

A STUDY ON BEHAVIORAL OBJECTIVES: DO THEY AFFECT LEARNING?

FINAL THESIS

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## CHAPTER 1

### INTRODUCTION

During the past thirty years a great deal of research has been performed focusing on improving the techniques of teaching. The research has concentrated on subjects like objectives, learning styles, cognitive development, cooperative learning, and discovery learning. Considering all the research, no matter what technique an instructor subscribes to, their lessons should always be built around a behavioral objective. Every instructor has a purpose to her lesson. One of the focal points of this research is the use and functions of behavioral objectives. Can behavioral objectives be used by students to enhance learning and prepare for assessment? Much of the literature on this topic has been definitive. With the changes in teaching over the past two decades the question is worthy of being asked again.

The purpose of this paper is to re-address the significance of behavioral objectives. By overtly letting students know the objectives at the beginning of each class will student performance improve? This study will use two techniques to investigate the use of objectives by instructors and students at the collegiate level. One technique is a time lapse, quasi experiment. This type of experiment introduces a variable halfway through the project. The variable that will be introduced is intended to act as a catalyst or suggestion to the students to examine their studying practices for tests. The second technique, using different subjects, will expose the students to the objectives of the instructor at every possible opportunity. The students will be shown how the objectives relate to the assessment. Both studies last a total of thirty weeks (two college semesters) and help answer the following question: What effects do these techniques have on student performance?

This research will also help to determine how effectively professors in the Department of Biological Sciences at the State University of New York College at Brockport are communicating their objectives to their students. The opportunity to study the correlation between class performance and objectives is included in the study. The null hypothesis of this study is that the presentation of lesson objectives will not influence student performance on assessments.

## **OPERATIONAL DEFINITION OF BEHAVIORAL OBJECTIVES**

In education there are two types of objectives. An instructional objective describes the desired learning in a clear precise manner, as well as specifying the outcomes in measurable terms. An effective objective describes the intended learning and not the process of instruction. When written properly, students can use these objectives to test their understanding of the subject matter. A good objective also explains the significance of what they are learning (Hunter, 1994). Students learn more effectively if they know what they are learning and why they are learning it.

In education today, objectives are stated in behavioral terms. A good **behavioral objective** states the intended learning in terms of a measurable behavioral characteristic or skill that the student is to demonstrate after the subject has been thoroughly covered. A good behavioral objective defines some level of mastery the student should be capable of performing. Sullivan (1969) states two very distinct advantages for using behavioral objectives: (1) they allow the teacher to know which behaviors the students should be able to perform after instruction; and (2) create a means to assess student performance in terms of the desired post instructional behavior thereby indicating the effectiveness of the instruction. The use of behavioral objectives also assists in the selection of the proper materials and activities to develop the desired behaviors.

## **CHAPTER 2: REVIEW OF THE LITERATURE**

### **BENEFITS OF OBJECTIVES**

Behavioral objectives have many uses. They assist the instructor in choosing the proper methods and materials for each lesson. They provide a method for assessing the effectiveness of the instruction as well as assessing student learning (Mager, 1984). What makes instruction effective is that it does what it set out to do. In effective instruction the instructor communicates knowledge the student does not already have through a technique that can be demonstrated by the student's behavior. Good instruction uses explicit objectives for three reasons:

- Clearly defined objectives provide the instructor a way to determine where they are going, and how they are going to get there.
- Objectives provide a means for testing and assessing both the student and the instructor.
- Objectives give the students the tools needed to organize their efforts towards meeting the objectives.

It has been shown that with clear objectives in hand students at all levels choose more appropriate means to prepare for testing and meet the desired outcomes (Mager, 1984). Providing the objectives of the lesson to the student prevents them from having to guess at what the importance of the lesson is. The objectives also provide the instructor an opportunity to monitor the class and assess if the objectives are being achieved (Gentile, 1988). Student failure to exhibit the behaviors outlined in the objectives demonstrates a breakdown in the process of instruction. Frequent assessment of the objectives can also help prevent misconceptions by the students. In essence, the outcome is that concise behavioral objectives provide clarity to an instructor's teaching and make the teaching more efficient. When the instruction is more efficient and effective the students can work more successfully towards those objectives in visible and

measurable means. It provides the students a means to select how to study as well as pointing the way to what to study.

Jonassen (1982) concluded that behavioral objectives provide three distinct advantages: (1) the development of instructional activities and materials; (2) information on the progress of the students; and (3) data about the effectiveness of the instructor. He argues that objectives eliminate hidden agendas and demonstrate an instructor's understanding of the learning process. With the use of behavioral objectives, there is the belief that students will find more freedom in the learning process and participate more in classes (Clark, 1972).

### **THE CONTROVERSY OVER THE USE OF BEHAVIORAL OBJECTIVES**

For twenty years the question whether the use of behavioral objectives has any positive effect on learning has been argued and researched. Empirical research has not provided significant evidence that the use of behavioral objectives improves learning (Yook, 1994). Some researchers have suggested several reasons why behavioral objectives have no apparent value:

1. The inconsistencies of the operational definition of behavioral objectives.
2. The lack of skill and training of students in using objectives.
3. The lack of training of the instructor in writing effective behavioral objectives and how to use them. (Kibler, Cegala, Barker, Miles, 1974; Kibler, Bassett & Byers, 1977).

Some researchers accept the use of behavioral objectives with reservations. Ojeman (1968) stated that teachers should realize that there is a distinct difference between classroom behavior and behavior chosen of the student's own free will. Students may choose to edit or leave points out of an explanation or procedure to save time. The use of objectives is effective only if the teacher incorporates these choices into the assessment process. The displayed behavior should demonstrate and not hide the important parts of the instruction that are significant pieces

of the subject that the instructor wants the student to know. One also has to be careful not to use prepared objectives developed by textbook writers and program developers. This can discourage the local development of programs and depersonalize the teaching experience (Weller, 1980). Using commercially prepared objectives tends to make the lesson someone else's and not the teacher's. This may affect the enthusiasm and effort of the teacher in providing effective instruction. It may also lead to the use of inappropriate materials to meet the behavioral objectives.

There are faulty empirical studies that demonstrate that objectives have a measurable effect on learning. Kaplan (1974) has performed a study on how the number of students in class affects performance based on the behavioral objectives. Kaplan and Rothkopf (1974) have also looked at how the quality of the behavioral objectives, which means how specific they were in identifying the desired outcome, influenced student performance. Lastly Kaplan and Rothkopf (1972) looked at providing partial or abbreviated objectives versus identifying the whole objective. Their focus was on the length of the objectives. If too long or wordy, the objective may be ineffective or misleading to the students. Effective behavioral objectives identify the desired learning without any ambiguity. The student should know precisely what they have to do to meet the behavioral objective.

There were some major flaws in each of these studies. No operational definition was provided for behavioral objectives and no examples of objectives were provided. The method of assessment was through rote fill in the blank questions where direct quotations were taken from the text. The researchers removed one key word from each question and a blank line of uniform length was substituted into the sentence. These flaws undermine the validity of each study and

should not be considered evidence of a positive correlation between objectives and student performance.

Another study was conducted to try to understand the usefulness of objectives in dealing with higher level test questions as well as highlighting areas of the lesson that the students would not predict as important (Duell, 1974). This study used behavioral objectives in the form laid out by Mager (1962), and provided example objectives used in the study. The testing consisted of questions that were either recognition questions or application questions. These types of questions are considered to be two separate cognitive levels. The results suggest that behavioral objectives do not necessarily help students achieve better on higher-level test questions. Duell found that if students could master lower level questions, then they could also master higher level questions on the same topic. This implied that the use of behavioral objectives helped direct students to the areas most important to study. He also found that the students' assessment of what was important in a specific topic was a determining factor on whether the objective helped them in that area or not. In areas the student had already predicted as important, objectives did not help to improve student performance. However, behavioral objectives did direct student attention to the areas which they did not predict as having any importance. This is a very important point in this research.

A study by Kibler et. al. (1974) reviewed fifty empirical studies on the use of objectives. Their conclusions provided mixed results concerning the effectiveness of behavioral objectives and offered three explanations for the inconclusive findings:

1. Operational definitions of behavioral objectives and examples of the objectives were not used in the studies.

2. Few students in the experiments received instruction on how to properly use objectives as study aides.
3. Few teachers are provided with training on the development and use of behavioral objectives.

Another study was conducted three years later by Kibler, Basset, and Byers (1977). This study came up with the same conclusions that Kibler (1974) originally found. However, though not helping student performance, the study does suggest many favorable arguments that support the continued use of behavioral objectives. Behavioral objectives provide direction to the teacher facilitating the choice of appropriate materials and activities for the desired outcome; identifying important subjects for the students; and, providing tools to the students to organize their efforts towards achieving the desired outcome.

### **SUMMARY**

There has been a great deal of research on using behavioral objectives in education. Clear, concise behavioral objectives provide instructors with a technique for assessing their teaching and their students as well as a way to select the proper materials for instruction. Behavioral objectives also serve to determine the means by which the teacher proceeds from point A to point B. In other words, if you do not know where you are going, how can you select a suitable method to get there? Education is successful only if it accomplishes what it set out to do. Objectives help establish the important outcomes intended by the teacher. Behavioral objectives can be used by students to organize their efforts and choose activities to meet them. The daily objectives can help teachers monitor their progress and effectiveness each day.

