forms of a test several times, will achieve the same relative position in the various distributions of scores. If there is a large amount of agreement in the resulting scores, the test is said to have a high degree of reliability. If a test is valid, it is considered to be reliable, but reliability does not guarantee validity.

Measures of reliability include: first, comprehensiveness; second, objectivity; third, length of test; fourth, intelligibility; fifth, statistical treatment of pupils' scores. In the building of this test, these measures were constantly kept in mind; and when refinement was made, questions were altered or eliminated where preliminary scores indicated that a change might be helpful. The study considered in the remainder of this chapter concerns

1. Clifford Woody and Paul V. Sangren. Administration of the Testing Program. World Book Co., New York, 1933. p. 41.

the manner of determining the reliability of the tests and the analysis and interpretation of the results obtained.

Comprehensiveness

Comprehensiveness is a term used by Lang² to indicate thoroughness of sampling. A test should be comprehensive to be reliable. The subject matter should be covered widely and in a representative way. When pupils object to a test and state that any great number of items are unfair, it means either that the teacher and pupils have not covered the area for which the test was built as a measure, or that the test itself is faulty in construction. The likelihood of error would probably be influenced by both factors. The field to be covered by the test should be well defined, and the items of the test must keep within the definition. It must be remembered that thoroughness of sampling refers to a balanced distribution of testing items within the field selected for measurement by the test.

In constructing this series of tests, the Biology aims as stated by the courses of study for Kansas, for Missouri, and for the Denver Public Schools, were followed. Briefly stated, they are as follows:

1. To learn how plants and animals live.

2. Albert R. Lang. Modern Methods in Written Examinations. Houghton Mifflin Co., Boston. 1930. p. 54.

2. To learn the interrelationships of plants and animals.
3. To learn how they depend on the world about them.
4. To learn how man has power to control them.
5. To learn how man depends upon plants and animals.
6. To learn the objectives necessary to health.

The field was defined further by the study of textbook material cited in Tables II and III of this study. The items selected for the test, while limited to this range of units, were chosen so that they covered the four divisions of the field in a thorough and balanced manner, as was shown in Table VII. It was not intended that all of the test items should be answered by any pupil, but that there should be a small per cent of items of sufficient difficulty to challenge the brightest pupils.

TABLE XVI
RANGE OF TEST SCORES

SCORES	Test I		Test II		Test III	
	A	B	A	B	A	B
Total Scores	6472	2995	6385	3240	78	78
Highest Score	96	95	106	103	80	80
Lowest Score	13	16	12	14	42	41
Median Score	62	68	71	64	61	62
Possible Points	100	100	110	110	100	100

Read table thus: The range of scores made on Test I, Form A, was from 13 to 96. The median on the same test was 62.

The reliability of the series of tests in this respect is shown in Table XVI, which shows the range between the high and low scores made by the pupils. Test I and Test II results are taken from the reports of the Every Pupil Scholarship Tests conducted by the Bureau of Educational Measurements. Test III results were obtained from tests administered by the writer for the purpose of determining validity and reliability.

Objectivity

Objectivity is defined as the freeing of the test from subjective factors in scoring the papers. Objectivity makes possible the scoring of papers without the possibility of the scorer's being influenced by the writer of the paper. Objectivity tends to make possible the correct use of but a single answer for each test item. This includes the impossibility of answering in terms of synonymous meanings which frequently shade off into various degrees of vagueness.

This series of tests is composed of four types of items: multiple-response, true-false, matching, and unrelated-word. These are answered by placing before each item a figure, or plus or minus (+ -), in the parenthesis in a column at the left side of the sheet. The elimination of the written recall type of item reduces the chance of using synonymous responses. This makes possible the correct

scoring of this series of tests without knowledge of the subject matter. No subjective factor affects the scoring. Thus, complete objectivity has been approached in the construction of these tests, a factor increasing reliability.

Length of Test

One of the chief objections to the old-type examinations is their brevity. This factor, and the fact that it is impossible to score them impartially is undoubtedly their chief shortcoming. Any test should contain a fair sampling of the subject matter tested. The larger the sampling, the more complete will be the analysis of the knowledge of the pupil tested. In general, the longer the test, the greater the reliability.

The specifications in this series of tests called for approximately one hundred items. One reason for adopting this length was the fact that it was thought one hundred test items could be answered by the average pupil during the class period of approximately forty minutes. Also, builders of other tests use lengths ranging between 80 and 125 test items, which would average about one hundred items in length.

A study was made to determine whether forty minutes is sufficient time for taking the tests. Test I, A and B forms, and Test III, A and B forms, were used for this study. Tabulations made are shown in Table XVII.

TABLE XVII
STUDY OF TIME AND LENGTH FACTORS

Item Studied	Test I		Test III	
	Form A	Form B	Form A	Form B
Number of Scores	32	32	78	78
Range of Time	25 - 40	19 - 40	25 - 50	28 - 46
Median Time	36	36	36	40

Read table thus: The 32 pupils wrote on Test I, Form A. The time required for completing the test ranged between 25 and 40 minutes, with a median time of 36 minutes.

It will be seen that half of the pupils finished in 36 minutes or less. This fact indicates that 40 minutes is a valid testing time.

The pupils taking Test I, Forms A and B, were divided on the basis of teachers' marks into three groups: first, A and B; second, C; third, D and F. The purpose was to determine whether the length of time required seemed to discriminate between the good and poor pupils. Tabulations made are shown in Table XVIII.

It will be noted that the poor students, according to teachers' marks, used slightly less time than the stronger pupils. However, the various medians are practically the same as the medians for all pupils combined, when the pupils were allowed the regulation time of 40 minutes.

By inspection of the time used by each pupil in answering Forms A and B of each test, there appeared to be a high positive correlation.

TABLE XVIII
RELATION BETWEEN TIME REQUIRED TO TAKE TEST
AND PUPILS' MARKS

Item Studied	Test I - Form A			Test II - Form B		
	A & B	C	D & F	A & B	C	D & F
Number of Pupils	14	8	10	14	8	10
Range of Time	25 - 40	33-40	30 - 39	19 - 40	25-40	26 - 40
Median Time	36	36	35	36	36	33

Read table thus: The 14 pupils whose classroom marks were A and B required 25 to 40 minutes, with a median of 36 minutes, to complete the test.

Apparently, from the above considerations, 40 minutes is sufficient time to allow for the administering of these tests.

The effect of the lengthening of a test is shown by a trial made of both forms of Test III, in which the length was increased from 80 to 100 items. The correlation between the A and B forms based upon 359 papers of the original test of 80 items was .687. Using the Spearman Prophecy Formula, it was ascertained that the addition of twenty items should produce a correlation of .73. The tests were given to 78 pupils and their scores computed on the basis of their performance on the original 80 items, and on the total of 100 items. The correlation between Forms A and B on 80 items was .64; on the total of 100 items it was .70, with an index of reliability of .836.

This experiment shows a marked increase in reliability

by the addition of 20 items and compares well with the correlation computed with the Spearman Prophecy Formula. Repetition of the tests, which procedure would have the effect of doubling their length, should produce a correlation of approximately .82. These facts tend to indicate that in the case of the A and B forms of Test III, at least, and probably in Tests I and II, 100 items is a desirable length.

Intelligibility

Intelligibility refers to the clarity of the test items and of the instructions to the pupil, explaining the procedure in marking the responses to the items. The work of clarifying the items was accomplished, in part, by obtaining the judgments of pupils who wrote on the trial forms. Teachers' criticisms were also utilized. While this method of obtaining reliability was not stressed at the time of the construction of the tests, the way pupils responded would seem to verify the intelligibility of the tests.

Statistical Treatment to Determine Reliability

The scores made by pupils on a test may be used to determine the reliability of the testing instrument. The measure most commonly used is the coefficient of correlations, obtained by one of three methods: first, by the use of equivalent forms; second, by dividing a single form into two parts, correlating the total correct responses of the

odd items against the total correct responses of the even items and "stepping up" the coefficient by the Spearman formula; third, by repeating a single form within a few days and correlating the two trials. All three methods were used, in part, in obtaining the reliability coefficients of this series of tests.

T The work required in building standardized tests is such that their reliability (their validity, of course, being assumed) is much higher than the average tests constructed by the classroom teacher. Monroe³ found that standardized tests which he studied, have an average coefficient of .67. Ruch⁴ studied 149 tests whose average reliability coefficient was .694.

The following quotations are given concerning the significance of the coefficient of reliability.

Smith and Wright⁵: The significance of a reliability coefficient is somewhat debatable; however, the following statement may be generally accepted. A reliability coefficient ranging from:

- .95 to .99 is seldom attained in standard tests.
- .90 to .94 is highly desirable in testing.
- .80 to .89 represents some of the best tests now on the market.
- .70 to .79 represents many tests now on the market.

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3. W. S. Monroe, J. C. DeVoss, and F. J. Kelly. Educational Tests and Measurements. Houghton Mifflin and Co., Boston. 1924 p. 42.
 4. G. M. Ruch. The Objective or New-type Examination. Scott, Foresman and Co., Chicago. 1929. pp. 140-144.
 5. L. H. Smith, and W. W. Wright. Tests and Measurements. Silver, Burdette and Co., Chicago. 1928. p. 37.

.69 and below is not satisfactory for individual measurement. Tests with such reliability coefficients are used in group testing.

Ruch and Stoddard⁶ state: A reliability coefficient ranging from:

- .95 to .99 - Very high; rarely found among present tests.
- .90 to .94 - High; equalled by a few of the best tests.
- .80 to .89 - Fairly high; fairly accurate for individual measurement.
- .70 to .79 - Rather low; adequate for group measurement, but not very satisfactory for individual measurement.
- Below .70 - Low; inadequate for individual measurement although useful for group averages and school surveys.

McCall⁷ states:

A class score for a class of ordinary size will be sufficiently reliable for most purposes even though the test's self-correlation is as low as .55. If used to make judgments concerning individual pupils, the self-correlation should be above .90.

Kelly⁸ states: A coefficient of at least .50 based upon data from a single grade range, should be required for purposes of group measurement, of at least .94 for purposes of individual measurement.

Correlations were made of the three sets of tests, using Form A and Form B. The index of reliability was found by taking the square root of the coefficient of correlation in each case. Table XIX gives the results.

It may be noted that the correlations between Tests I,

6. Giles M. Ruch, and George D. Stoddard. Tests and Measurements in High School Instruction. World Book Co., New York. 1927. p. 156.
7. William A. McCall. How to Measure in Education. Macmillan Co., New York. 1922. p.310 - 311.
8. Truman L. Kelley. Interpretation of Educational Measurements. World Book Co., New York. 1927. p. 211.

II, and III are .699, .645, and .687, respectively. While the Test II correlation is in the middle 60's, the other two are on the verge of .70. Considering the preceding statements concerning reliability coefficients, it may be observed that the series of tests under consideration meet the requirements for testing instruments to be used in group testing. They might also be used for individual testing where the results are not expected to be the sole determining factor.

Self-correlations were also used on all the tests. The results of these, based on the correct odd scores compared with the correct even scores, are shown in the second and third sections of Table XIX. These were "stepped up" by the use of the Spearman formula⁹ for the correction of error. The averages of the coefficients of the A and B forms of the three tests are .81, .826, and .735, respectively. These coefficients indicate that one would secure reliable results from the use of the two forms.

From the application of the Spearman Prophecy formula,¹⁰ it would seem that repeating any test, thus doubling its length, would yield a reliable result, since the computed coefficients of reliability would then be .82, .78, and .81, respectively.

9. Henry E. Garrett. Statistics in Psychology and Education. Longmans, Green, and Co., New York. 1926. pp. 269-271.

10. Ibid.

TABLE XIX
CORRELATIONS BETWEEN FORM A AND FORM B

	Test I	Test II	Test III
Number of Scores	346	234	359
r Form A vs. B	.699 ± .018	.648 ± .024	.687 ± .018
Index of Reliability (A/B)	.836	.804	.828
Number of Papers	200	334	238
Cor. Form A (odd vs. even)	.709*	.68 ± .019	.597 ± .027
Coef. of Reliability	.83	.809	.747
Index of Reliability	.91	.899	.864
	*State Test.		
Number of Papers	123	193	237
Cor. Form B (odd vs. even)	.662 ± .014	.73 ± .022	.574 ± .029
Coef. of Reliability	.796	.843	.723
Index of Reliability	.892	.916	.851

Read table thus: The reliability coefficient obtained by correlating the scores of 346 pupils on Test I, Forms A and B, was .699 ± .018. The index of reliability is .836, and so forth. The coefficient of reliability obtained by self correlation of Test I, Form A, is .83. The index of reliability was .91. Compared with the self correlation of Test I, Form B, which is .796, there is a difference of .034 in favor of Form A, and so forth.