Studies indicate mixed results concerning the usefulness of behavioral objectives. There is a lack of an operational definition for behavioral objectives that leads to the improper use and development of objectives. Empirical studies have failed to demonstrate that the use of objectives

helps students achieve higher grades. There is evidence suggesting a lack of instruction on the proper use of objectives for teachers and students. This study will examine how effectively some college instructors are emphasizing their objectives, and what happens to class performance as the students begin to associate the objectives with assessment.

One important point emerged from the literature. Behavioral objectives direct students to areas of importance they should study. Behavioral objectives especially emphasize areas that students typically did not identify as important (Duell, 1974). In some small measure, this does demonstrate the value of using behavioral objectives in education. Remember a good behavioral objective tells the students, in measurable terms, what is the desired learning. They have clearly defined goals to work towards during assessment. Anything that helps a student to learn and master content should become an integral part of any teacher's repertoire.

### **CHAPTER 3: PRE STUDY**

The original study has been included as a pre- study because it does offer some insight into the question of whether professors are making their objectives public. The pre-study was performed to see how well students were able to identify a specific instructor's lesson objectives. Several instructors volunteered to participate. However, only one professor was used due to his regular class meeting time, his highly structured and organized lectures, and his class size. This instructor teaches an upper division class on biological genetics. He has been teaching at SUNY Brockport for approximately 25 years. He has a Ph.D. in molecular biology from SUNY Buffalo. He was an excellent choice for the study because prior to each lecture he identifies his objectives for that lecture by writing them on the chalkboard and briefly going over them. He maps the path he is going to take to meet his lesson objectives and identifies the desired learning.

The pre-study was designed as a quasi-time lapse experiment. This type of study introduces a variable after a specific amount of time lapses. The variable is then measured for some effect. In this study the desired effect was to see how the introduced variable influenced student performance. The hypothesis remained that there would be no measurable effect of the variable on student performance.

#### **PROCEDURE**

Appendix E is a copy of the letter of instructions given to the professor. During a meeting before the start of the study he was asked to choose ten males and ten females as subjects for the duration of the study. These students were to be surveyed at the end of each class. An overhead was projected (Appendix C) that asked the students to identify the objectives of each lecture. Halfway through the semester a new overhead was used to survey the students in the quasi-time lapse experiment. (Appendix D) Added to the new overhead was the question:

“Do you use these instructional goals to assist you in studying for tests?”

The professor was asked to use the same twenty members of the class, ten females and ten males, for the duration of the semester. He was also asked to report their test grades to see if any significant increase in grades occurred after the midterm. The researcher intended to perform a correlation coefficient test on the scores to see if a significant increase in test scores occurred. The null hypothesis was that there would be no effect on student grades or performance when the new variable was introduced in the time-lapse experiment.

## DATA

The survey of the students was to be taken after each lecture session. The class met three times weekly for an one-hour lecture. Table 1 represents the first sample of twenty-one students. One of the problems with the design of this experiment was the lack of a consistent sample of students large enough to be statistically significant. The professor reported two objectives for the first lecture. Thirty-three percent of the students sampled were able to identify the first objective compared to 71% for the second objective.

**Table 1: Objectives from September 9, 1996**

INDIVIDUAL	OBJECTIVE 1	OBJECTIVE 2
1. Female	match	match
2. Female		match
3. Female		match
4. Female	match	match
5. Female	match	
6. Male		match
7. Male		match
8. Male		match
9. Male		match
10. Male	match	match
11. Female		
12. Female		match
13. Female		match
14. Female	match	
15. Female		match
16. Female		

17. Male		match
18. Female	match	match
20. Female		
21. Female	match	match
Main objectives of professor: 1. Genes are located on chromosomes 2. What is sex linkage?	7 out of 21  mean: .33	15 out of 21  mean: .71

Table 2 represents the second day of sampling. On the second sample date the cooperating professor surveyed 13 students. Since no way of tracking or identifying the students was built into the experiment, it is unknown whether any of these students were members of the original sample of 21 students. Eighty-four percent of the students sampled were able to determine the objective of the instructor. It is difficult to determine any reasons for the mean success rate. Table 3 shows comparable results from a sample of ten students. Table 4 is also included and shows a success rate of 100 percent. However, the professor surveyed only 6 students. This makes this information rather useless. A complete discussion of the sampling errors can be found in the next section.

**TABLE 2: OBJECTIVE FROM Sept. 13, 1996:**

INDIVIDUAL	OBJECTIVE 1
1. Male	match
2. Female	match
3. Male	
4. Female	match
5. Female	match
6. Female	match
7. Female	match
8. Female	match
9. Female	match
10. Female	
11. Female	match
12. Female	match
13. Male	match
Main objective(s) of professor.	11 out of 13 matches

1. Understand the concept of linkage.	mean: .85
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**TABLE 3: OBJECTIVES FROM Oct. 9, 1996:**

INDIVIDUAL	OBJECTIVE 1
1. Male	match
2. Female	match
3. Female	match
4. Female	
5. Female	
6. Female	
7. Female	match
8. Female	match
9. Male	match
10. Male	match
Main objective(s) of professor. 1. To learn the structure and synthesis of DNA.	7 OUT OF 10 matches mean: .7

**TABLE 4: OBJECTIVES FROM Oct. 23, 1996:**

INDIVIDUAL	OBJECTIVE 1
1. Female	match
2. Female	match
3. Female	match
4. Female	match
5. Female	match
6. Male	match
Main objective(s) of professor. 1. To consider the mutation and repair of DNA.	Sample size too small.

Halfway through the semester, the professor introduced the time lapse variable that asked whether the students used these objectives to study for exams. Tables 5 and 6, which make up Appendices A and B, represent the sampling of the entire class. It is unknown why the cooperating professor decided to sample the whole class. As the reader can see, there are no responses in Table 6 for the time-lapse variable. It is believed that the instructor failed to ask the

time lapse question regarding using the objectives for studying. An average of seventy-seven and seventy-eight percent of the students successfully matched the objectives of the professor on the two sampling dates. Only 44 of the students reported using the objectives for preparation or studying for tests in Table 5. (See Appendix A)

## **DISCUSSION OF PRE STUDY**

Statistically speaking, the pre-study was not well designed. The first and most serious problem concerned the sample. The cooperating professor failed to maintain a consistent sample of students and a means to identify them was never established. A better random sampling of the class should have been used to establish the test subjects. The researcher should have played a more integral role in this study by sitting down with the professor and his class list. With proper random sampling techniques the test subjects for the study could have been identified. This should have been done before the study and would have alleviated the mistakes by the participating professor. The participating professor failed to use the same twenty students throughout the study as had been discussed in the meeting before starting the study. During the end of the experiment the instructor decided to survey the whole class.

The second problem that arose was the surveying of the class. In a time lapse experiment it is important to expose the test subjects to the variable as much as possible. The hit and miss surveying did not expose the test subjects to the time-lapse variable as much as the researcher had hoped. Realizing that time in a required collegiate course can be limited, a more consistent schedule of sampling dates could have been arranged. During his last survey, he had lost the transparency and used his own failing to introduce the time-lapse variable. These inconsistencies undermine drawing any conclusions from the pre-study.

Appendix C and D show the two transparencies used to survey the students during the pre-study. A more controlled means of surveying the students should have been used creating a more consistent set of responses for use in the experiment. It would also have increased the students' exposure to the time lapse variable. The repeated questioning of whether they used the objectives for studying may have modified their study behavior.

## **CONCLUSION**

There is a lack of empirical evidence to draw any firm conclusions from the pre-study. A link between the pre-study and student assessment was never clearly established. All of this data seems rather meaningless without that link. However, students were relatively successful at identifying the objectives of the instructor. A consistent 3/4 of the class could identify the objectives of the professor at the end of the lesson. The question still remained on whether this helped the students with assessment. It can be stated that this instructor is communicating his lesson objectives well. As can be seen in the data tables, he rarely puts his objectives in behavioral terms. An interesting follow up experiment with this professor would be to help him rewrite all his lesson objectives in proper behavioral format. By repairing the flaws in this pre-study and performing the same quasi-time lapse experiment and then measuring student success in the class, more insight on the benefits of behavioral objectives as study aids could be obtained.

There is a low percentage of the class that reports using the lesson objectives to prepare for assessment. This may indicate that students are still not being trained in the use of objectives for the purpose of studying. Study habits are fairly well established by the time students reach college. The idea that behavioral objectives link assessment and class lecture does not seem to be well established. If it was, it would seem obvious that more students would report using lesson objectives, if provided, to prepare for exams.

## CHAPTER 4: FOLLOW-UP STUDY

After reviewing the results of the pre-study, a follow up study was developed. The same principles were being examined: Do objectives influence student performance on assessment? The class chosen was instructed by a first year assistant professor with a Ph.D. in plant biology. He had prior teaching experience at the University of California at Davis where he earned his doctorate. The class was a non-major's biology class that fulfills the college's general education requirements for quantitative skills. It is also a required course for students wishing to enter the nursing program. This provides a dynamic mix of students that are serious in the class and those that, dare I say, put forth a minimal effort. A closer working relationship was established with both the class and the professor. The professor is young and energetic. He was amicable in allowing the researcher to assist him and make suggestions in the structure of his lessons.