The index of reliability was computed for each form, as may be noted from Table XIX. This measure is defined as the maximum value which the reliability coefficient can take. It tends to indicate the correlation of the true scores representing the actual abilities of the pupils, if it were possible to make such scores. The range of the six results extend from .804 to .916. The average of the results for each test is as follows: Test I, .879; Test II, .873; Test III, .847. An index of reliability such as is given here indicates substantial reliability.

CHAPTER IV

INTERPRETATION AND USE OF RESULTS

The only valid reason for the construction of a test is for use as a measuring instrument. The interpretation of the results obtained through the use of the test is the factor of chief interest to the teacher. The arrangement of the test upon the paper, economy factors of cost and time required in the grading of the papers, and the ease with which scores may be compiled and recorded, are essential steps in the satisfactory use of any test. These latter considerations have been secured in this group of tests by compactness of arrangement of items, the omission of drawings, consecutive numbering of items, and the elimination of weighted answers. Time of scoring the papers ranges from one to two minutes each. Simplicity and accuracy have been sought throughout the study.

Development of Norms

Test scores, in themselves, have no meaning unless it is possible to interpret them adequately. For this test the raw scores may be interpreted into percentile scores by use of the percentile norms listed in Table XX.

The percentile scores for Test I and Test II were computed by the Bureau of Educational Measurements for use in connection with the Every Pupil Scholarship Tests. It will be noted that they are based on from 2995 to 6472

TABLE XX

PERCENTILES OF THE FREQUENCY DISTRIBUTION OF THE CLASS SCORES REPORTED FOR EACH TEST.

	Test I		Test II		Test III	
	Form A	Form B	Form A	Form B	Form A	Form B
Possible number of points	100	100	110	110	80	80
Highest Score	96	95	106	103	68	68
99 % did not exceed	89	91	97	93	67	67
95 % did not exceed	82	85	90	86	62	64
90 % did not exceed	78	82	87	81	59	61
80 % did not exceed	73	78	82	75	55	58
75 % did not exceed	71	76	80	73	53	56
70 % did not exceed	69	74	78	71	52	54
60 % did not exceed	66	71	74	67	49	51
50 % did not exceed	62	68	71	64	47	48
40 % did not exceed	59	65	68	60	45	46
30 % did not exceed	55	61	65	57	43	43
25 % did not exceed	52	59	63	55	42	42
20 % did not exceed	50	56	61	53	41	41
10 % did not exceed	44	50	55	47	38	38
5 % did not exceed	38	45	50	43	35	36
1 % did not exceed	30	35	41	36	30	33
Lowest Score	13	16	12	14	28	28
Total Scores Reported	6472	2995	6385	3240	392	360

Read table thus: In Test I, Form A, there are 100 points possible. The highest score made by any pupil was 96; (con)

pupil scores for the various forms. The number of these scores was adequate to give the percentile norms for these forms a high degree of reliability.

The percentile scores for Test III were computed by the writer from the scores obtained on these forms in the schools where the tests were used for experimental purposes. The number of these scores was, of course, insufficient to provide norms whose reliability is very high, but they are valuable as tentative norms.

It may be observed from Table XX that the two forms of each test are in reasonable agreement. Error counts indicate that the exchange of a few items between A and B forms would practically equate the two equivalent forms in respect to percentile score values.

D Translation of Scores into School Marks

By use of the percentile table, test scores may be readily translated into school marks. First, it is necessary to convert the raw scores into percentile scores which are then easily translated into school marks.

To do this, it is necessary to decide more or less arbitrarily what each school mark shall mean in terms of percentile scores. In the translation made in Table XXI, it is assumed that the following interpretation shall be made: for a percentile score of 90 or more, give a mark of A; for a percentile score of 75 to 89, give a mark of B;

 (from p. 48) 99% did not exceed 89; and so on. The median score was 62.

for a percentile score of 25 to 75, give a mark of C; for a percentile score of 10 to 25, give a mark of D; and for a percentile score less than 10, give a mark of F.

↑ If the suggested plan were accepted for a class, it would be a simple process to convert all scores for a class into school marks by use of Table XXI.

TABLE XXI

SUGGESTION FOR THE TRANSLATION OF SCORES INTO SCHOOL MARKS

School Mark	Test I		Test II		Test III	
	A	B	A	B	A	B
A Percentile score 90 or higher.	78 and above	82 and above	87 and above	81 and above	59 and above	61 and above
B Percentile score of 75 - 89.	77 - 71	81 - 76	86 - 80	80 - 73	58 - 53	60 - 56
C Percentile score of 25 - 74.	70 - 52	75 - 59	79 - 63	72 - 55	52 - 42	55 - 42
D Percentile score of 10 - 24.	51 - 44	58 - 50	62 - 55	54 - 47	41 - 38	41 - 38
F Percentile score of less than 10.	43 and lower	49 and lower	54 and lower	46 and lower	37 and lower	37 and lower

Read table thus: A pupil making a score of 78 or above on Test I, Form A, would be given a grade of A; a pupil making a score of 71 - 77 inclusive, would be given a grade of B; and so forth.

Uses of Tests

The extent to which a test may be used depends upon the resourcefulness of the teacher. This test, with its three forms, may be used as a measure in any way that the average standardized test may be used. Primarily, it may be used to measure achievement of a class. This is the most common use of tests. The results may be translated into school marks as previously indicated.

A second use for which the test is valuable is to determine ability. The combined results of Forms A and B of either test, supplemented by other class data, should indicate with fair reliability, whether a pupil is doing passing work.

A third use would include the comparison of Biology classes in the same school, or between different schools in the same or different school systems. Such uses were discovered valuable in the Every Pupil Scholarship Tests where a large number of schools competed.

A fourth use might be of a diagnostic nature. By making an error count, the resourceful teacher should be able to determine which pupils need remedial attention. Since the test is divided into three groups, there will be three points in the year's work where this may be done. This diagnostic use may be extended to the resectioning of classes into groups of equal ability. Where this cannot be done, sectioning within classes might be accomplished.

CHAPTER V

SUMMARY AND CONCLUSIONS

An examination of the materials of this study will indicate the following results and conclusions:

1. The test, as constructed, fulfills its purpose of measuring achievement in Biology, especially in Kansas and the mid-continent area.
2. The test, as constructed, is entirely objective, both as to method of recording pupils' responses, and as to the method of scoring.
3. The test, as constructed, follows accepted methods in obtaining validity.
4. The test, as constructed, shows high validity when the scores are correlated with teachers' marks.
5. The test, as constructed, shows substantial reliability as is indicated by the coefficients of reliability. It appears to be a reliable measure of group achievement, or suitable for individual measurement when accompanied by other measures of ability.
6. The test, as constructed and used in the State Every Pupil Test, has percentile norms of good reliability.
7. The tests, as constructed, are adaptable to the many requirements demanded by the classroom teacher, as group testing, diagnosis, and so on.
8. The tests, as constructed, have proved their merit in the Every Pupil Scholarship Tests conducted by the Bureau of Educational Measurements, State Teachers College, of Emporia.

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APPENDIX

Part I

The percentile scores and other information given in Table XX for Tests I and II were taken from the following sources:

1. For Test I, Form A:

Schrammel, H. E., and McIntosh, H. W., "Report of the Thirteenth Every Pupil Scholarship Contest, December 10, 1930". Kansas State Teachers College, Bulletin of Information. Number 87, January, 1931.

2. For Test I, Form B:

Schrammel, H. E., and Davis, Vera, "Report of the Seventeenth Nation-wide Every Pupil Scholarship Test, January 10, 1933". Kansas State Teachers College, Bulletin of Information, Number 118, February, 1933.

3. For Test II, Form A:

Schrammel, H. E., and McIntosh,^{H.W.} "Report of the Fourteenth Every Pupil Scholarship Contest, March 25, 1931".

Kansas State Teachers College, Bulletin of Information. Number 95, April, 1931.

4. For Test II, Form B:

Schrammel, H. E. and Davis, Vera, "Report of the Eighteenth Nation-wide Every Pupil Test, April 5, 1933". Kansas State Teachers College, Bulletin of Information. Number 121, April 1933.

5. For Test III, the percentile scores were compiled from

frequency distributions made by the writer from scores obtained from several high schools.

Part II

The General Science Tests, to which reference was made on page 22, are listed as follows:

1. Dvorak, A. "General Science Scale", Public School Publishing Co., Bloomington, Ill. 1924.
2. Ruch, G.M., and Popenoe, H.F. "General Science Test", World Book Co., New York. 1923.
3. Ruch, G.M., and Stoddard, G.D. "Iowa High School Content Examination", University of Iowa. 1924, 1925.
4. Powers, S.R. "Powers General Science Test", Teachers College, Columbia University, New York. 1927.
5. Toops, H.A. "General Science Test Reprint", SCHOOL SCIENCE AND MATHEMATICS, Vol. XXV, No. 8. 1925.

TEST I * FORM A
EVERY PUPIL SCHOLARSHIP CONTEST

56

Directions: Answer the easiest parts first. Go back and work on the others. You will have exactly 40 minutes.

PA:IH

Bureau of Educational Measurements
Kansas State Teachers College, Emporia

BIOLOGY

By John R. Williams, Emporia High School
Emporia, Kansas

Possible points 100

Number Wrong
and omitted

FINAL SCORE

Pupil Age Grade

School Town State Date

PART I

DIRECTIONS: Place the number of the part which makes the best answer to the statement in the parenthesis at the front of the statement.

(3) Biology is a: 1. habit. 2. education. 3. science.

In this sample, "science" is the correct answer. The number in front of the word "science" is 3. The figure 3 has been placed in the parenthesis.

- () 1. The larva of the house fly is usually found in: 1. flesh. 2. wood. 3. filth. 4. sand. 5. water.
- () 2. One of the most useful birds to man is: 1. jay. 2. eagle. 3. grackle. 4. hawk. 5. owl.
- () 3. The adaptation for food-gathering by bees is: 1. tongue. 2. proboscis. 3. palps. 4. chela. 5. tubule.
- () 4. The group to which gnawing mammals belong is: 1. rodents. 2. mollusks. 3. ruminants. 4. arachnids. 5. aves.
- () 5. A valuable natural enemy of the mosquito is: 1. robin. 2. starfish. 3. Thalesa fly. 4. dragon fly.
- () 6. Mammals breathe by means of: 1. lungs. 2. spiracles. 3. gills. 4. pores. 5. stomach.
- () 7. The number of legs on true insects is: 1. eight. 2. six. 3. four. 4. two.
- () 8. The chela is an organ of the: 1. crayfish. 2. frog. 3. lizard. 4. beetle. 5. oyster.
- () 9. The special groups of tissue called ganglia are composed of: 1. muscle tissue. 2. bone tissue. 3. blood tissue. 4. nerve tissue.
- () 10. The term "altricial" refers to the young of the: 1. fish. 2. horse. 3. robin. 4. chicken. 5. elephant.
- () 11. To kill a sucking insect use a: 1. stomach poison. 2. bran mash. 3. paint. 4. contact poison. 5. Paris green.
- () 12. A group of similar cells with similar function is a: 1. tissue. 2. organ. 3. system. 4. organism. 5. tumor.
- () 13. Fehling's solution is a test for: 1. cellulose. 2. fat. 3. protein. 4. starch. 5. glucose.
- () 14. Tube feet are characteristic of the: 1. clam. 2. amoeba. 3. starfish. 4. crayfish. 5. bat.
- () 15. The fertilization of a reproductive cell brings together: 1. ganglia. 2. chromosomes. 3. enzymes. 4. neurons.
- () 16. The antennae of an insect are attached to: 1. thorax. 2. abdomen. 3. chela. 4. mandibles. 5. head.
- () 17. The stage of growth of the cell following fertilization is: 1. blastula. 2. pupa. 3. chrysalis. 4. gastrula. 5. medulla.
- () 18. An insect which shows warning coloration is the: 1. butterfly. 2. wasp. 3. grasshopper. 4. ant. 5. cricket.
- () 19. The best method of eradicating mosquitoes is: 1. smoke. 2. poisoning. 3. trapping. 4. pouring oil on water. 5. raising goldfish.
- () 20. An enzyme is a: 1. catalytic agent. 2. hormone. 3. vitamin. 4. oxidizing agent. 5. hydrate.
- () 21. A nymph is a: 1. sea-animal. 2. frog. 3. young insect. 4. pupa. 5. moth.
- () 22. An amoeba obtains oxygen by means of: 1. spiracles. 2. tubes. 3. gills. 4. osmosis. 5. transpiration.
- () 23. Molting is an important process in the life history of the: 1. hydra. 2. grasshopper. 3. cabbage butterfly. 4. fish. 5. turtle.
- () 24. Respiration occurs in the: 1. lungs. 2. skin. 3. blood. 4. bones. 5. cells.
- () 25. An organism that lives on another living organism is called: 1. parasite. 2. host. 3. saprophyte. 4. hybrid. 5. sport.
- () 26. The green glands are structures found in the: 1. lizard. 2. hydra. 3. clam. 4. honey-bee. 5. crayfish.
- () 27. Insects breathe by means of: 1. lungs. 2. gills. 3. cilia. 4. tracheae. 5. bronchi.
- () 28. The pair of fins of fish which correspond to the hind legs of mammals is: 1. caudal. 2. anal. 3. pelvic. 4. pectoral. 5. dorsal.
- () 29. The living material found in animal cells is called: 1. blood. 2. lymph. 3. solution. 4. chitin. 5. protoplasm.
- () 30. Iodine is used as a test for: 1. sugar. 2. starch. 3. fat. 4. protein. 5. vitamins.
- () 31. The insect which does most damage to the apple crop is the: 1. Tussock moth. 2. codling moth. 3. apple fungus. 4. ladybug.
- () 32. When the temperature of an animal remains the same as its environment, it is said to be: 1. dormant. 2. warm-blooded. 3. cold-blooded. 4. retrogressive. 5. hibernating.
- () 33. A favorite fresh-water fish is: 1. shad. 2. herring. 3. gar. 4. lamprey. 5. trout.
- () 34. The open season for hunting wild ducks ends: (1) Oct. 31. (2) Nov. 30. (3) Dec. 31. (4) Jan. 31. (5) March 1.
- () 35. Very young fish are called: 1. fry. 2. spawn. 3. scale. 4. nymph. 5. suckers. 6. sunfish.
- () 36. The simplest group of animals is called: 1. bacteria. 2. germs. 3. chloroplasts. 4. protozoa. 5. insects.

PART II.

DIRECTIONS: In the parenthesis in front of Column I place the number of the word or phrase found in Column II that matches it or makes a true statement.

(a)

Column I.

- () 37. The study of animal life is called:
- () 38. Absorption of oxygen into the cell:
- () 39. The nutrient containing the element nitrogen:
- () 40. The living material composing all cells:
- () 41. Different stages of growth with marked changes in structure:
- () 42. Poisons used to control insects:
- () 43. Hair-like vibrating organs of small swimming animals.
- () 44. An organism that lives on, or at the expense of another:
- () 45. A body regulator necessary to diet:
- () 46. The natural removal of the outer covering of an organism:
- () 47. Tendency to resemble parents:
- () 48. The study of bird life:
- () 49. The laying of eggs by fish:
- () 50. The act of bringing the air into the lungs:
- () 51. The man who died while attempting to prove the cause of yellow fever:
- () 52. An eminent American authority on fish:
- () 53. An eminent American authority on birds:

Column II.

- 1. antenna
- 2. breathing
- 3. Chapman
- 4. cilia
- 5. comstock
- 6. entomology
- 7. environment
- 8. fat
- 9. heredity
- 10. insecticide
- 11. Jordan
- 12. Lazear
- 13. metabolism
- 14. metamorphosis
- 15. molting
- 16. ornithology
- 17. parasite
- 18. protein
- 19. protoplasm
- 20. respiration
- 21. spawning
- 22. vitamin
- 23. zoology

(b)

Column I.

- () 54. Amphibian
- () 55. Aves
- () 56. Carnivora
- () 57. Crustacea
- () 58. Diptera
- () 59. Hymeroptera
- () 60. Insectivora
- () 61. Lepidoptera
- () 62. Primate
- () 63. Protozoa
- () 64. Reptilia
- () 65. Rodent

Column II.

- 1. ape
- 2. beayer
- 3. bee (honey)
- 4. butterfly
- 5. crab
- 6. housefly
- 7. mole
- 8. paramecium
- 9. robin
- 10. skunk
- 11. toad
- 12. turtle

PART III.

DIRECTIONS: Read the following sentences carefully. If a statement is true, place a plus (+) in the parenthesis in front of the statement, as in example A below. If the statement is false, make a minus (-) in the parenthesis in front of it as in example B. Make the + and the - small and clear.

Examples: (+) A. Apples are good to eat.
 (-) B. Potatoes grow on trees.

- () 66. Animal-life is entirely dependent upon plant-life for food.
- () 67. A cell cannot exist alone.
- () 68. Crustaceans are so-called because of their hard outer covering.
- () 69. Insects are more injurious to human welfare than snakes.
- () 70. The paramecium moves by means of its trichocysts.
- () 71. The San Jose scale is a beneficial organism used to eradicate the boll weevil.
- () 72. Gill slits are common to all vertebrates at some stage in their life history.
- () 73. The gall fly is an important agent of pollination of plants.
- () 74. Codling moths are enemies of young cod fish.
- () 75. The young frog swallows the tail it had as a tadpole.
- () 76. Worker bees can replace a dead queen by the development of a fertilized cell.
- () 77. The malarial protozoa are scattered by the bites of the anopheles mosquito.
- () 78. Enzymes are injurious forms of protozoa.
- () 79. The frog has gills in the tadpole stage.
- () 80. Audubon is noted for his careful classification of mammals.
- () 81. Matter can neither be created nor destroyed.
- () 82. Major Walter Reed was a noted ornithologist.
- () 83. All birds are beneficial to man.
- () 84. Insects spread plant diseases.
- () 85. Insects form the most numerous single class of animals.
- () 86. Biologically, man is classified as an animal.
- () 87. Head lice are the most important of the external human parasites.
- () 88. Since careful studies of the breeding habits of fish have been made there is little danger of the supply being depleted.
- () 89. The life cycle of man is fundamentally similar to that of the frog or fish.
- () 90. The food habits of the skunk make it decidedly beneficial to the farmer.
- () 91. Insects with complete metamorphosis are termed altricial.
- () 92. The tachina fly spreads Texas fever among cattle.
- () 93. The tail fin of the catfish is named the chela.
- () 94. All mammals give birth directly to the offspring.
- () 95. Sponges are plants having animal characteristics.
- () 96. Single-celled animals have life processes similar to the more complex types.
- () 97. A balanced terrarium is a situation in which land plants and animals continue to live together indefinitely with relationship of interdependence.
- () 98. The mammals are the class of animals most highly beneficial to man.
- () 99. The indifference of the public permits the killing of beneficial birds.
- () 100. The control of insects has become an international problem.

TEST I * FORM A
Biology

PA:IIH

Papers must be scored according to this key. Give one point for each correct answer. An omission is counted as an error. See special directions for scoring on "General Directions." Cut off the answers and paste the narrow strip on a card board. This will be a good scoring stencil.

Possible score: 100 points.

PAGE I.
PART I.
Column I.

PAGE I.
PART I.
Column II.

- | | |
|---------|---------|
| | 18. (2) |
| | 19. (4) |
| 1. (3) | 20. (1) |
| 2. (5) | 21. (3) |
| 3. (1) | 22. (4) |
| 4. (1) | 23. (2) |
| 5. (4) | 24. (3) |
| 6. (1) | 25. (1) |
| 7. (2) | 26. (5) |
| 8. (1) | 27. (4) |
| 9. (4) | 28. (3) |
| 10. (3) | 29. (5) |
| 11. (4) | 30. (2) |
| 12. (1) | 31. (2) |
| 13. (5) | 32. (3) |
| 14. (3) | 33. (5) |
| 15. (2) | 34. (3) |
| 16. (5) | 35. (1) |
| 17. (1) | 36. (4) |

PAGE 2.
PART II.
Column I.

PAGE 2.
PART III.
Column II.

- 37. (23)
- 38. (20)
- 39. (18)
- 40. (19)
- 41. (14)
- 42. (10)
- 43. (4)
- 44. (17)
- 45. (22)
- 46. (15)
- 47. (9)
- 48. (16)
- 49. (21)
- 50. (2)
- 51. (12)
- 52. (11)
- 53. (3)
- 54. (11)
- 55. (9)
- 56. (10)
- 57. (5)
- 58. (6)
- 59. (3)
- 60. (7)
- 61. (4)
- 62. (1)
- 63. (8)
- 64. (12)
- 65. (2)

PART III.

- 66. (+)
- 67. (-)
- 68. (+)
- 69. (+)
- 70. (-)
- 71. (-)
- 72. (+)
- 73. (-)
- 74. (-)
- 75. (-)
- 76. (+)
- 77. (+)
- 78. (-)
- 79. (+)
- 80. (-)
- 81. (+)
- 82. (-)
- 83. (-)
- 84. (+)
- 85. (+)
- 86. (+)
- 87. (+)
- 88. (-)
- 89. (+)
- 90. (+)
- 91. (-)
- 92. (-)
- 93. (-)
- 94. (+)
- 95. (-)
- 96. (+)
- 97. (+)
- 98. (+)
- 99. (+)
- 100. (+)

TEST I * FORM B
EVERY PUPIL SCHOLARSHIP TEST
 January 10, 1933.

Bureau of Educational Measurements
 Kansas State Teachers College, Emporia

BIOLOGY

By John R. Williams, Emporia High School,
 Emporia, Kansas.

Possible score 100

Number wrong
 and omitted

FINAL SCORE

Directions: Answer the easiest parts first. Go back and work on the others. You will have exactly 40 minutes.

Name Age Grade

School Teacher

Town State Date

PART I.

DIRECTIONS: Place the number of the part which makes the best answer to the statement in the parenthesis before the statement.

(3) Biology is a: 1. habit. 2. education. 3. science. In this sample, "science" is the correct answer. The number of the word "science" is 3. The figure 3 has been placed in the parenthesis.

- () 1. The larva of the mosquito is usually found in: 1. dust. 2. air. 3. filth. 4. flesh. 5. water.
- () 2. The special adaptation by which the crayfish swims backwards is: 1. swimmerets. 2. chela. 3. uropod. 4. maxilliped. 4. mandible.
- () 3. The order to which house flies belong is: 1. homoptera. 2. diptera. 3. lepidoptera. 4. hemiptera. 5. orthoptera.
- () 4. The amoeba obtains oxygen by means of its: 1. spiracles. 2. lungs. 3. cell wall. 4. stomata. 5. gills.
- () 5. The back or upper side of an insect is called: 1. ventral. 2. lateral. 3. inferior. 4. dorsal. 5. subordinate.
- () 6. Energy of motion is named: 1. potential. 2. spontaneous. 3. organic. 4. kinetic. 5. inorganic.
- () 7. The term "praecocial" refers to the young of the: 1. turkey. 2. robin. 3. crow. 4. owl. 5. canary.
- () 8. A group of tissues acting together as a unit is termed: 1. a system. 2. an organism. 3. a tumor. 4. an organ. 5. a chain.
- () 9. Iodine solution is a test for: 1. starch. 2. fat. 3. protein. 4. sugar. 5. cellulose.
- () 10. Jointed appendages are characteristic of the: 1. fish. 2. bird. 3. mammal. 4. snake. 5. lobster.
- () 11. The fertilization of a reproductive cell brings together: 1. catalysis. 2. chromosomes. 3. enzymes. 4. neurons. 5. ganglia.
- () 12. An animal showing warning coloration is the: 1. rat. 2. rabbit. 3. lion. 4. rattlesnake. 5. skunk.
- () 13. The best method of eradicating house flies is: 1. destruction of breeding places. 2. trapping. 3. poisoning. 4. swatting.
- () 14. The stage in the life history of a louse known as a "nit" is the: 1. egg. 2. larva. 3. pupa. 4. adult. 5. nymph.
- () 15. Molting is an important process in the life history of the: 1. fish. 2. turtle. 3. hydra. 4. crayfish. 5. mammal.
- () 16. The gas provided the cells by respiration is: 1. carbon dioxide. 2. hydrogen. 3. oxygen. 4. nitrogen. 5. helium.
- () 17. A parasitic insect is the: 1. house fly. 2. butterfly. 3. carrion beetle. 4. grasshopper. 5. head louse.
- () 18. The acid used by bees and ants when they sting is: 1. formic. 2. acetic. 3. hydrochloric. 4. nitric. 5. citric.