For the sample, it was decided to use the entire class that consisted of 112 students. They ranged from freshman to seniors in college from all academic disciplines. A few of them were returning adult students. This sample provided a good cross section of the college's population.

This research was to be more straightforward than the previous experiment. The instructor was going to make every possible effort to link his objectives to his tests and make the students aware of his lesson objectives before the beginning of each lecture. The instructor would report the test grades to the researcher and a correlation would be performed on the test means to see if there was any significant relationship between test grades and behavioral objectives. The null hypothesis is that there is no relationship between known behavioral objectives and student performance on tests.

## **PROCEDURE**

The follow-up study began the spring semester (1997) that followed the pre-study. During the first class session, the professor distributed his class syllabus. This was the second semester the professor was to teach this class. To improve student performance he felt that he would add key vocabulary terms and biological principles to the syllabus as study aids. He emphasized several times that students should study these terms and principles since they would appear on the tests. The course syllabus is included in Appendix G to this paper.

The sample was a group of 112 students. These students ranged from ages of students in their late teens to older adults continuing their education. This class is a general education class for the college. This means that there was a mixture of all ages and educational disciplines in the class and provided an excellent cross section of the population of the college.

Each lecture began by the instructor placing his lesson objectives on the chalkboard. Before beginning his lesson he would go over what he had put on the board. This included identifying new vocabulary he would be introducing found in the syllabus. During the semester he emphasized that these items would help the students prepare for the exams. During the first half of the semester he spent considerable time emphasizing the links between the terms, lecture objectives, the comprehensive study guide, and assessment. After each test, he would go through the test question by question. During this time he would point out how these questions were related to the lesson objectives he put on the chalkboard before each lecture. He would also indicate the terms and biological principles covered and where they could be found in the student's syllabus.

The professor administered four semester exams and one final exam. After each of the exams, the professor would spend time going over each question on the exam and establish the

links between the assessment, lesson objectives, and the study guide. For each question, he explicitly explained how the objectives could have been used to answer each question. As the semester progressed, time constraints grew. With each progressive exam less time was spent on this task. The tests were mostly multiple-choice style exams that were graded by a computer. Copies of each of the tests are included in Appendix H through L. The computer analysis and scores were given to the researcher by the cooperating professor. For each test the class mean was calculated. These means were then plotted on a graph. The trendline for this data was plotted and a correlation coefficient was determined. To show a significant relationship between the test means and behavioral objectives the correlation coefficient would have to be higher than 0.9.

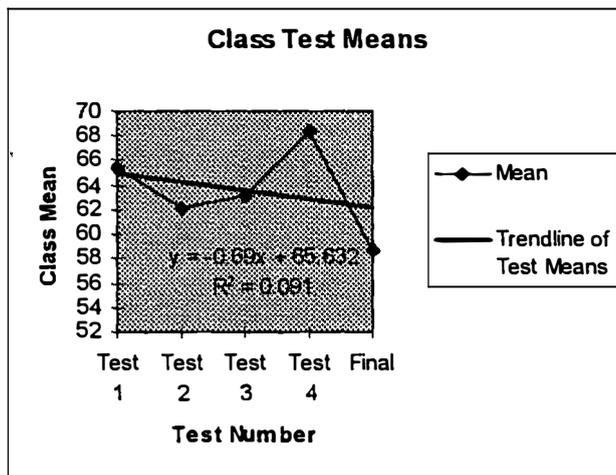
At the beginning of this study the researchers discussed that attendance records may prove beneficial in analyzing individual student performance. Attendance to class does play a role in student performance, especially at the collegiate level. Each day, the professor would pass a sign-in sheet around the room. However, the sheet rarely made it around the entire room. An accurate measure of attendance would be something to develop for any follow up study.

## **DATA**

The test score for each student and the class test means are reported in Appendix F. For each test the mean was calculated for the entire class. For Test 1, 107 students were present for the test. The mean for this exam was 65.35. One hundred five students took test two and the mean was 62.10. Test 3 was taken by 106 students with a mean of 63.20. Test 4 was taken by 103 students with a mean of 68.42. The final exam was taken by 106 students in the class and the mean for this exam was 58.74.

The means were calculated to plot the class data on an XY scatterplot. Once plotted, a trendline can be inserted to see if there is any significant correlation between the test scores and the variable being tested. Figure 1 below represents the class data.

Figure 1: Chart of Mean Values



The trendline and  $r^2 = 0.091$  represents an extremely small shared variance among the five testing situations. As the links to assessment and lesson objectives were emphasized and made, it was hoped that a significant increase in the test scores would occur. However, this data demonstrates that no such relationship ever occurred.

Test 4 seemed to have a much higher mean than the other tests. A one way analysis of variance was performed to see if there was a significant difference between the test means. At the  $p=.05$  level of significance the critical F score was 2.39. The obtained F score was a 2.73. The analysis can be found at the end of Appendix F. This suggests that there was a significant difference between this testing situation and the other tests. This test was developed from a test bank of New York State Board of Regent's test questions used in regents biology courses throughout the state.

## DISCUSSION

The original null hypothesis was that presentation of behavioral objectives at the beginning of each lesson would not affect student performance on tests. This research fails to reject this hypothesis. Behavioral objectives seem to have no influence on student performance.

Only two of the means for the tests were above the failing grade level. One of those two tests was just slightly above the failing mark. Exam 4 was developed using a test bank of New York State Regents test questions for practically the entire exam. Students did perform better on this test. One of the biggest surprises during this study was the number of students that missed one or more of the exams during the semester. One student missed all four regular exams and took only the final exam for the course. This may indicate student apathy.

The results of this research were both surprising and alarming. The students of this class were required to buy a textbook that included a CD-ROM study guide with sample test questions. The Department of Biological Sciences maintains a computer lab, open to the students, with the latest computer equipment. The college also has an academic computing facility with several computer labs available to the students. One of the first lab exercises performed in the class is an exercise to familiarize the students with the computer resources available to them. Students could have used the CD-ROM study guide in any of these computer facilities. It seems unlikely that few students took advantage of the study guide disk that came with their textbook.

The cooperating professor is an individual that makes himself visible, is very approachable, and is readily available to the students for help. The course syllabus contained new vocabulary and biological principles that the students should have known for each exam. Throughout the semester students continuously asked whether the information within the study guide provided with the course syllabus was important and beneficial to study. Several times the professor

reported that it was the same students asking this question. The professor also conducted study sessions before each exam. Very few students took advantage of the study sessions.

This course also has a laboratory component with it. The laboratory exercises are designed by the instructor to enhance the material being covered in lectures. With all of these resources available to the students during this research, the poor performance on the exams is quite confusing.

This research reinforces what the literature states: student awareness of the objectives has no effect on student learning. It is unclear whether pure student apathy or instructional design is behind these low scores. How the material is presented does play a role in student performance. It would add support to this research if samples of the objectives presented by the professor were available.

In his paper on improving undergraduate lectures, Thomas Zolty of Central Michigan University (1990) states that extensive planning and clear objectives are essential to good pedagogy. He states that a good objective defines “student actions and/or the product of those actions; specific conditions, such as the length of presentations, level of English accepted, and due dates; and standards by which the student’s work is assessed” (Zolty, 1990, p.6). Zolty’s parameters include components of good behavioral objectives. Zolty refers to actions or products that are measurable products of the student. These are essential components of good behavioral objectives. Zolty also makes the point that students should be made aware of what they may be learning and why they should be attentive to the subject at the beginning of each lesson. These activities were being carried on during this course. Teacher lesson objectives were clearly defined and links to assessment were made.

Test 4 has a higher mean compared to the other tests given in the course. The professor used the Regent's test bank questions to develop this test. The one way analysis of variance shows that there is a significant difference between this test and the others. It is possible that this test is more authentic in assessing the behavioral objectives than those written by the professor. The New York State tests are designed to assess specific behavioral objectives within the state's curriculum. In effect, this could mean the students found the test easier. The questions may be worded better and are more closely associated with assessing behavioral objectives. The wording of these questions may be more relevant to the subject being studied.

## **CONCLUSION**

This research fails to reject its null hypothesis. As the literature review shows, there seems to be no relationship between student performance on tests and behavioral objectives.

The teaching world is forever looking for ways to improve and enhance student learning. Many approaches and new techniques have been developed over the years and there are no easy answers. The most widely used means of teaching remains to be the lecture, especially at the collegiate level. This means that faculty members need to be well prepared for each class with clear objectives in hand. They also need to be aware of the limitations of their students. Poor students generally have poor study skills. Behavioral objectives are clear road maps that should be used to drive both the presenter and the learner. More instruction should be provided on both the writing and use of behavioral objectives for both participants in the learning process. An unclear or poorly written objective will only frustrate and confuse a learner more than he or she already is.