- () 19. Spiracles are breathing organs of: 1. crayfish. 2. insects. 3. birds. 4. frogs. 5. mammals.
- () 20. The man who applied the term "cell" to the units of structure of tissues was: 1. Hooke. 2. Darwin. 3. Jenner. 4. Pasteur. 5. Koch.
- () 21. The test for sugar is made by treating the material with: 1. copper sulfate. 2. iodine. 3. Fehling's solution. 4. nitric acid. 5. ferrous sulfate.
- () 22. The most serious insect pest of corn is the: 1. chinch bug. 2. corn ear worm. 3. cut worm. 4. European borer. 5. grasshopper.
- () 23. A game-bird rapidly becoming extinct is the: 1. crow. 2. hawk. 3. wild turkey. 4. ostrich. 5. turtle dove.
- () 24. The sharp pointed projections that serve as strainers on the inside of the gills of fish are called: 1. arches. 2. fins. 3. covers. 4. slits. 5. rakers.
- () 25. A bird with long, sailing wings is the: 1. robin. 2. swallow. 3. English sparrow. 4. chickadee. 5. turtle dove.
- () 26. The bird which lives largely on ants and wood borers is the: 1. wren. 2. flicker. 3. song sparrow. 4. oriole. 5. phoebe.
- () 27. One of the insects most useful to man is the: 1. ladybug. 2. house fly. 3. wood borer. 4. cicada. 5. termite.
- () 28. A valuable natural enemy of wood borers is the: 1. hawk. 2. termite. 3. opossum. 4. thalassa fly. 5. carrion beetle.
- () 29. Plant lice are commonly killed by the use of: 1. bran mash. 2. Paris green. 3. Black Leaf 40. 4. Bordeaux mixture.
- () 30. A paramecium obtains oxygen by means of: 1. transpiration. 2. osmosis. 3. spiracles. 4. tubes. 5. gills.
- () 31. The specialized organ by which the crayfish captures food is the: 1. uropod. 2. swimmeret. 3. mandible. 4. antenna. 5. chela.
- () 32. The change undergone during the pupa stage is called: 1. evolution. 2. metamorphosis. 3. photosynthesis. 4. osmosis.
- () 33. The date when it was proved that yellow fever was carried by the mosquito was: (1) 1700. (2) 1775. (3) 1850. (4) 1900. (5) 1918.
- () 34. The special adaptation of frogs for food-taking is located on the: 1. tongue. 2. teeth. 3. front feet. 4. rear feet. 5. nose.
- () 35. A bird with a hooked upper beak is the: 1. English sparrow. 2. robin. 3. owl. 4. oriole. 5. wren.
- () 36. The number of divisions characteristic of the bodies of insects is: 1. two. 2. three. 3. four. 4. five. 5. seven.
- () 37. The exoskeleton is characteristic of: 1. amphibians. 2. vertebrates. 3. mammals. 4. birds. 5. crustaceans.
- () 38. The walking appendages of a crayfish are attached to the: 1. thorax. 2. chela. 3. abdomen. 4. head. 5. uropod.

PART II.

PART III.

DIRECTIONS: In the parenthesis before each item of Column I place the number of the word or phrase found in Column II that matches the item or makes a true statement.

DIRECTIONS: Read the following sentences carefully. If a statement is true, place a plus (+) in the parenthesis before the statement, as in example A below. If the statement is false, make a minus (-) in the parenthesis before it, as in example B.

Column I.

Column II.

- () 39. The organism which in its early life is attached to the gill of a fish
- () 40. The animal group that competes most with man for domination
- () 41. Animals that spend their winters at a considerable distance from their summer homes
- () 42. An area set aside for the protection of wild life is called a
- () 43. Fertilization of the egg requires that its nucleus be united with a
- () 44. A commonly found animal fossil
- () 45. The simple food manufactured by the leaf is
- () 46. The species of frog commonly found in all parts of the United States.
- () 47. An example of a pouched mammal
- () 48. When a plant is grafted upon a root, the part used is a
- () 49. Birds whose young are hatched helpless are termed
- () 50. A common insect belonging to the order Orthoptera
- () 51. The sex of the drone bee is
- () 52. One of the worst of the sucking insects of the orchard is the
- () 53. The name of a common moth
- () 54. A common amphibian is the
- () 55. The parasites that attack caterpillars are
- () 56. Ganglia are connected with other parts of the body by
- () 57. The name of a common butterfly
- () 58. A common lizard found in west-central United States is the
- () 59. The greatest use of water in the body is as a
- () 60. The snake considered most deadly
- () 61. An important digestive gland
- () 62. The order to which gnawing animals belong
1. altricial
2. bud
3. carnivora
4. catalytic agent
5. cecropia
6. cobra
7. dinosaur
8. external parasites
9. female
10. grape sugar
11. freshwater clam
12. frog
13. grasshopper
14. horned toad
15. insects
16. internal parasites
17. leopard
18. male
19. Mexican beetle
20. migratory
21. nerves
22. opossum
23. pancreas
24. porcupine
25. praecocial
26. preserve
27. protein
28. python
29. reclamation project
30. Rodentia
31. San Jose scale
32. solvent
33. sperm nucleus
34. tiger swallow-tail
35. twig

Examples

- (+) A. A frog is an animal.
- (-) B. All animals have wings.
- () 63. The amoeba protects itself by means of trichocysts.
- () 64. Ants commonly have but one adult queen in a colony.
- () 65. Especially formed structures that assist in food-getting are termed "adaptations."
- () 66. Since birds are more active than other vertebrates, oxidation is carried on more rapidly.
- () 67. Bats reproduce by laying and hatching eggs.
- () 68. Crayfish will kill and eat goldfish, in an aquarium.
- () 69. The beaver is an insect-eating animal.
- () 70. Digestion involves both physical and chemical change.
- () 71. The Guernsey is a leading beef breed of cattle.
- () 72. Birds hibernate in winter.
- () 73. Young hatchery fish that have grown until able to care for themselves, are called " fry."
- () 74. The cerebellum of the frog is small and poorly developed.
- () 75. Transient birds spend only the summer in a given locality.
- () 76. Hawks and owls are valuable aids to the farmer in preventing rabbits from becoming a menace.
- () 77. Wood borers are examples of round worms.
- () 78. The separation of the sperm nuclei from the contents of the egg cell, is called fertilization.
- () 79. The outer slimy layer on fish forms upon contact with impurities in water.
- () 80. Insect pests are best controlled by the discovery and protection of their natural enemies.
- () 81. "Homo sapiens" is the species name of the horse.
- () 82. Birds sometimes spread disease.
- () 83. An ornithologist is one who studies and classifies insects.
- () 84. Plants manufacture the complex proteins required by animals.
- () 85. Because of structure, man is classed as a mammal.
- () 86. Reptiles have four metamorphic stages in their life history.
- () 87. Human disease may be caused by protozoa.
- () 88. Many animal cells contain little or no protoplasm.
- () 89. A host is an organism upon which a parasite lives.
- () 90. Several of the rodents are commonly used as human food.
- () 91. The most important life function of an organism is ability to reproduce successfully.
- () 92. Vitamins change starch into sugar.
- () 93. Sexual reproduction results from the union of a sperm nucleus with an egg cell.
- () 94. Mammals inhabit only the temperate zones of the earth.
- () 95. Arsenate of lead is a poison commonly used in water to destroy mosquito larvae.
- () 96. Certain inherited traits of plants and animals are reproduced in definite proportions in the offspring of the plant or animal.
- () 97. "That all living animals and plants have had living parents," is termed the "Law of Life."
- () 98. Small children are naturally afraid of snakes.
- () 99. A terrarium is a place where classified insect collections are kept.
- () 100. "Plumage" refers to the hairy covering of mammals.

TEST I * **Biology** FORM B
KEY

January 10, 1933.

Papers must be scored according to this key. Give one point for each correct answer. An omission is counted as an error. See special directions for scoring on "General Directions."

Possible score 100

**PAGE 1.
PART I.
Column I.**

**PAGE 1.
PART I.
Column II.**

1. (5	19. (2
2. (3	20. (1
3. (2	21. (3
4. (3	22. (4
5. (4	23. (3
6. (4	24. (5
7. (1	25. (2
8. (4	26. (2
9. (1	27. (1
10. (5	28. (4
11. (2	29. (3
12. (5	30. (2
13. (1	31. (5
14. (1	32. (2
15. (4	33. (4
16. (3	34. (1
17. (5	35. (3
18. (1	36. (3
	37. (5
	38. (1

**PAGE 2.
PART II.
Column I.**

**PAGE 2.
PART III.
Column II.**

39. (11	63. (—
	64. (—
40. (15	65. (+
	66. (+
41. (20	67. (—
	68. (+
	69. (—
	70. (+
42. (26	71. (—
	72. (—
43. (33	73. (+
	74. (+
44. (7	75. (—
45. (10	76. (+
46. (17	77. (—
	78. (—
	79. (—
47. (22	80. (+
48. (35	81. (—
	82. (+
49. (1	83. (—
	84. (+
50. (13	85. (+
	86. (—
51. (18	87. (+
52. (31	88. (—
	89. (+
	90. (+
53. (5	91. (+
54. (12	92. (—
55. (16	93. (+
	94. (—
56. (21	95. (—
57. (34	96. (+
58. (14	97. (+
	98. (—
	99. (—
59. (32	100. (—
60. (6	
61. (23	
62. (30	

EVERY PUPIL SCHOLARSHIP CONTEST

Bureau of Educational Measurements
 Kansas State Teachers College, Emporia

Possible Points 110

BIOLOGY

By John R. Williams, Emporia High School
 Emporia, Kansas.

Number wrong and omitted

FINAL SCORE

Directions: Answer the easiest parts first. Go back and work on the others. You will have exactly 40 minutes.

I:IP

Pupil _____ Age _____ Grade _____
 School _____ Town _____ State _____ Date _____

PART I

DIRECTIONS: Place the number of the part which makes the best answer to the statement in the parenthesis at the front of the statement.

(3) Biology is a: 1. habit. 2. education. 3. science. In this sample, "science" is the correct answer. The number in front of the word "science" is 3. The figure 3 has been placed in the parenthesis.