There is no clear link between behavioral objectives and student learning. However, the value of behavioral objectives in instructional design is tremendous. As a teacher, this researcher

is aware of the difference in his lessons when his objectives are not clear and concise. When a proper behavioral objective has been developed, the researcher's lessons are much more focused and directed towards a specific goal. They provide a clear and concise means in developing the means to teach important content to students. A quality instructor should be prepared to deliver a lesson with a definitive goal. Increasing student awareness of what behavioral objectives are and how to use them only increases the study tools at their disposal to prepare for being assessed. Special attention should be given to how teachers also assess those behavioral objectives. Assessments should be designed with the behavioral objectives in mind. Assessment is ineffective if it does not focus on what the teacher expects the students to be able to do. A more concerted effort must be done earlier in the education of children on what a behavioral objective is and how it can be used to help learning. This researcher emphasizes to his students that they should rewrite the behavioral objective written on the chalkboard before each lesson, and turn it into a question. This practice should give the student a series of highly directed study questions with a performance goal to help them prepare for tests. With all the new teaching techniques being studied, it might be beneficial to look at all the questions raised by this research again.

**APPENDIX A**

**TABLE 5: DATA FROM Nov. 1, 1996:**

Main objective(s) of professor.

1. To learn the mechanism of RNA synthesis and processing in eukaryotes.

INDIVIDUAL	OBJECTIVE 1	Do you use the objectives to help prepare for testing?
1. Female	Match	Yes
2. Male	Match	Yes
3. Female		
4. Male	Match	
5. Male	Match	Yes
6. Male	Match	No
7. Female	Match	Yes
8. Female		
9. Female	Match	Yes
10. Female	Match	Yes
11. Male	Match	Yes
12. Female	Match	Yes
13. Female	Match	No
14. Female		
15. Male	Match	
16. Male	Match	Yes
17. Male	Match	Yes
18. Female	Match	Yes
19. Female	Match	Yes
20. Male		
21. Female	Match	
22. Female		
23. Female	Match	Yes
24. Female	Match	Yes
25. Male	Match	No
26. Female	Match	Yes
27. Female	Match	Yes
28. Male	Match	Yes
29. Male	Match	Yes
30. Male	Match	Yes
31. Female	Match	Yes
32. Female	Match	Yes
33. Female	Match	No
34. Male	Match	Yes

35. Male	Match	Yes
36. Male	Match	Yes
37. Male	Match	Yes
38. Female	Match	Yes
39. Male	Match	Yes
40. Male	Match	Sometimes
41. Male	Match	Yes
42. Male	Match	
43. Female	Match	Yes
44. Female	Match	Yes
45. Female	Match	Yes
46. Female	Match	
47. Female	Match	No. not always clear
48. Female	?	No (study details)
49. Male	Match	
50. Male		Yes ("somewhat")
51. Male	Match	
52. Male	Match	No
53. Female	Match	Yes
54. Male	Match	Yes
55. Male	Match	No
56. Female	Match	Yes
57. Male		
58. Male	Match	Yes
59. Male		
60. Male	Match	Yes
61. Male		
62. Male		
63. Female	Match	
64. Male	Match	
65. Female	Match	Yes
66. Male	Match	Yes
67. Female	Match	Yes
68. Female	Match	
69. Male	Match	
70. Male	Match	Yes
71. Female	Match	Yes
72. Female	Match	Yes

Keys: F = female  
M = male

m = match

y = yes  
n = no

APPENDIX B

TABLE 6: Objectives from Nov. 20, 1996:

Main objective(s) of professor:

1. Discuss the structure of eukaryotic DNA and how DNA is sequenced.

INDIVIDUAL	OBJECTIVE 1	Do you use the objectives to help prepare for testing?
1. Female	Match	
2. Female	Match	
3. Male	Match	
4. Female		
5. Male	Match	
6. Female	Match	
7. Male	Match	
8. Male		
9. Male		
10. Male	Match	
11. Male	Match	
12. Male		
13. Male	Match	
14. Male	Match	
15. Male	Match	
16. Female	Match	
17. Male	Match	
18. Male	Match	
19. Male		
20. Male	Match	
21. Male	Match	
22. Female	Match	
23. Male	Match	
24. Male	Match	
25. Male		
26. Female	Match	
27. Male	Match	
28. Female	Match	
29. Female	Match	
30. Male	Match	
31. Male	Match	
32. Female	Match	
33. Male	Match	

34. Female	Match	
35. Female	Match	
36. Male	Match	
37. Female	Match	
38. Female	Match	
39. Female	Match	
40. Male	Match	
41. Female	Match	
42. Male		
43. Male	Match	
44. Male	Match	
45. Female	Match	
46. Male	Match	
47. Male		
48. Male	Match	
49. Male		
50. Male	Match	
51. Female	Match	
52. Male	Match	
53. Male	Match	
54. Female		
55. Female	Match	
56. Female		
57. Female		
58. Female	Match	
59. Female	Match	
60. Male	Match	
61. Female	Match	
62. Male	Match	
63. Male		
64. Female	Match	
65. Female	Match	
66. Female		
67. Male		
68. Male	Match	
69. Female		
70. Male	Match	
71. Female	Match	
72. Male	Match	
73. Female	Match	
74. Female	Match	
75. Female	Match	
76. Male		

77. Male	Match	
78. Female	Match	
79. Female	Match	

Keys: F = female

M = male

m = match

y = yes

n = no

## APPENDIX C

### BIOLOGICAL SCIENCES STUDY

*Please answer the following:*

What were the Professor's instructional goals or main points in his lecture?

APPENDIX D

BIOLOGY STUDY

WHAT WERE THE MAIN INSTRUCTIONAL GOALS OR OBJECTIVES OF THE PROFESSOR?

DO YOU USE THEM TO HELP GUIDE YOUR STUDYING FOR TESTS?

## APPENDIX E

### MEMORANDUM

*To: Dr. Norment, Dr. Smith, Dr. Buttner, Dr. Lending, Dr. Kline, Dr. Makarewicz*  
*From: Kenneth Warren*  
*Date: 09/05/96*  
*Subject: Research Project for Master's in Science, Teaching Secondary Education*

Last spring, you graciously agreed to cooperate in a research project with me. I am looking for a correlation between lecture objectives and class performance. For this study, I will be researching two types of objectives. First, objects that are non-behavioral. They explicitly describe the desired learning and what the students will be assessed on. Secondly, there are objectives that are behavioral. This type of objective describes the desired learning, and includes a desired observable behavior which should be displayed when the objective is successfully met. Both types of objectives should include measurable outcomes.

In two studies, Kaplan and Rothkopf (1974) found that the presentation of non-behavioral objectives improved student performance. In a similar study, Orpha Duell (1974) could not find a significant correlation between student performance and objectives. An additional study by Yook (1994) at the University of Minnesota did not find a significant correlation either. This study focused on the presentation of behavioral objectives.

I would like to begin collecting data starting September 9. The study will be a time lapse study. I will place some index cards, an overhead sheet, and an envelope in your mailbox each morning. The overhead will have a question asking students to identify the objective of that day's lecture. At the end of each lecture, please ask your students to write their reply on the index card. For comparison, you should also fill out a card identifying the lesson objective(s). This should be performed until midterm. **From September 9 to midterm, I would like you to continue teaching exactly as you always have.** After the semester midterm, the above procedures will continue. However, at this time I would like to ask each of you to introduce each lecture with your goal/objective. Again, your objectives should explicitly describe your main points, and what you will be assessing your students on. The time spent introducing the lecture should not take too much time away from your classes. In theory, these introductions should provide students with

the key directions of studying for testing. Class means will be used to establish if there were any significant improvements in total class performance. I would like to add that, at no time, will names of classes or individuals be identified.

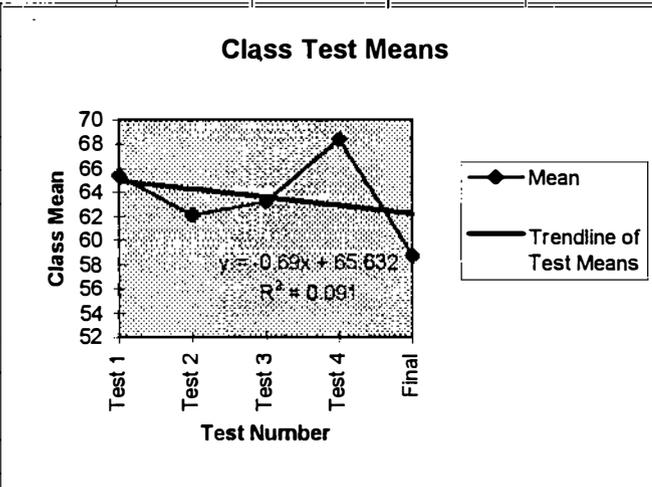
Should you have any questions, please call me. I would like to thank you for your cooperation and participation in this study.