- () 1. A valuable natural enemy of the mosquito is the: 1. robin. 2. starfish. 3. Thalesa fly. 4. dragon fly.
- () 2. The term "altricial" refers to the young of the: 1. fish. 2. horse. 3. robin. 4. chicken. 5. deer.
- () 3. The house fly is known to spread: 1. yellow fever. 2. typhoid. 3. malaria. 4. mumps. 5. influenza.
- () 4. The substance in the body in which life is generated is: 1. lymph. 2. cell wall. 3. endospore. 4. blood. 5. protoplasm.
- () 5. Meat-eating animals are classed as: 1. omnivorous. 2. herbivorous. 3. carnivorous. 4. gregarious. 5. prococtious.
- () 6. A protozoan disease is: 1. diphtheria. 2. malaria. 3. pneumonia. 4. tuberculosis. 5. smallpox.
- () 7. Root hairs absorb plant-food materials by: 1. osmosis. 2. photosynthesis. 3. capillarity. 4. transpiration. 5. synthesis.
- () 8. Rice is high in: 1. protein. 2. carbohydrate. 3. fat. 4. mineral. 5. vitamins.
- () 9. The mosquito which carries yellow fever is: 1. hymenoptera. 2. culex. 3. anopheles. 4. diptera. 5. aedes.
- () 10. To kill a sucking insect use a: 1. stomach poison. 2. paint. 3. bran mash. 4. Paris green. 5. contact poison.
- () 11. Food is absorbed from the small intestine by the: 1. villi. 2. lacteals. 3. corpuscles. 4. pancreas. 5. ducts.
- () 12. The enzyme which makes proteins soluble is: 1. ptyalin. 2. hydrochloric acid. 3. trypsin. 4. steapsin. 5. amylopsin.
- () 13. Who discovered the germ of tuberculosis? 1. Leeuwenhoek. 2. Koch. 3. Stiles. 4. Pasteur. 5. Harvey.
- () 14. A group of similar cells with similar function is a: 1. tumor. 2. organism. 3. system. 4. tissue. 5. organ.
- () 15. Fehling's solution is a test for: 1. cellulose. 2. glucose. 3. starch. 4. protein. 5. fat.
- () 16. The fertilization of a reproductive cell brings together: 1. ganglia. 2. chromosomes. 3. enzymes. 4. neurons. 5. sperm cells.
- () 17. Muscles are attached to bones by means of: 1. mesenteries. 2. ligaments. 3. tendons. 4. villi. 5. segments.
- () 18. The element which distinguishes proteins from starches and fats is: 1. iron. 2. potassium. 3. calcium. 4. sodium. 5. nitrogen.
- () 19. The hammer, anvil and stirrup bones are found in the: 1. ear. 2. pelvis. 3. nose. 4. shoulder. 5. hand.
- () 20. The stage of growth of the cell following fertilization is: 1. blastula. 2. pupa. 3. chrysalis. 4. gastrula. 5. medulla.
- () 21. Molting is an important life process in the life his-

- () 22. Respiration occurs in the: 1. lungs. 2. skin. 3. blood. 4. cells. 5. bones.
- () 23. Iodine is used as a test for: 1. sugar. 2. fat. 3. protein. 4. starch. 5. vitamins.
- () 24. An animal whose temperature remains nearly the same as that of its environment is said to be: 1. dormant. 2. cold-blooded. 3. warm-blooded. 4. retrogressive. 5. hibernating.
- () 25. Seed-producing plants are classified as: 1. bryophytes. 2. thallophytes. 3. spermatophytes. 4. pteridophytes. 5. geotrophites.
- () 26. The blood is carried from the heart to the lungs by the: 1. aorta. 2. ascending vena cava. 3. iliac artery. 4. jugular vein. 5. pulmonary artery.
- () 27. The habitat of adult tape worms is: 1. man's intestines. 2. man's kidneys. 3. man's lungs. 4. water. 5. ground.
- () 28. The portion of dicotyledonous plant stems where growth occurs is called: 1. cortex. 2. cambium. 3. xylem. 4. phloem. 5. pith.
- () 29. Milk sours because of: 1. age. 2. warmth. 3. bacteria. 4. thunder. 5. protozoa.
- () 30. Reproduction resulting from the union of a sperm and an egg is called: 1. budding. 2. fission. 3. cell division. 4. asexual. 5. sexual.
- () 31. The process of food manufacture by green plants is called: 1. osmosis. 2. transpiration. 3. respiration. 4. photosynthesis. 5. analysis.
- () 32. With respect to bacteria, man: 1. never needs them. 2. is neutral to their activity. 3. would suffer if all bacteria were destroyed.
- () 33. A person whose body resists the attack of disease germs is said to be: 1. susceptible. 2. dormant. 3. exotic. 4. immune.
- () 34. Severe cases of diphtheria are often cured by the use of: 1. antitoxin. 2. vaccine. 3. alcohol. 4. quarantine.
- () 35. Oxygen is carried in the blood by uniting with the: 1. plasma. 2. leucocytes. 3. white corpuscles. 4. lymph. 5. haemoglobin.

PART II

DIRECTIONS: In the parenthesis write the number of the word unrelated to the others.

Example:

- (2) 1. peach. 2. oak. 3. plum. 4. cherry. 5. apricot.
 The word unrelated to the others is "oak" because it is not a fruit. Hence a "2" has been placed in the parenthesis.
- () 36. 1. esophagus. 2. trachea. 3. stomach. 4. intestine. 5. liver.
- () 37. 1. sight. 2. hearing. 3. digestion. 4. smell. 5. touch.
- () 38. 1. chicken. 2. duck. 3. guinea. 4. turkey.
- () 39. 1. sheep. 2. goat. 3. horse. 4. cow.
- () 40. 1. bird. 2. fish. 3. frog. 4. turtle. 5. salamander.
- () 41. 1. amoeba. 2. paramecium. 3. vorticella. 4. hydra. 5. bacteria.
- () 42. 1. root. 2. stem. 3. leaf. 4. flower. 5. cocoon.
- () 43. 1. house-fly. 2. mosquito. 3. tachina fly. 4. codling moth. 5. wasp.

- () 44. 1. housefly. 2. bee. 3. wasp. 4. grasshopper. 5. sawfly.
- () 45. 1. labrum. 2. labium. 3. maxilla. 4. mandible. 5. molar.
- () 46. 1. vitamin. 2. plasma. 3. serum. 4. corpuscles. 5. fibrinogen.
- () 47. 1. sugar. 2. starch. 3. enzyme. 4. fat. 5. protein.
- () 48. 1. thyroid. 2. parathyroid. 3. thymus. 4. pancreas. 5. adrenal.
- () 49. 1. palate. 2. molar. 3. incisor. 4. cuspid. 5. bicuspid.
- () 50. 1. liver fluke. 2. tapeworm. 3. hookworm. 4. trichinella. 5. amoeba.
- () 51. 1. cambium. 2. terminal bud. 3. medullary ray. 4. pith. 5. xylem cells.
- () 52. 1. trypsin. 2. steapsin. 3. amylopsin. 4. lymph. 5. phyalin.
- () 53. 1. neuron. 2. ganglion. 3. cranium. 4. cerebellum. 5. medulla.
- () 54. 1. cornea. 2. iris. 3. retina. 4. lens. 5. sinus.
- () 55. 1. diphtheria. 2. diabetes. 3. tuberculosis. 4. pneumonia. 5. asthma.

PART III

DIRECTIONS: Decide what part of the body each disease listed in Column I chiefly affects. Then find the name of this part in Column II and write its number in the parenthesis before the name of the disease in Column I. Next, find in Column III, an important symptom of each disease and write its number in the parenthesis following the name of the disease.

Column I.

Column II.

Column III.

Location	Symptom	Column II.	Column III.
() 56. Adenoids	57. ()	1. bones	12. degeneration
() 58. Alcoholism	59. ()	2. digestive tract	13. excessive urine containing sugar
() 60. Appendicitis	61. ()	3. lungs	14. enlarged thyroid gland
() 62. Diabetes	63. ()	4. nerve centers and body tissues.	15. general debility and aenemia
() 64. Diphtheria	65. ()	5. nasal pharynx	16. intense pain near right groin
() 66. Goltre	67. ()	6. pancreas	17. lime deficiency and bone weakness
() 68. Hookworm	69. ()	7. red blood corpuscles	18. obstruction of nasal passages
() 70. Malaria	71. ()	8. thyroid gland	19. persistent cough
() 72. Rickets	73. ()	9. throat and tonsils	20. periodic chills
() 74. Scurvy	75. ()	10. upper intestine	21. swollen sore throat with fever
() 76. Tuberculosis	77. ()	11. vermiform appendix	22. ulcers in mouth and digestive tract.

PART IV.

DIRECTIONS: Read the following sentences carefully. If a statement is true, place a plus (+) in the parenthesis in front of the statement, as in example A below. If the statement is false, make a minus (-) in the parenthesis in front of it as in example B. Make the + and the - small and clear.

Examples: (+) A. Apples are good to eat.
(-) B. Potatoes grow on trees.

- () 78. The best natural method of insect control is the protection of our bird life.
- () 79. The structure of the amoeba is such that it illustrates "division of labor."
- () 80. Carbon dioxide waste of animals is necessary to the welfare of plant life.
- () 81. The root hairs are the true absorbing organs of the plant.
- () 82. The stem of the leaf is called the lenticel.
- () 83. Pepsin is an enzyme secreted by the pancreas.
- () 84. Carbohydrates contain a high percent of protein.
- () 85. Worker bees can replace a dead queen by proper feeding of a fertilized cell.
- () 86. The San Jose scale is a beneficial fungus used to eradicate the boll weevil.
- () 87. Iron is necessary in human diet to maintain a proper blood supply.
- () 88. The retina is a layer or coat of the eye, composed of nerve cells.
- () 89. Zoology is the study of animal and plant life.
- () 90. The skeleton of man is classified as an exoskeleton.
- () 91. Enzymes are injurious forms of protozoa.
- () 92. A plant grows by increasing the number of its cells.
- () 93. Yeast is a small, one-celled animal which causes fermentation.
- () 94. Matter can be neither created nor destroyed.
- () 95. Major Walter Reed was a famous ornithologist.
- () 96. Insects spread plant diseases.
- () 97. The Schick test shows whether one is susceptible to the poison from the germs that cause diphtheria.
- () 98. The poisons formed by the burning of tobacco have never been found to be beneficial to the human body.
- () 99. Glycogen changes to lactic acid in the muscle during muscular activity.
- () 100. The life cycle of man is fundamentally similar to that of the frog or fish.
- () 101. The bones of the pectoral girdle are well protected by muscles.
- () 102. Grasses are classed as dicotyledonous plants.
- () 103. Transpiration is the process by which plants obtain water through their root hairs.
- () 104. The Thalesa fly spreads yellow fever when it bites man.
- () 105. The house fly spreads typhoid by biting people.
- () 106. A food is a substance which when taken into the body, supplies energy and builds tissue.
- () 107. Ruminants are "cud chewing" animals.
- () 108. Tuberculosis may be inherited.
- () 109. Duroc-Jersey cows give the highest percent of butterfat of any breed.
- () 110. Influenza is an old disease, appearing in all parts of the world.

Biology Scoring Key

TEST II IMP FORM A

Papers must be scored according to this key. Give one point for each correct answer. An omission is counted as an error. See special directions for scoring on "General Directions." Cut off the answers and paste the narrow strip on a card board. This will be a good scoring stencil.

Possible score 110

**PAGE 1.
PART I.
Column I.**

**PAGE 1.
PART I.
Column II.**

	22. (4)
	23. (4)
	24. (2)
1. (4)	
2. (3)	25. (3)
3. (2)	26. (5)
4. (5)	27. (1)
5. (3)	28. (2)
6. (2)	29. (3)
7. (1)	30. (5)
8. (2)	31. (4)
9. (5)	32. (3)
10. (5)	33. (4)
11. (1)	34. (1)
12. (3)	35. (5)
13. (2)	
14. (4)	
15. (2)	
16. (2)	
17. (3)	36. (2)
18. (5)	37. (3)
19. (1)	38. (2)
20. (1)	39. (3)
	40. (1)
	41. (5)
	42. (5)
21. (3)	43. (3)

PART II.

**PAGE 2.
PART II.
Column I.**

**PAGE 2.
PART II.
Column II.**

44. (4)	50. (5)
45. (5)	51. (2)
46. (1)	52. (4)
47. (3)	53. (3)
48. (4)	54. (5)
49. (1)	55. (2)

PART III.

PART III.

	56. (5)	57. (18)
	58. (4)	59. (12)
	60. (11)	61. (16)
	62. (8)	63. (13)
	64. (9)	65. (21)
	66. (8)	67. (14)
	68. (10)	69. (15)
	70. (7)	71. (20)
	72. (1)	73. (17)
	74. (2)	75. (22)
	76. (3)	77. (19)

PART IV.

PART IV.

78. (+)	95. (-)
79. (-)	96. (+)
80. (+)	97. (+)
81. (+)	98. (+)
82. (-)	99. (+)
83. (-)	100. (+)
84. (-)	101. (-)
85. (+)	102. (-)
86. (-)	103. (-)
87. (+)	104. (+)
88. (-)	105. (-)
89. (-)	106. (+)
90. (-)	107. (+)
91. (-)	108. (-)
92. (+)	109. (-)
93. (-)	110. (+)
94. (+)	

TEST II * FORM B

EVERY PUPIL SCHOLARSHIP TEST
April 5, 1933.Bureau of Educational Measurements
Kansas State Teachers College, Emporia

BIOLOGY

By John R. Williams, Emporia High School,
Emporia, Kansas.