APPENDIX F: STUDENT SCORES AND TEST MEANS								
Student	Test 1	Test 2	Test 3	Test 4	Final Exam			
7076	39	38	38	38	48			
2333	61	55	58	60	52			
1128	63	55	87	52	56			
2631	63	66	73	75	81			
8680	61	45	60	67	66			
346		66	53	79	66			
3478		53	40	62	47			
7752	68	74	69	67	75			
9322	86	74	64	65	68			
7569	68	72	60	69	60			
6936	86	89	64	81	71			
6402	71	60	71	52	65			
2680	36	60	28	65	34			
4159	58	62		58	43			
4025	66	64	69	62	58			
9624	61	66	64	62	56			
5203	61	40		50	41			
7861	47	60	60	54	44			
4236	58	49	44	77	43			
8055		49	33					
6583	54	62	55	58	60			
4563	80	89	87	85	76			
7387	64	51	67	71	44			
4974	51	43	60	62	42			
2817	85	68	73	83	61			
8083	68	74	68	83	66			
2484	63	64	67	77	68			
1131	90	64			75			
1777	75	68	67	69	67			
8627	66	55	58	71	56			
9416	68	57	56	77	58			
7488	42	53	53	58	35			
549	75	68	71	77	68			
5376	93	89	91	94	37			
433	44	57	47	65	39			
8943	64		69	73	67			
908	73	74	58	65	49			
9050					24			
1255	69	68	69		65			
9968	75	72	82	75	75			
6285	46	70	69	69				
9732	73	87	69	83	73			
5656	75		67	58	67			
3498	86	70	69	85	58			
3774	69	47	53	72	61			
5145	70	57	71	65	48			
1042	71	55	51	48				
5278	85	79	80	72	68			
3797	66	55	62	52	60			

5925	56	49	53	73	62
394	63	62	64	56	57
8625	80	74	78	81	75
4172	64	72	58	67	58
9778	51	45	58	58	43
7689	63	64	53	62	57
2240	51	43	51	54	54
1431	53	45	53	56	53
8986	71	64	49	60	70
8361	69	62	64	77	58
1520	64		60	73	58
1020	68	85	78	85	63
620	64	68	44	56	46
7973	71	55	71	88	73
8939	42	32			
2946	64	68	73	75	61
760	63	49	69	73	71
6576	80	77	89	83	77
2779	61	60	80	81	72
8897	71	57	47	56	46
7240	76	70	78	65	57
9299	51	57	80	75	63
3255	66	72	64	75	62
8528	56	72	64	65	60
935	58	55	44		
1984	47		42		46
1067	83	79	64	75	63
3185	49	38	58	52	49
8940	58	74	64	67	63
9970	49	34	62	67	53
2819	53	64	56	75	53
338	87	81	84	77	76
1510	53	40	60	54	53
3211	71	79	78	79	68
3673	59	64	53	69	51
1662	85	91	76	90	78
5168	68	49	58	62	49
2760	69	62	67	75	60
8123	73	57	69	75	71
7642	42	68	78	69	60
6152	44		40	56	43
7014	69	55	42	50	54
762	73	57	51	65	58
1451	64	62	56	65	53
3412	86	72	67	79	85
8676	64	68			57
3725	37	62	60	58	46
5657	51	51	44	58	56
8886	71	72	78	60	57
4076	80	70	76	69	63
6381	78	74	69	85	75

5482	64	68	78	73	61
7982	56	47	38		
3186	82	81	84	90	72
6837	63	55	67	54	51
5969	64	47	76	79	68
1667	78	51	71	77	68
2994	69	55	67	77	61
1680	76	68	71	85	68
2523			56	58	46
2466	81	71	73	75	62
6560	58	43	51	60	38
9891	69	62	69	52	54
<b>Sum</b>	<b>6992</b>	<b>6521</b>	<b>6699</b>	<b>7047</b>	<b>6226</b>
<b>n</b>	<b>107</b>	<b>105</b>	<b>106</b>	<b>103</b>	<b>106</b>
<b>MEAN</b>	<b>65.34579</b>	<b>62.10476</b>	<b>63.19811</b>	<b>68.41748</b>	<b>58.73585</b>

	<b>Mean</b>
Test 1	65.35
Test 2	62.1
Test 3	63.2
Test 4	68.42
Final	58.74



**Anova: Single Factor**

<b>SUMMARY</b>				
Groups	Count	Sum	Average	Variance
Column 1	112	6992	62.42857	334.7696
Column 2	111	6521	58.74775	353.154
Column 3	112	6699	59.8125	360.9465
Column 4	112	7047	62.91964	464.0926
Column 5	112	6226	55.58929	302.9289

**ANOVA**

Source of Variatio	SS	df	MS	F	P-value	F crit
Between Groups	3966.777	4	991.6942	2.730462	0.028482	2.38802
Within Groups	201210.8	554	363.1964			
<b>Total</b>	<b>205177.6</b>	<b>558</b>				

## Biology 111 Principles of Biology

This is a survey of biology with an emphasis on how organisms function. There are no prerequisites for this course. It is intended for students who are not majoring in biology and who have not had a college biology course. This is a time consuming course, but one that adds much to your college education.

The course consists of readings, lectures and laboratories. The text is *Biology: Concepts & Connections* by N. A. Campbell, L. G. Mitchell and J. B. Reece. (There is also a web site associated with the text - [www.aw.com/bc/sci/bio](http://www.aw.com/bc/sci/bio).) The text and lectures are meant to compliment each other, and for each lecture there will be a reading in the text. A listing of lectures and readings is in the attached course schedule, as is the sequence of laboratory exercises. Also attached is a listing of terms and key concepts for each lecture.

In this course, your understanding of the material will be evaluated by exams and by laboratory assignments, quizzes and reports. There will be four exams and a final. For the most part, exams will be in a multiple choice format. The final will be comprehensive. The laboratory quizzes and assignments are largely up to each laboratory instructor. However, in all laboratory sections, two lab reports will be assigned. These reports will be evaluated on writing skills and organization, in addition to content.

Your grade will be based on your combined score for all exams and all laboratory quizzes, assignments and reports. The attached sheet entitled "Grading" gives more information on how grades will be assigned and on the SUNY Brockport attendance policy. A sheet with some advice on studying is also attached.

If you have questions, at any point in the course, you can e-mail us or visit us during our office hours. Additionally, there is a list server for this course. Through this list server, we can send everyone in the class announcements or answers to common questions, and you can ask questions of us as well. The attached sheet entitled "Volvox" explains how to use the list server.

If you have a special need that is the result of a disability, please let us know as soon as possible (after class or during our office hours), so that we can work out whatever arrangements are necessary.

The Staff: Dr. Hunter, Instructor, Office 203 LE, Phone 5753, e-mail: [jhunter](mailto:jhunter)  
Office Hours: Tu 830-10, F 2-4

Dr. Buttner, Lab Coordinator, Office B-4 LE, Phone 5750, e-mail: [jbuttner](mailto:jbuttner)  
Dr. Haynes, Lab Instructor, Office B-45 LE, Phone 5783, e-mail: [jhaynes](mailto:jhaynes)  
Mr. Taylor, Lab Instructor, Office B-4 LE, Phone 5765, e-mail: [wtaylor@frontiernet.net](mailto:wtaylor@frontiernet.net)  
Ms. Robinson, Lab Instructor, Office 105 LE, Phone 5756, e-mail: [JR8853](mailto:JR8853)  
Ms. Root, Lab Instructor, Office 110 LE, Phone 5746, e-mail: [DR2577](mailto:DR2577)

M	March 24	Organism Function III. Nutrition (& Digestion)	C21,C32.1-2
W	March 26	Organism Function IV. Gas Exchange	C22, C32.4
F	March 28	Organism Function V. Water Balance	C25.5-11, 32.3-4
		Laboratory: Circulation and the Heart	
M	March 31	Organism Function VI. Control & Integration	C26.1-3, C28.1-9
W	April 2	Organism Function VII. Senses & Motion	C29, C30
F	April 4	Review of Organism Function.	-
		Laboratory: The Sensory World	
M	April 7	Exam III. Organism Function	
W	April 9	Ecology & Evolution I. Overview of Ecology	-
F	April 11	Ecology & Evolution II. Populations	C35.1-6
		No Laboratory This Week	
M	April 14	Ecology & Evolution III. Population Interactions	C36.1-6
W	April 16	Ecology & Evolution IV. Communities & Biomes	C34.6-18
F	April 18	Ecology & Evolution IV. Ecosystems	C36.8-17
		Laboratory: Aquatic Ecology	
M	April 21	Ecology & Evolution V. Overview of Evolution	C14.1-6, 9.1-7
W	April 23	Ecology & Evolution VI. From Genes to Traits	C9.9-13
F	April 25	Ecology & Evolution VII. Alleles in Populations	C14.8-15
		Laboratory: Inheritance	
M	April 28	Ecology & Evolution VIII. Evolution & Speciation	C15.1-6
W	April 30	Review for Ecology & Evolution	-
F	May 2	Exam IV. Ecology & Evolution	-
		Laboratory: Adaptation	
M	May 5	History of Life on Earth	C16.1-6, C17.1-6
W	May 7	Humans - Our influence on the Biosphere	C38
F	May 9	Review for Final	
		Laboratory: Review of Problem Solving	

**May 12th      Final Exam Week - Exam Date TBA**

Laboratory Sections - All meet in Room 114 Lennon Hall.

Section 01	Tuesdays 900-1115	Dr. Haynes
Section 02	Tuesdays 1130-145	Ms. Root
Section 03	Tuesdays 2-415	Ms. Robinson
Section 04	Wednesdays 930-1145	Dr. Haynes
Section 05	Wednesdays 1200-215	Dr. Buttner
Section 06	Wednesdays 230-445	Mr. Taylor
Section 07	Tuesdays 430-645	Ms. Robinson

## Biology 111 - Advice on Studying

According to my copy of *The New American Webster Handy College Dictionary*, studying is “the mental effort of understanding”. And understanding all of the material presented in a college course requires a considerable effort. Therefore, your work habits all but determine how much of the material you will understand by the semester’s end.

About work habits, my advice to you is simple:

*Go to class, every class, and take notes you can study from.*

*Read the text, all the readings in the text, more or less as scheduled.*

*Review your notes, not just prior to an exam but regularly.*

*Concentrate when you read and review, and avoid distractions.*

Put another way:

*The purpose of the lectures and of the text is to help you understand the material. If you don’t go to class or read the text, you don’t get that help.*

*If you review your notes soon after you take them and later several times more, you will retain more of the material more easily than if you neglect your notes until close to the exam.*

*The mental effort of studying requires concentration, which will be much easier in a quiet and interruption-free environment.*

Also, if you are having difficulty with the papers or exams in this and/or other courses, you can get assistance with studying, math, computer and writing skills at the Center for Academic Improvement (B-10 Cooper Hall x2293).

## Biology 111 - Course Content

Below is a list of terms and key concepts for each lecture in the course. The objective of each lecture is to help you understand the concepts and terms that are covered. The exams will evaluate your understanding of these concepts and terms.

### Cell Biology

Lecture: Chemical Basis of Life I

Relevant Reading: Chapter 2.

Key Concepts: Structure of Atoms, Nature of Chemical Bonds.

Terms: Atoms, Ions, Elements, Protons, Neutrons, Electrons, Electron Shells, Chemical Bonds - Ionic, Covalent Bonds, Polarity of Molecules, Hydrogen Bonds.

Lecture: Chemical Basis of Life II

Relevant Reading: Chapter 3.

Key Concepts: Properties of Water and the Structures, Properties, Functional Roles of the Major Types of Organic Molecules.

Terms: Solutions (Solute, Solvent), Properties of Water, Organic Molecules, Monomers, Polymers, Functional Groups, Carbon Backbones, Lipids, Carbohydrates, Proteins, Nucleic Acids

Lecture: Cell Structure

Relevant Reading: Chapter 4.

Key Concepts: Cell Theory, Fluid Mosaic Model, Structure of Prokaryotic & Eukaryotic Cells.

Terms: Cell Theory, Prokaryotic/Eukaryotic Cells, Cytoplasm, Cell Walls, Membranes, The Fluid Mosaic Model, Lipid Bilayers, Phospholipids, Plasma Membrane, Organelles, Ribosomes, Cytoskeleton, Membrane Bound Organelles, Nucleus, Chromosomes, Internal Membrane System, Golgi Apparatus, Smooth endoplasmic reticulum, Rough Endoplasmic Reticulum, Lysosomes, Vesicles, Vacuoles, Chloroplast, Thylakoid Membrane, Stroma, Mitochondria Cristae, Matrix.

Lecture: Energetics

Relevant Reading: Chapter 5.

Key Concepts: Diffusion, Transport Into/Out of Cells, The Laws Of Thermodynamics, Chemical Reactions, Enzyme Function.

Terms: Diffusion, Osmosis, Transport, Endocytosis, Exocytosis, Facilitated, Passive Transport, Active Transport, Energy, Potential Energy, Kinetic Energy, The Laws of Thermodynamics, Reactions, Reactants, Products, Activation Energy, Catalysts, Exergonic, Endergonic, Coupling Reactions, Enzymes, Cofactors, Lock and Key Model, Structure and Function of ATP.

**Lecture: Protists and Fungi**

**Relevant Reading:** Chapter 17.20-28, Chapter 18.17-18

**Key Concepts:** Specialization of Organelles, Limits on Specialization and Size of a Single Cell, Growth and Structure of Fungi, Function of Mycorrhizae.

**Terms:** Phagocytosis, Pseudopods, Contractile Vacuole, Cilia, Flagella, Eye Spot, Protist, Amoebas, Ciliates, Flagellates, Cytoplasmic Streaming, Euglenophyta, Spores, Hypha (pl. = Hyphae), Chitin, Mycelium, Septa (pl. = Septum), Mycorrhizae.

**Lecture: Plants I**

**Relevant Reading:** Chapter 18, Chapter 31

**Key Concepts:** Structure of Plant Cell, Function of the Tissues within Plant Organs, Organization of Plant Organ Systems, Indeterminate growth of Plants.

**Terms:** Vacuole, Plasmodesmata, Epidermal Tissue, Vascular Tissue (Phloem, Xylem), Ground Tissue, Cuticle, Stoma (pl. = stomata), Stomatal Guard Cells, Mesophyll, Meristems, Roots, Stems, Leaves, Root Cap, Root System, Shoot System.

**Lecture: Plants II**

**Relevant Reading:** Chapter 18, Chapter 31

**Key Concepts:** The Plant "Life Cycle", Plant Reproduction and Development, Distinctions Between Major Plant Groups.

**Terms:** Bryophytes, Ferns, Gymnosperms, Angiosperms, Sporophyte, Gametophyte, Ovule, Seed, Fruit, Carpel, Anther, Sepals, Petals, Pollen Grain, Flower, Cone.

**Lecture: Animals I**

**Relevant Reading:** Chapter 19, Chapter 20, Chapter 27.1-12

**Key Concepts:** Evolutionary Trends in Animals, Characteristics of Major Animal groups, Structure and Function of Animal Tissue Types.

**Terms:** Epithelial Tissue, Connective Tissue, Muscle Tissue, Nervous Tissue, Neurons, Glial Cells, Basement Lamina, Actin, Myosin, Extra-Cellular Matrix, Radial Symmetry, Bilateral Symmetry, Cephalization, Gut Tube, Coelom, Platyhelminthes, Annelida, Arthropoda, Exoskeleton, Mollusca, Chordates, Bones.

**Lecture: Animals II**

**Relevant Reading:** Chapter 19, Chapter 20, Chapter 27.1-12

**Key Concepts:** Formation and Properties of Sperm and Egg Cells, General Process of Animal Development from Zygote to Gastrulation (to Neurulation in Chordates), Contrast Between Animal and Plant "Life Cycles".

**Terms:** Gametes, Sperm, Egg, Acrosome, Zygote, Cleavage, Gastrulation, Neurulation, Organogenesis, Growth, Gametogenesis, Endoderm, Mesoderm, Exoderm.

**Lecture: Animals III**

**Relevant Reading:** Chapter 19, Chapter 20, Chapter 27.1-12

**Key Concepts:** Divergence of Chordate groups, Cumulative Change in Chordate Body Plan as One Class Evolved from Another.

**Terms:** Gill Slits, Notochord, Dorsal Nerve Chord, Tail, Myomeres, Amniote Egg, Yolk, Homeothermic.

Lecture: Senses & Motion

Relevant Reading: Chapters 29 and 30

Key Concepts: Creation of a Sensory Stimulus, Mechanism of Muscle Contraction.

Terms: Muscle Fibers, Transverse Tubules, Sarcoplasmic Reticulum, Myofibrils, Sarcomere, Photoreceptor Cell, Rhodopsin, Cochlea Hair Cells.

## **Ecology and Evolution**

Lecture: Overview of Ecology

Relevant Reading: (Introductory Sections of Subsequent Readings are Relevant).

Key Concepts: Exchange of Materials Between the Abiotic & Biotic Components of Ecosystems, Difference Between a Community and an Ecosystem, Niche, Environment, Interdependence of Species.

Terms: Biome, Ecosystem, Community, Population, Trophic Levels, Niche.

Lecture: Populations

Relevant Reading: Chapter 35.1-6

Key Concepts: Change in Population Size and How the Environment Affects Population Growth.

Terms: Population, Biotic Potential, Exponential Growth, Carrying Capacity, Logistic Growth.

Lecture: Population Interactions

Relevant Reading: Chapter 36.1-6

Key Concepts: Categories of Interactions (Mutually Beneficial, One + & One -, Both -, Etc.); Competitive Exclusion

Terms: Community, Resource, Competition, Competitive Exclusion, Mutualism, Predation, Parasitism.

Lecture: Communities & Biomes

Relevant Reading: Chapter 34.6-18

Key Concepts: An Organism's Distribution Being Determined by Physical Environment and by Biotic Interactions, Difference Between a Niche and a Habitat, Forces Creating Global and Local Patterns of Temperature and Rainfall.

Terms: Keystone Species, Biomes, Habitat.

Lecture: Ecosystems

Relevant Reading: Chapter 36.8-17

Key Concepts: Ecosystem, Trophic Levels, Nutrient Cycles (Involving Pools and Fluxes), How Energy Passes Through an Ecosystem, The Carbon Cycle, The Nitrogen Cycle.

Terms: Fluxes, Pools (or compartments), Primary Producers, Consumers (Primary, Secondary, Tertiary)

Lecture: Overview of Evolution

Relevant Reading: Chapter 14.1-6, Chapter 9.1-7

Key Concepts: Adaptation, Evolution, Natural Selection, Determining Genotypes of Offspring

Terms: Homozygous, Heterozygous, Punnett Square, Adaptation, Natural Selection, Evolution.

Name: \_\_\_\_\_

Section: \_\_\_\_\_

Directions: On your answer sheet, fill in your name, the date and your social security number (under identification number). For each question, choose the best possible answer and mark your answer on the answer sheet **carefully**, using a # 2 pencil.