Possible score 110

Number wrong
and omitted

FINAL SCORE

Directions: Answer the easiest parts first. Go back and work on the others. You will have exactly 40 minutes.

Name Age Grade

School Teacher

Town State Date

PART I

DIRECTIONS: Place the number of the part which makes the best answer to the statement in the parenthesis before the statement.

(3) Biology is a: 1. habit. 2. education. 3. science.

In this sample, "science" is the correct answer. The number of the word "science" is 3. The figure 3 has been placed in the parenthesis.

- () 1. A valuable natural enemy of plant lice is the:
1. cicada. 2. aphid. 3. cockroach. 4. lady bug.
5. cricket.
- () 2. The term "praecocial" refers to the young of the:
1. robin. 2. sparrow. 3. pigeon. 4. crow. 5. quail.
- () 3. Rats are known to spread: 1. malaria. 2. goiter.
3. scurvy. 4. typhoid. 5. bubonic plague.
- () 4. The form of protoplasm composing the main body
of a cell is: 1. nucleus. 2. cytoplasm. 3. endosperm.
4. vacuole. 5. nucleolus.
- () 5. Milk cows are classified as: 1. primates. 2. rodentia.
3. insectivores. 4. ungulata. 5. carnivora.
- () 6. A disorder caused by bacteria is: 1. diphtheria.
2. malaria. 3. hook worm. 4. goiter. 5. rickets.
- () 7. Foods are absorbed into the cells of our bodies by:
1. synthesis. 2. osmosis. 3. transpiration. 4. reduction.
5. digestion.
- () 8. The food containing a high per cent of protein is:
1. potato. 2. apple. 3. hominy. 4. butter. 5. egg.
- () 9. The mosquito which carries the malarial germ is
the: 1. aphid. 2. aedes. 3. anopheles. 4. culex.
5. diptera.
- () 10. A contact poison is commonly used to kill the:
1. army worm. 2. potato beetle. 3. codling moth.
4. San Jose' scale. 5. grasshopper.
- () 11. Fats are absorbed from the intestine into the:
1. lacteals. 2. veins. 3. capillaries. 4. spleen.
5. liver.
- () 12. The enzyme secreted in the saliva is: 1. ptyalin.
2. trypsin. 3. hydrochloric acid. 4. steapsin.
5. amylopsin.
- () 13. The man that originated vaccination for smallpox
was: 1. Koch. 2. Jenner. 3. Lister. 4. Darwin.
5. Audubon.
- () 14. A group of tissues acting together as a unit of
structure is called: 1. a cell. 2. a system. 3. an
organ. 4. a chromosome.
- () 15. When a substance containing starch is treated
with iodine, its color becomes: 1. red. 2. yellow.
3. green. 4. brown. 5. blue.
- () 16. The female reproductive cell is named: 1. ganglion.
2. sperm. 3. ovum. 4. neuron. 5. nucleus.
- () 17. Bones are bound together at joints by: 1. muscles.
2. tendons. 3. sutures. 4. ligaments. 5. mesenteries.
- () 18. The element especially required to form haemoglobin
of the blood is: 1. iron. 2. sodium. 3. calcium.
4. hydrogen. 5. oxygen.
- () 19. The carpal bones are found in the: 1. wrist.
2. shoulder. 3. face. 4. fingers. 5. ankle.
- () 20. The double-walled, cup-like group of cells which
forms one stage of growth after fertilization of the
egg is named: 1. chromosome. 2. blastula.
3. gastrula. 4. gamete. 5. medulla.
- () 21. Adolescence is an important stage in the life of:
1. insects. 2. man. 3. frogs. 4. birds. 5. carnivora.
- () 22. Digestion of food is completed in the: 1. esophagus.
2. trachea. 3. stomach. 4. liver. 5. intestine.
- () 23. The chemical used to test for protein in a food is:
1. iodine. 2. Fehling's solution. 3. nitric acid.
4. sulfuric acid. 5. glucose.
- () 24. An example of a cold-blooded animal is the:
1. hippopotamus. 2. elephant. 3. bear. 4. fish.
penguin.
- () 25. An example of an angiosperm plant is: 1. fern.
2. moss. 3. bean. 4. pine. 5. fungus.
- () 26. The fat enters the blood stream in the human
body by way of: 1. villi. 2. thoracic duct. 3. vena
cava. 4. aorta. 5. esophagus.
- () 27. The hookworm usually enters the human body by
way of the: 1. mouth. 2. nose. 3. hands. 4. feet.
5. intestine.
- () 28. The tissue of plant stems which carries water upward
is called: 1. cortex. 2. cambium. 3. xylem.
4. phloem. 5. pith.
- () 29. The chief element supplied by milk, used by the
human body is: 1. iron. 2. carbohydrate. 3. iodine.
4. sodium. 5. calcium.
- () 30. A plant that reproduces by budding is: 1. yeast.
2. amoeba. 3. bacteria. 4. hydra. 5. aves.
- () 31. The process by which the cells of an organism obtain
oxygen is called: 1. breathing. 2. respiration.
3. chemical union. 4. dialysis. 5. transfusion.
- () 32. The disease which causes the highest American
death-rate is: 1. tuberculosis. 2. smallpox. 3. scarlet
fever. 4. heart disease.
- () 33. The process of food manufacture in plants is:
1. transpiration. 2. digestion. 3. photosynthesis.
4. respiration.
- () 34. If one is susceptible to diphtheria, it may be proved
by: 1. the Schick test. 2. the Dick test. 3. vaccination.
4. quarantine. 5. culture.
- () 35. When glycogen is used in muscular activity, the
substance formed as waste is called: 1. mineral
ash. 2. liver sugar. 3. lactic acid. 4. diastase.

PART II.

DIRECTIONS: In the parenthesis write the number of the word unrelated to the others.

Example: (2) 1. peach. 2. oak. 3. plum. 4. cherry.
5. apricot.

The word unrelated to the others is "oak," because it is not a fruit. Hence a "2" has been placed in the parenthesis.

- () 36. 1. epithelial. 2. connective. 3. cardiac. 4. auricle. 5. epidermal.
- () 37. 1. absorption. 2. mastication. 3. excretion. 4. reproduction. 5. irritability.
- () 38. 1. bulb. 2. corn. 3. seed. 4. tuber. 5. rhizome.
- () 39. 1. Hereford. 2. Holstein. 3. Jersey. 4. Ayrshire. 5. Brown Swiss.
- () 40. 1. butter. 2. lard. 3. oleo. 4. lean meat. 5. cream.
- () 41. 1. crayfish. 2. clam. 3. crab. 4. lobster. 5. shrimp.
- () 42. 1. epidermis. 2. palisade. 3. lenticel. 4. stomata. 5. chlorophyll.
- () 43. 1. wood borers. 2. potato beetle. 3. boll weevil. 4. carrion beetle. 5. May beetle.
- () 44. 1. swallow-tail. 2. monarch. 3. sulphur. 4. cecropia. 5. buckeye.

- () 45. 1. caudal fin. 2. chela. 3. uropod. 4. maxilliped. 5. mandible.
- () 46. 1. artery. 2. vein. 3. plasm. 4. trachea. 5. esophagus.
- () 47. 1. vitamin. 2. pepsin. 3. ptyalin. 4. trypsin. 5. steapsin.
- () 48. 1. liver. 2. thymus. 3. gastric. 4. salivary. 5. pancreas.
- () 49. 1. periosteum. 2. pericardium. 3. peritoneum. 4. peristalsis. 5. pleura.
- () 50. 1. culex. 2. diptera. 3. anopheles. 4. aedes. 5. spongomyia.
- () 51. 1. terminal bud. 2. lenticel. 3. leaf scar. 4. bark. 5. cambium.
- () 52. 1. trypsin. 2. haemoglobin. 3. plasma. 4. lymph. 5. corpuscle.
- () 53. 1. cartilage. 2. neuron. 3. marrow. 4. medullary canal. 5. periosteum.
- () 54. 1. cornea. 2. tympanum. 3. cochlea. 4. semicircular canal. 5. eustachian tube.
- () 55. 1. diabetes. 2. goiter. 3. dwarfism. 4. malaria. 5. rickets.

PART III.

DIRECTIONS: Decide what part of the body each disease listed in Column I chiefly affects. Then find the name of this part in Column II and write its number in the parenthesis before the name of the disease in Column I. Next, find in Column III an important symptom of each disease and write its number in the parenthesis following the name of the disease.

Column I.	Column II.	Column III.
<p>Location</p> <ul style="list-style-type: none"> () 56. Cancer () 58. Dwarfism () 60. Influenza () 62. Mumps () 64. Peritonitis () 66. Rabies () 68. Scarlet fever () 70. Smallpox () 72. Trichinosis () 74. Gall stones () 76. Whooping cough 	<p>Symptom</p> <ul style="list-style-type: none"> () 57. 1. any tissue or organ () 59. 2. blood and nerve tissue () 61. 3. body tissues and respiratory tract () 63. 4. lining of abdominal cavity () 65. 5. liver () 67. 6. muscles () 69. 7. muscles, nerves, or respiratory tract () 71. 8. regions of growth () 73. 9. salivary glands () 75. 10. skin () 77. 11. throat and trachea 	<ul style="list-style-type: none"> 12. choking, spasmodic cough 13. eruptions with yellow pus 14. fever and loss of mind 15. fever, pain, inflamed bronchial tubes 16. inflammation of abdominal tissue 17. inflammation of muscle tissue 18. pain in bile duct 19. short stature, often imbecile 20. sores or enlarged tissues 21. sudden, high fever and red rash 22. swollen glands

PART IV.

DIRECTIONS: Read the following sentences carefully. If a statement is true, place a plus (+) in the parenthesis before the statement, as in example A below. If the statement is false, make a minus (-) in the parenthesis before it, as in example B.

Examples

(+) A. A frog is an animal.

(-) B. All animals have wings.

- () 78. The Tachina fly causes sleeping sickness.
- () 79. The organs of man illustrate "division of labor" in an organism.
- () 80. Animal life can live independently of plant life.
- () 81. Carbon dioxide gas is obtained by plants through the leaves.
- () 82. The petiole is a part of the flower.
- () 83. Steapsin is an enzyme secreted in the stomach.
- () 84. Casein is a protein compound.
- () 85. Drone bees are of the male sex.
- () 86. The trichinella is a beneficial parasite.
- () 87. Iodine is necessary in human diet to maintain proper bone growth.
- () 88. Astigmatism is the adjustment of the eye to near and far sight.
- () 89. Botany is the study of plant life.
- () 90. Muscles in the body are commonly found in antagonistic pairs.
- () 91. Enzymes are the secretions of ductless glands.
- () 92. The cells of a plant increase in size but not in number.
- () 93. Mold is caused by a microscopic protozoa.
- () 94. Energy can be neither created nor destroyed.
- () 95. Robert Koch introduced vaccination for smallpox.
- () 96. Plant diseases may be carried by seeds of plants.
- () 97. The Dick test detects susceptibility to germs of scarlet fever.
- () 98. Experiments indicate that poisons of burning tobacco tend to injure eyesight.
- () 99. An excess of carbon dioxide is the chief cause of fatigue of muscles.
- () 100. It has been discovered that undulant fever is an old disease.
- () 101. Muscles are attached to bones by ligaments.
- () 102. Food is absorbed from the intestine by the process of osmosis.
- () 103. Alcohol has the properties of a food.
- () 104. The use of poison sprays is dangerous to bird life.
- () 105. Disease epidemics commonly follow periods of warfare.
- () 106. Disease is always caused by either bacteria or protozoa.
- () 107. The life functions of the human are similar to those of any other mammal.
- () 108. Cereal crops are classed as monocotyledons.
- () 109. Stomata permit the passage of gases through the epidermis of leaves.
- () 110. The cambium is the portion of the stem which makes possible the increase in diameter.

Biology
TEST II KEY FORM B

April 5, 1933.

Papers must be scored according to this key. Give one point for each correct answer. An omission is counted as an error. See special directions for scoring on "General Directions."

Possible score 110

PAGE 1
PART I.
Column I.

PAGE 1
PART I.
Column II.

- | | |
|---------|---------|
| 1. (4) | 17. (4) |
| 2. (5) | 18. (1) |
| 3. (5) | 19. (1) |
| 4. (2) | 20. (3) |
| 5. (4) | 21. (2) |
| 6. (1) | 22. (5) |
| 7. (2) | 23. (3) |
| 8. (5) | 24. (4) |
| 9. (3) | 25. (3) |
| 10. (4) | 26. (2) |
| 11. (1) | 27. (4) |
| 12. (1) | 28. (3) |
| 13. (2) | 29. (5) |
| 14. (3) | 30. (1) |
| 15. (5) | 31. (2) |
| 16. (3) | 32. (4) |
| | 33. (3) |
| | 34. (1) |
| | 35. (3) |

PAGE 2
PART II.
Column I.

PAGE 2
PART II.
Column II.

36. (4)
37. (2)
38. (2 or 3)
39. (1)
40. (4)
41. (2)
42. (3)
43. (4)
44. (4)

45. (1)
46. (3)
47. (1)
48. (2)
49. (4)
50. (2)
51. (5)
52. (1)
53. (2)
54. (1)
55. (4)

PART III.

PART III.

56. (1)
58. (8)
60. (7)
62. (9)
64. (4)
66. (2)
68. (3)
70. (10)
72. (6)
74. (5)
76. (11)

57. (20)
59. (19)
61. (15)
63. (22)
65. (16)
67. (14)
69. (21)
71. (13)
73. (17)
75. (18)
77. (12)

PART IV.

PART IV.

78. (—)
79. (+)
80. (—)
81. (+)
82. (—)
83. (—)
84. (+)
85. (+)
86. (—)
87. (—)
88. (—)
89. (+)
90. (+)
91. (—)
92. (—)

93. (—)
94. (+)
95. (—)
96. (+)
97. (+)
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99. (—)
100. (+)
101. (—)
102. (+)
103. (—)
104. (+)
105. (+)
106. (—)
107. (+)
108. (+)
109. (+)
110. (+)

TEST III * FORM A

Directions: Place the number of the part which makes the best answer to the statement, in the parenthesis at the front of the statement.

(3) Biology is a: 1. habit. 2. education. 3. science.

In this sample, "science" is number three and the correct answer. The figure "3" has been placed in the parenthesis.

- (4) 1. Corn stems are classified according to structure as: 1. dicotyledon. 2. diadelphous. 3. trifoliolate. 4. monocotyledon.
- (2) 2. Not required for the germination of seeds: 1. water. 2. light. 3. heat. 4. oxygen.
- (3) 3- Brightly colored flowers are usually pollinated by: 1. birds. 2. wind. 3. insects. 4. water. 5. rodents.
- (2) 4. The portion of the stem where growth in diameter occurs: 1. xylem. 2. cambium. 3. phloem. 4. bark. 5. pith.
- (1) 5. Cells divide by a process called: 1. fission. 2. digestion. 3. photosynthesis. 4. union. 5. assimilation.
- (3) 6. The Irish potato is a: 1. bulb. 2. corm. 3. tuber. 4. seed. 5. rhizome.
- (4) 7. The name of the process by which plants give off water vapor: 1. respiration. 2. evaporation. 3. suffocation. 4. transpiration. 5. geotropism.
- (2) 8. The seeds form within the: 1. calyx. 2. ovary. 3. corolla. 4. anthers. 5. spur.
- (3) 9. A whorl of leaves arranged spirally on a very short stem is called: 1. mosaic. 2. bulb. 3. rosette. 4. palisade. 5. rhizome.
- (2) 10. The fruit of the apple is a: 1. drupe. 2. pome. 3. thyrse. 4. pepo. 5. berry.
- (5) 11. Growth in length of root occurs in the: 1. central cylinder. 2. cortex. 3. epidermis. 4. root cap. 5. meristem.
- (2) 12. The stage of the wheat rust commonly termed "red rust": 1. teleuto. 2. uredo. 3. aecidium. 4. sporidia.
- (4) 13. The inflorescence of the blue grass is: 1. head. 2. solitary. 3. umbel. 4. panicle. 5. raceme.
- (4) 14. Formulated the laws of heredity: 1. Burbank. 2. Koch. 3. Darwin. 4. Mendel. 5. Lister.

TEST III * FORM A

- (3)15. The bean seed was attached while growing by the:
1. hypocotyl. 2. cotyledon. 3. hilum.
4. plumule. 5. scutellum.
- (1)16. When a leaf is composed of several to many leaflets,
it is said to be: 1. compound. 2. clasping.
3. serrate. 4. simple. 5. twining.
- (2)17. An essential organ of a flower is: 1. petal.
2. stamen. 3. sepal. 4. bract. 5. calyx.
- (5)18. The fruit of the dandelion is a: 1. nut. 2. drupe.
3. samara. 4. berry. 5. akene.
- (4)19. When the ovules are attached to the outer ovary wall,
the placentation is: 1. centrifugal. 2. axial.
3. excurrent. 4. parietal. 5. free central.
- (3)20. An animal food commonly obtained from stems:
1. bran. 2. shorts. 3. silage. 4. chopped turnips.
- (5)21. A plant whose stem is used for human food:
1. castor bean. 2. banana. 3. mullein. 4. turnip.
5. Irish potato.
- (1)22. The economic use of the tuber: 1. food. 2. lumber.
3. ornament. 4. clothing. 5. medicine.
- (2)23. A commercial product obtained from leaves: 1. sago.
2. tobacco. 3- coffee. 4. pepper. 5. rubber.
- (3)24. A substance from the juice of stems: 1. vinegar.
2. hemp. 3. turpentine. 4. alcohol. 5. strychnine.
- (5)25. A medicinal product obtained from stems: 1. opium.
2. castor oil. 3. mandrake. 4. strychnine.
5. witch hazel.
- (1)26. A commercial product obtained from roots:
1. tapioca. 2. sago. 3. camphor. 4. pepper.
5. asparagus.
- (3)27. The economic use of the root of the turnip:
1. ornament. 2. medicine. 3. food. 4. paper.
5. condiment.
- (5)28. The economic use of the root of the ginger:
1. ornament. 2. fertilizer. 3. food. 4. paper.
5. condiment.
- (2)29. A plant whose leaves are used in medicine: 1. corn.
2. coca. 3. licorice. 4. daisy. 5. aconite.
- (3)30. A plant whose floral part is used for food:
1. poppy. 2. peppermint. 3. artichoke. 4. potato.
5. asparagus.
- (3)31. The fruit not dehiscent: 1. bean. 2. poppy.
3. corn. 4. violet. 5. lily.
- (5)32. A name designating a family of degenerates, illus-
trating the effect of heredity: 1. Darwin.
2. Mendel. 3. Harvey. 3. Galton. 5. Kallikak.
- (2)33. The father of modern surgery: 1. Pasteur.
2. Lister. 4. Jenner. 3. Koch. 5. Gray.

TEST III * FORM A

- (4)34. An example of a hybrid: 1. horse. 2. cow.
3. sheep. 4. mule. 5. hog.
- (5)33. The name of the apparent character of the first Mendelian cross: 1. recessive. 2. introvert.
3. aggregate. 4. extrovert. 5. dominant.

Part II - Unrelated Word

Directions: In the parenthesis write the number of the word unrelated to the others, as "ash" in the example:

- (2) 1. peach. 2. ash. 3. plum. 4. cherry. 5. apricot.
- (4)36. 1. elm. 2. poplar. 3. catalpa. 4. spruce. 5. oak.
- (5)37. 1. calyx. 2. corolla. 3. ovary. 4. stigma. 5. lenticel.
- (3)38. 1. blade. 2. petiole. 3. medullary ray. 4. stipule.
5. vein.
- (3)39. 1. apple. 2. pear. 3. peach. 4. quince.
5. crabapple.
- (1)40. 1. samara. 2. pepo. 3. berry. 4. pome. 5. drupe.
- (1)41. 1. corymb. 2. berry. 3. samara. 4. pome. 5. akene.
- (1)42. 1. moss. 2. mold. 3. mushroom. 4. rust. 5. smut.
- (4)43. 1. Anjou. 2. Bartlett. 3. Kieffer. 4. Richmond.
5. Seckle.
- (5)44. 1. Bessey. 2. Gray. 3. Lister. 4. Burbank.
5. Muzzy.
- (2)45. 1. yeast. 2. tuber. 3. bread mold. 4. rust.
5. smut.
- (1)46. 1. rose. 2. daisy. 3. cosmos. 4. zinnia. 5. aster.
- (2)47. 1. Champion. 2. Concord. 3. Elberta. 4. Crawford.
5. Crosby.
- (3)48. 1. clover. 2. alfalfa. 3. timothy. 4. soy bean.
5. vetch.
- (2)49. 1. tuber. 2. legume. 3. rhizome. 4. stolon.
5. corm.
- (1)50. 1. Rockefeller Foundation. 2. Bureau of Fisheries.
3. Biological Survey. 4. Public Health Service.
5. U. S. Forestry service.

Part III - True - False

Directions: Read the following sentences carefully. If a statement is true, place a plus (+) in the parenthesis before the statement, as in example A, below. If the statement is false, make a minus (-) in the parenthesis before it, as in example B.

Examples

- (+) A. A frog is an animal.
- (-) B. All animals have wings.

TEST III * FORM A

- (-) 51. The round-shaped bacteria are known as bacillus forms.
- (-) 52. Diseases in which certain tissues take on an abnormal growth are termed "inherited" diseases.
- (+) 53. Algae are simple aquatic plants, containing chlorophyll, capable of maintaining an independent existence.
- (-) 54. The first stage of growth of the young plant from the seed occurs when the plumule breaks out of the testa.
- (+) 55. Roots are food absorbing organs of plants.
- (+) 56. Xylem tubes carry water from the roots to the stems.
- (-) 57. The shedding of leaves by a plant is termed transpiration.
- (+) 58. Stamens are essential parts of a flower.
- (+) 59. The fruit of the tomato is a berry.
- (-) 60. Yeast is a monocotyledonous plant.
- (+) 61. Forests are good agents of flood prevention.
- (-) 62. A balanced terrarium is a situation in which water plants and animals continue to live together indefinitely with relationship of interdependence.
- (-) 63. Cattle are dipped in septic tanks to remove the Texas fever tick.
- (+) 64. Modern surgery attempts to prevent bacteria from entering wounds by sterilizing all operating instruments.
- (+) 65. New discoveries in science consist in making clear some previously existing fact of nature.
- (-) 66. Heredity is the study of the biological and social agencies which may improve or impair the inborn physical and mental qualities of man.
- (-) 67. Pasteurized milk is free from all bacteria.
- (+) 68. Bacteria normally inhabit the human intestine.
- (-) 69. Tapeworms are a form of one-celled plant protozoa.
- (+) 70. Pleurococcus is a form of alga.
- (+) 71. Stipules are small projections at the base of the petiole.
- (-) 72. The life processes of plants differ widely from the life processes of animals.
- (+) 73. The viability of a seed refers to its power to resume activity and to grow when proper conditions are provided.
- (+) 74. The food stored in the cotyledons of the seed must be digested before it is available for the embryo.
- (-) 75. Large fleshy roots are characteristic of the grass family.
- (-) 76. The fibrovascular bundles in monocotyledons are arranged in rings in the woody tissue.
- (+) 77. The organs through which gas and water pass from the leaf surface are called stomata.

TEST III * FORM A

- (-) 78. The arrangement of the flowers on the plant is called placentation.
 (+) 79. The ripened ovary and its contents is commonly named the fruit.
 (+) 80. The method of attachment of the ovules in the ovary of a plant is called placentation.

TEST III * FORM A

20 Additional Items

Part IV - Matching

Directions: Before Column I, place the number of the word or statement in Column II which matches it.

Example: (5) 1. Leaf 5. A part of a tree.