1. True or False: Electrons are part of the nucleus of an atom.
  1. True
  2. False
  
2. True or False: Water is a non-polar molecule.
  1. True
  2. False
  
3. Atoms are bonded together by interaction of their:
  1. outer electron shells
  2. nuclei
  3. protons
  4. neutrons
  
4. Which type of bonding is responsible for holding together Hydrogen atoms and Oxygen atoms in a water molecule?
  1. covalent
  2. ionic
  3. hydrogen
  4. oxygen
  
5. A key word describing covalent bonding is:
  1. gain
  2. loss
  3. sharing
  4. transfer

11. The largest unit of the following is the:
  1. cell.
  2. molecule.
  3. organelle.
  4. atom.
  
12. True or False: Prokaryotes have a membrane surrounding their nucleus.
  1. True
  2. False
  
13. A new “wonder food” is being distributed by a rival company. The researchers in your company determine that the “wonder food” contains only carbon, oxygen and hydrogen. At this point, the researchers:
  1. can say with certainty that the food is not made of proteins.
  2. can say with certainty that the food is made of proteins.
  3. can say with certainty that the food is made of lipids.
  4. can say with certainty that the food is not made of lipids.
  
14. The sub-units of proteins are:
  1. amino acids
  2. nucleic acids
  3. carbohydrates
  4. lipids
  
15. True or False: There are non-polar regions within lipid molecules.
  1. True
  2. False
  
16. True or False: All cells have a plasma membrane.
  1. True
  2. False
  
17. Membranes are composed of:
  1. a single layer of lipid molecules
  2. two layers of lipid molecules
  3. a mosaic of several layers of lipid molecules
  4. one to several layers of lipid molecules

25. Materials could cross the plasma membrane without the expenditure of energy through:
1. exocytosis
  2. endocytosis
  3. diffusion
  4. active transport
26. You are given a special balloon that is permeable to water but not to sucrose. (Sucrose cannot cross into or out of the balloon.) The balloon is filled with a solution of 20% sucrose and 80% water. You place the balloon in a beaker that is filled with a solution of 50% sucrose and 50% water. Which of the following will occur?
1. Water will leave the balloon.
  2. Water will enter the balloon.
  3. Water will not enter or leave the balloon.
  4. Sucrose will enter the balloon.
27. In the equation  $2\text{H}_2 + \text{O}_2 \longrightarrow 2\text{H}_2\text{O}$ ,
1.  $\text{H}_2$ ,  $\text{O}_2$  and  $\text{H}_2\text{O}$  are all reactants
  2.  $\text{H}_2$ ,  $\text{O}_2$  and  $\text{H}_2\text{O}$  are all products
  3.  $\text{H}_2$  and  $\text{O}_2$  are reactants and  $\text{H}_2\text{O}$  is a product
  4.  $\text{H}_2$  and  $\text{O}_2$  are products and  $\text{H}_2\text{O}$  is a reactant
28. Most of a cell's enzymes are:
1. lipids.
  2. proteins.
  3. amino-acids.
  4. nucleic acids.
  5. carbohydrates
29. When an enzyme catalyzes a reaction,
1. it lowers the activation energy of the reaction.
  2. it raises the activation energy of a reaction.
  3. it becomes a product.
30. The reaction converting ATP to ADP and P is an:
1. exophotic reaction
  2. exionic reaction
  3. exergonic reaction
  4. endothermic reaction

38. In respiration and photosynthesis, a proton (H<sup>+</sup>) gradient across a membrane is used to produce:
1. ATP
  2. NADH and NADPH
39.  $C_6H_{12}O_6 + 6 O_2 \longrightarrow 6 CO_2 + 6 H_2O$  is the formula for:
1. photosynthesis
  2. respiration
  3. glycolysis
  4. anaerobic respiration
40. True or False: Rubisco is the enzyme which adds CO<sub>2</sub> to an organic molecule.
1. True
  2. False
41. The function of chloroplasts is:
1. cellular respiration.
  2. intracellular transport of proteins.
  3. lipid synthesis.
  4. photosynthesis.
  5. intracellular digestion.
42. Material which appears to be blue to human vision:
1. absorbs blue wavelengths of light.
  2. reflects blue wavelengths of light.
  3. neither of the above.
43. True or False: During photosynthesis, water molecules are split into hydrogen ions and oxygen molecules.
1. True
  2. False

51. UCA is a codon that specifies the amino acid serine. What would be the complementary base sequence on the tRNA that pairs with this codon?
1. UCA
  2. TCA
  3. AGU
  4. TCG
52. Genes are made of:
1. ATP.
  2. RNA
  3. DNA
  4. Proteins
53. Between DNA strands, nucleotide bases pair (hydrogen bond) in specific combinations, one of which is:
1. adenine with cytosine
  2. cytosine with guanine
  3. adenine with guanine
  4. cytosine with thymine
54. Ribosomes are directly involved in:
1. lipid synthesis
  2. carbohydrate synthesis
  3. protein degradation
  4. protein synthesis
55. All transfer RNA:
1. contain at least one stop and one start codon.
  2. contain thymine.
  3. are composed of two strands held together by hydrogen bonds.
  4. have a site to which an amino acid attaches.

## Principles of Biology 1997

## Exam II

Name: \_\_\_\_\_

Section: \_\_\_\_\_

For each question, choose the best possible answer, and then carefully mark that choice (and only that choice).

1. Which of the following processes occur(s) during interphase?
  1. growth of the aster
  2. duplication of the chromosomes
  3. cell growth
  4. all of the above
  5. both b and c
  
2. True or False: The products of meiosis are two genetically identical cells.
  1. True
  2. False
  
3. In the nucleus of a diploid cell, two \_\_\_\_\_ chromosomes have genes coding for essentially the same proteins and have these genes in the same positions along each chromosome.
  1. homologous
  2. heterozygous
  3. complementary
  4. polyploid
  
4. Which of the following is a difference between mitosis and meiosis?
  1. In mitosis four daughter cells are produced, whereas in meiosis two daughter cells are produced.
  2. In mitosis two daughter cells are produced, whereas in meiosis four daughter cells are produced.
  3. Cells produced by mitosis are diploid, whereas cells produced by meiosis are haploid.
  4. In mitosis a cell divides once, whereas in meiosis it divides twice.
  5. 2, 3, and 4

5. What does the term semi-conservative mean in reference to DNA replication?
  1. A few mutations appear.
  2. Only part of the original DNA strand is conserved.
  3. Only part of a DNA molecule is copied.
  4. Each new DNA molecule contains one old strand.
  
6. In a fruit fly in which the diploid number of chromosomes is 8, the chromosome number in each gamete is normally:
  1. 2.
  2. 4.
  3. 8.
  4. 16.
  
7. During meiosis, the chromosomes of homologous pairs often twist around each other, break, exchange segments, and rejoin. This process usually contributes to:
  1. reduction from  $2N$  to  $1N$ .
  2. non-disjunction of homologous chromosomes.
  3. increased variability among offspring.
  4. the formation of polyploid (more than  $2N$ ) offspring.
  
8. True or False: Each chromosome contains one long double-stranded DNA molecule.
  1. True
  2. False
  
9. True or False: During meiosis, all chromosomes inherited from the maternal parent become segregated into separate gametes from the paternal chromosomes.
  1. True
  2. False
  
10. True or False: During mitosis and during meiosis, the “spindle” is the structure that is attached to the chromosomes and causes them to move.
  1. True
  2. False
  
11. True or False: Animal cells are examples of prokaryotes.
  1. True
  2. False

12. True or False: Prokaryotes have a true nucleus.
  1. True
  2. False
  
13. True or False: Through conjugation, bacteria can exchange plasmids.
  1. True
  2. False
  
14. Viruses replicate:
  1. inside your cells
  2. on the outer surface of your cells
  3. in the fluid of your blood.
  4. in any body fluid surrounding living cells.
  5. none of these
  
15. Bacteria have:
  1. cell walls
  2. ribosomes
  3. DNA
  4. all of these
  5. 1 and 3
  
16. Pseudopods are structures characteristic of:
  1. bacteria
  2. amoebas
  3. fungi
  4. lichens
  5. viruses
  
17. The first eukaryotic organisms were most like the members of the Kingdom:
  1. Fungi
  2. Animalia
  3. Protista
  4. Plantae

18. The intimate, mutually beneficial association formed between a fungus and the root of a plant is called a(n):
1. ingrowth
  2. mycorrhiza
  3. hyphae
  4. mycelium
  5. none of the above
19. True or False: There are both unicellular and multicellular eukaryotes.
1. True
  2. False
20. True or False: A strand of fungal cells is called a hypha.
1. True
  2. False
21. True or False: In spore-producing plants, meiosis occurs in sporangia.
1. True
  2. False
22. Which is responsible for continued growth in plants?
1. xylem
  2. phloem
  3. meristems
  4. epidermal tissue
23. A pine tree produces:
1. spores but not seeds.
  2. seeds.
  3. fruits.
  4. both seeds and fruits.
24. In the alternation of generations that characterizes plant life cycles, the diploid generation produces:
1. spores
  2. gametes
  3. zygotes