- | | | |
|------|--------------------|---------------------------------------|
| (16) | 1. Fibrous | 1. Anther. |
| (13) | 2. Drupe | 2. Covering of ovules. |
| (7) | 3. Pollination | 3. Embryo. |
| (11) | 4. Wheat | 4. Food-carrying tubes. |
| (18) | 5. Vegetables | 5. Food manufacture by plants. |
| (2) | 6. Integument | 6. Inflorescence. |
| (17) | 7. Testa | 7. Insects. |
| (1) | 8. Pollen | 8. Laws of heredity. |
| (19) | 9. Tuber | 9. Maple. |
| (6) | 10. Umbel | 10. Modified seed-leaves. |
| (20) | 11. Scion | 11. Monocotyledon. |
| (9) | 12. Samara | 12. Mosaic. |
| (3) | 13. Egg | 13. Peach. |
| (4) | 14. Phloem | 14. Point where stem grows in length. |
| (5) | 15. Photosynthesis | 15. Red rust of grain. |
| (22) | 16. Fire | 16. Roots of grass. |
| (8) | 17. Mendel | 17. Seed coat. |
| (14) | 18. Terminal bud | 18. Source of vitamin. |
| (10) | 19. Scutellum | 19. Stem for food storage. |
| (15) | 20. Uredospore | 20. Stock. |
| | | 21. Theory of evolution. |
| | | 22. Worst enemy of forests. |

TEST III * FORM B

Directions: Place the number of the part which makes the best answer to the statement, in the parenthesis at the front of the statement.

(3) Biology is a: 1. habit. 2. education. 3. science.

In this sample, "science" is number three and the correct answer. The figure "3" has been placed in the parenthesis.

- (1) 1. Elm stems are classified according to structure as:
1. dicotyledon. 2. trifoliolate. 3. diadelphous.
4. monocotyledon.
- (2) 2. Necessary for the germination of seeds: 1. nitrogen.
2. oxygen. 3. carbon dioxide. 4. hydrogen.
- (4) 3. Inconspicuous flowers, small in size, are usually
pollinated by: 1. birds. 2. wind. 3. insects.
4. self. 5. rodents.
- (4) 4. Irregular air pores in the surface of smooth stems:
1. leaf scars. 2. buds. 3. annual rings.
4. lenticels.
- (2) 5. The process of cell union in the flower to form seed:
1. fission. 2. fertilization. 3. pollination.
4. transportation. 5. Katabolism.
- (1) 6. The onion is a: 1. bulb. 2. corm. 3. tuber.
4. seed. 5. rhizome.
- (1) 7. Digestion in plants usually takes place in:
1. leaves. 2. root. 3. twigs. 4. stems. 5. flowers.
- (5) 8. To form the seed, pollen unites with the: 1. calyx.
2. anther. 3. stamen. 4. stems. 5. ovule.
- (2) 9. Leaves arranged upon a branch to fill all spaces
without overlapping are termed: 1. rosette. 2. mosaic.
3. palisade. 4. panicle. 5. samara.
- (4) 10. The fruit of tomato is a: 1. drupe. 2. pome. 3. pepo.
4. berry. 5. samara.
- (2) 11. Food is stored in the root chiefly in the: 1. central
cylinder. 2. cortex. 3. epidermis. 4. root cap.
5. meristem.
- (5) 12. The spore-producing organ of mold is a: 1. ovary.
2. flower. 3. hypha. 4. sporophyte. 5. sporangium.
- (1) 13. The inflorescence of the tulip is: 1. solitary.
2. umbel. 3. head. 4. panicle. 5. raceme.
- (2) 14. Noted for his skill in selecting and propogating
plants: 1. Kock. 2. Burbank. 3. Darwin. 4. Mendel.
5. Lister.

TEST III * FORM B

- (4)15. The name given a family of degenerates, illustrating the effect of heredity: 1. Darwin. 2. Mendel. 3. Galton. 4. Jukes. 5. Harvey.
- (3)16. The man that discovered the germ of tuberculosis; 1. Pasteur. 2. Lister. 3. Koch. 4. Jenner. 5. Gray.
- (4)17. A fruit that is dehiscent: 1. corn. 2. tomato. 3. samara. 4. legume. 5. plum.
- (4)18. The growing tip of the stem of the germinating seed is named: 1. hypocotyl. 2. cotyledon. 3. hilum. 4. plumule. 5. scutellum.
- (5)19. When the blade of a leaf is in one piece, it is said to be: 1. multiple. 2. compound. 3, clasping. 4. serrate. 5. simple.
- (5)20. The calyx of a flower is composed of: 1. stamens. 2. pistils. 3. anthers. 4. petals. 5. sepals.
- (2)21. The fruit of the cherry is a: 1. nut. 2. drupe. 3. samara. 4. akene. 5. pome.
- (2)22. When the ovules are attached to the central wall, the placentation is : 1. centrifugal. 2. axial. 3. excurrent. 4. parietal.
- (3)23. An animal food commonly obtained from stems: 1. shorts. 2. flour. 3. fodder. 4. beet pulp. 5. bran.
- (5)24. A plant whose stem is used for human food: 1. flax. 2. banana. 3. catnip. 4. turnip. 5. asparagus.
- (4)25. The economic use of the stem of the walnut: 1. food. 2. ornament. 3. clothing. 4. lumber. 5. medicine.
- (3)26. A commercial obtained from stems: 1. beet sugar. 2. rice. 3. jute. 4. peppermint. 5. crisco.
- (3)27. A substance obtained from the juice of stems: 1. alcohol. 2. linen. 3. rubber. 4. opium. 5. vinegar.
- (5)28. A medical product obtained from stems: 1. strychnine. 2. rhubarb. 3. linseed oil. 4. cocaine. 5. turpentine.
- (4)29. The economic use of the root of the sassafras: 1. ornament. 2. food. 3. fertilizer. 4. medicine. 5. condiment.
- (2)30. The economic use of the root of the rhubarb: 1. ornament. 2. medicine. 3. food. 4. paper. 5. condiment.
- (2)31. A commercial product sometimes obtained from roots: 1. pepper. 2. sugar. 3. cocoa. 4. asparagus. 5. campher.
- (4)32. A plant whose floral part is used for food: 1. tobacco. 2. spearmint. 3. carrot. 4. cauliflower. 5. cabbage.
- (1)33. A plant whose leaves are used in medicine: 1. wormwood. 2. wheat. 3. hemp. 4. sunflower. 5. jute.

TEST III * FORM B

- (2)34. A commercial product obtained from leaves: 1. hops.
2. tea. 3. opium. 4. tapioca. 5. camphor.
- (4)35. An example of a hybrid: 1. Holstein. 2. Hereford.
3. Percheron. 4. Mule. 5. Poland China.
- (4)36. The name of the hidden character in the first Mendelian
cross: 1. introvert. 2. dominant. 3. extrovert.
4. recessive. 5. aggregate.

Unrelated-word

Directions: In the parenthesis write the number of the word
unrelated to the others, as "ash" in the example:

- (2) 1. peach. 2. ash. 3. plum. 4. cherry. 5. apricot.
- (2)37. 1. pine. 2. oak. 3. spruce. 4. fir. 5. arbor vitae.
- ((4)38. 1. sepal. 2. petal. 3. ovary. 4. plumule. 5. stamen.
- (5)39. 1. cutin. 2. epidermis. 3. palisade cells. 4. stomata
5. testa.
- (3)40. 1. beet. 2. carrot. 3. irish potato. 4. sweet
potato. 5. radish.
- (4)41. 1. samara. 2. nut. 3. akene. 4. pome. 5. legume.
- (3)42. 1. raceme. 2. umbel. 3. legume. 4. head. 5. panicle.
- (2)43. 1. Winesap. 2. Bartlett. 3. Delicious. 4. Grimes
Golden. 5. Jonathan.
- (4)44. 1. Mendel. 2. Gray. 3. Smith. 4. Garner. 5. Leeuwenhoek
- (3)45. 1. rust. 2. yeast. 3. rhizome. 4. bread mold. 5. smut.
- (1)46. 1. daisy. 2. poppy. 3. nasturtium. 4. phlox. 5. petunia
- (4)47. 1. Moore's Early. 2. Concord. 3. Niagara. 4. Snyder.
5. Catawba.
- (3)48. 1. kaffir. 2. cane. 3. corn. 4. sudan. 5. milo.
- (2)49. 1. akene. 2. rhizome. 3. samara. 4. capsule. 5. nut.
- (1)50. 1. U. S. Public Health Service. 2. Carnegie Institute.
3. Rockefeller Foundation. 4. Milbank Memorial
Foundation.

True - False

Directions: Read the following sentences carefully. If a
statement is true, place a plus (+) in the parenthesis
before the statement, as in example A, below. If the state-
ment is false, make a minus (-) in the parenthesis before
it, as in example B.

Examples:

- (+) A. A frog is an animal.
- (-) B. All animals have wings.

TEST III * FORM B

- (-) 51. Bacteria corkscrew in shape are known as coccus forms.
- (-) 52. Diseases caused by chemical agents, as poisons, are termed " biological " diseases.
- (+) 53. Fungi compose a low order of plants, do not contain chlorophyll, and maintain a parasitic existence.
- (-) 54. The first stage of growth of the young plant from the seed occurs when the cotyledons break through the testa.
- (+) 55. Many perennial roots serve as organs of food storage.
- (+) 56. Phloem tubes transfer food from leaves to parts using it.
- (+) 57. The process by which leaves give off water is called transpiration.
- (+) 58. The pistil of a flower is an essential part.
- (+) 59. The fruit of the apple is a pome.
- (-) 60. Bread mold is a dicotyledonous plant.
- (+) 61. Forest-covered mountains are considered good sources of water supply for many large cities.
- (-) 62. A balanced aquarium is a situation in which land plants and animals continue to live together indefinitely with relationship of interdependence.
- (-) 63. Milk is treated in septic tanks at a temperature of 160 degrees Fahrenheit to kill all bacteria.
- (+) 64. Modern surgery attempts to prevent bacteria from entering wounds by operating in an environment freed from bacteria.
- (+) 65. New discoveries of science consist of the recognition of relationships not previously noticed and described.
- (-) 66. Eugenics is the study which seeks to explain the nature of differences and similarities between parent and offspring.
- (-) 67. Milk boiled for twenty minutes is said to be pasteurized.
- (+) 68. The removal of waste from the intestine is aided by the presence of desirable bacteria.
- (-) 69. The trichinella is a form of bacteria.
- (+) 70. Spirogyra is a form of alga.
- (+) 71. The petiole is the stem of the leaf.
- (-) 72. The economic use to man of plants differs widely from his economic use of animals.
- (+) 73. A seed which is viable but inactive is said to be dormant.
- (+) 74. The scutellum aids in the digestion of the food of the endosperm of the corn kernel for use by the embryo plant.
- (-) 75. Fibrous roots are characteristics of the carrot family.
- (-) 76. The fibrovascular bundles in dicotyledons are scattered irregularly throughout the pith.
- (+) 77. Ordinary horizontal aerial leaves bear most of their stomata upon the lower surface.
- (+) 78. The transfer of pollen from one plant to another is called pollination.

TEST III * FORM B

- (+)79. Fruits may grow upon plants commonly termed vegetables.
- (+)80. When the petals and sepals of a flower are attached to the receptacle below the ovary, the flower is hypogynous.

TEST III * FORM B

20 Additional Items

Part IV - Matching

Directions: Before Column I, place the number of the word or statement in Column II which matches it.

- | | |
|----------------------------|------------------------------------|
| Example: (5) 1. Leaf | 5. A part of a tree. |
| (22) 1. Cleistogamous | 1. A benefit derived from forests. |
| (12) 2. Fertilization | 2. Acorn. |
| (20) 3. Berry | 3. Air pores. |
| (17) 4. Cereal | 4. Apple. |
| (8) 5. Plumule | 5. Black rust of grain. |
| (4) 6. Pome | 6. Dicotyledon. |
| (16) 7. Hilum | 7. Excretion of water by plants. |
| (15) 8. Hypocotyl | 8. First bud of plant embryo. |
| (13) 9. Fascicled | 9. Fruit of composite. |
| (14) 10. Internode | 10. Leaf for food storage. |
| (21) 11. Xylem | 11. Method of reproduction. |
| (9) 12. Akene | 12. Ovule. |
| (6) 13. Garden pea | 13. Roots for food storage. |
| (10) 14. Cotyledon | 14. Section of stem. |
| (11) 15. Budding | 15. Seed root. |
| (3) 16. Stomata | 16. Seed scar. |
| (7) 17. Transpiration | 17. Source of starch. |
| (5) 18. Teleutospore | 18. Successful plant improvement. |
| (1) 19. Flood prevention | 19. Theory of evolution. |
| (18) 20. Burbank | 20. Tomato. |
| | 21. Water-carrying tubes. |
| | 22. Violet. |