25. A structure which plant cells have but is lacking in animal cells is:
1. a plasma membrane.
  2. ribosomes.
  3. a nucleus.
  4. a cell wall.
26. True or False: The shoot apical meristem produces an apical cap of cells that covers the meristem and protects it from damage.
1. True
  2. False
27. Plants have vascular tissue made of dead cells through which water and minerals move from the roots. This vascular tissue is called:
1. xylem
  2. phloem
  3. stomata
  4. mesophyll
28. The more physically conspicuous stage of the moss life cycle is the:
1. diploid stage
  2. haploid stage
  3. gametangia
  4. zygote
29. Which of the following is true of ferns?
1. They are seedless vascular plants
  2. They have a free-living gametophyte
  3. Both 1 and 2
  4. None of the above
30. The ripened ovary of a flower, which aids in seed dispersal, is called:
1. an ovule
  2. a casing
  3. a fruit
  4. a cone
  5. a sporangia

31. Which of the following features is (are) characteristics of animals?
1. They are multicellular
  2. They are eukaryotic
  3. They are heterotrophic
  4. They lack cell walls
  5. All of the above
32. Which phylum consists of bilaterally symmetrical animals with a digestive tract that has only one opening?
1. Chordata
  2. Platyhelminthes
  3. Annelida
  4. Arthropoda
33. A feature which is not typical of most sponges is:
1. bilateral symmetry
  2. radial symmetry
  3. pores
  4. a central cavity
34. True or False: Flatworms (Platyhelminthes) have a true coelom.
1. True
  2. False
35. Which animals readily exchange gases through their moist skin?
1. Mammals
  2. Reptiles
  3. Birds
  4. Amphibians
  5. None of the above.
36. Animals that are segmented and have jointed appendages and an exoskeleton are members of the phylum:
1. Platyhelminthes
  2. Annelida
  3. Arthropoda
  4. Chordata

37. Which of the following characteristics is (are) seen only in chordates?
1. bilateral symmetry
  2. a coelom
  3. gill slits
  4. a notochord
  5. both 3 and 4
38. In animals, \_\_\_\_\_ tissue produces an extracellular matrix.
1. connective.
  2. epithelial.
  3. dermal.
  4. vascular.
39. True or False: The acrosome is a protective structure surrounding the egg cell of animals.
1. True
  2. False
40. True or False: Mammals are a phylum within the Animal Kingdom.
1. True
  2. False
41. True or False: During animal development, gastrulation is the formation of three cell layers by the invagination of the ball of cells and the migration of cells.
1. True
  2. False
42. Which tissue type is characterized by tightly connected cells underlain by a basement lamina?
1. nervous
  2. muscle
  3. epithelial
  4. connective
43. True or False: In the animal life cycle, the products of meiosis undergo mitotic cell divisions before functioning as gametes.
1. True
  2. False

44. A coelom is defined as a body cavity lined with:
1. endoderm
  2. ectoderm
  3. mesoderm
  4. a digestive tract
45. For chordates, a major evolutionary innovation that occurred in fishes was the:
1. hinged jaw
  2. bones
  3. paired appendages
  4. all of the above
46. You find a small elongated animal embedded in sand with one end sticking out. It has segmental musculature, a coelom, a series of openings on either side of the body and a complete digestive tract with an anus located part way down the body. This animal is:
1. an annelid (Annelida)
  2. a flatworm (Platyhelminthes)
  3. a sponge (Porifera)
  4. a lancelet (Chordata)
  5. an arthropod (Arthropoda)
47. True or False: Amphibians have an amniotic egg.
1. True
  2. False

Principles of Biology Spring 1997  
Exam III

Name: \_\_\_\_\_

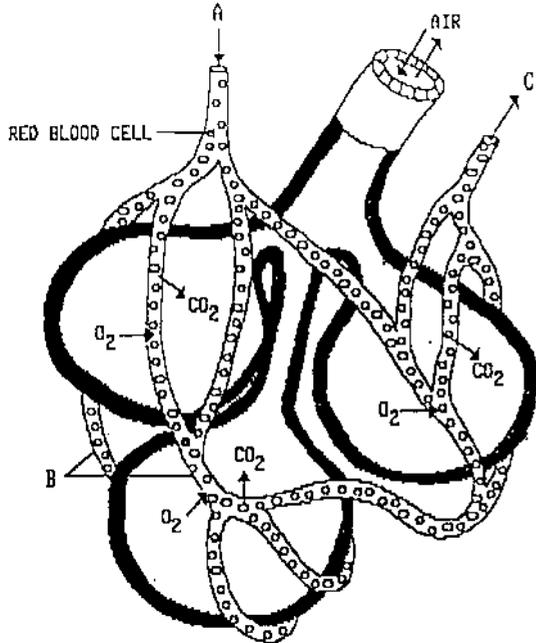
Section: \_\_\_\_\_

1. This term describes the maintenance of a constant internal environment:
  1. physiology
  2. homeostasis
  3. equilibrium
  
2. Which of the following processes is *not* involved in heat exchange between an animal and its environment?
  1. radiation
  2. conduction
  3. convection
  4. induction
  5. evaporation
  
3. Which of the following is a physiological response that takes place in many animals when they get too hot?
  1. slowing of the heart rate
  2. constriction of blood vessels in the skin
  3. contraction of muscles
  4. increased blood flow to the skin
  5. retention of water
  
4. Homeostasis depends on:
  1. positive feedback control
  2. positive and negative feedback control
  3. negative feedback control
  4. predictable environmental conditions
  5. predictable internal conditions

5. In which kind of vessel does blood have the lowest velocity?
  1. arteries
  2. arterioles
  3. capillaries
  4. venules
  5. veins
  
6. In which of the following animals does the respiratory system require no assistance from the circulatory system?
  1. salmon
  2. grizzly bear
  3. earthworm
  4. partridge
  5. cockroach
  
7. Oxygen is mostly transported through the body
  1. dissolved in the blood
  2. dissolved in red blood cells
  3. bound to hemoglobin
  4. bound to dissolved iron
  5. bound to carbon
  
8. The blood vessels that are close enough to all cells for diffusion to be an effective means of exchange are called:
  1. arteries
  2. arterioles
  3. capillaries
  4. venules
  5. veins
  
9. True or False: In an open circulatory system, there is no heart.
  1. True.
  2. False.
  
10. Systemic circulation transports blood:
  1. to the body tissues.
  2. to the lungs.
  3. to both the lungs and the other body tissues.

11. The heart of a fish contains:
  1. one chamber.
  2. two chambers.
  3. three chambers.
  4. four chambers.
  
12. True or False: Veins carry blood from the heart to capillaries.
  1. True
  2. False
  
13. Which of the following is an essential macronutrient for plants and is obtained directly from the atmosphere?
  1. manganese
  2. cobalt
  3. magnesium
  4. hydrogen
  5. carbon
  
14. True or False: Amylase in our saliva begins the digestion of starch.
  1. True.
  2. False.
  
15. The main function of our large intestine is:
  1. protein digestion.
  2. lipid digestion.
  3. absorption of water and ions.
  4. absorption of glycogen.
  
16. Most digested food material is absorbed into the blood stream from the:
  1. stomach.
  2. small intestine.
  3. large intestine.
  4. pancreas.

17. Bile is produced in the:
1. pancreas.
  2. stomach.
  3. small intestine.
  4. liver.
18. Which of the following choices lists the organs of the human digestive tract in the correct order?
1. oral cavity, esophagus, stomach, large intestine, small intestine.
  2. oral cavity, esophagus, stomach, small intestine, large intestine
  3. esophagus, oral cavity, stomach, small intestine, large intestine
  4. esophagus, oral cavity, stomach, large intestine, small intestine
19. Which of the following nutrients does *not* begin undergoing digestion until it reaches the small intestine?
1. fat
  2. protein
  3. starch
  4. complex carbohydrate
  5. polypeptide
20. An ideal surface for exchanging gases with the atmosphere would be:
1. small and wet.
  2. large and wet.
  3. small and dry.
  4. large and dry.
21. True or False: Each segment of the earthworm has a small lung-like organ that functions in gas exchange.
1. True.
  2. False.



Questions 22-25 refer to this diagram.

22. Compared to the blood entering A, the blood leaving the vessel network at C has a lower concentration of:
1. hemoglobin and carbon dioxide.
  2. oxygen and hemoglobin.
  3. oxygen.
  4. carbon dioxide.
  5. oxygen and carbon dioxide.
23. These air sacs are known as:
1. bronchioles.
  2. tracheae.
  3. alveoli.
  4. nephrons.
  5. glomeruli
24. The blood vessels (B) surrounding these sacs are known as:
1. veins.
  2. lymphatic ducts.
  3. capillaries.
  4. arteries.
  5. Bowman's capsules.
25. The process most directly involved with the exchange of gases between these air sacs and blood vessels is:
1. exocytosis.
  2. endocytosis.
  3. active transport.
  4. diffusion.
  5. hydrolysis.

26. True or False: The aveoli are bundles of capillaries within the bowman's capsules of the kidney.
1. True
  2. False
27. Which of the following substances in *not* reabsorbed in the human kidney?
1. water
  2. urea
  3. sugar
  4. sodium
  5. amino acids
28. During pressure filtration in the glomerulus, which of the following does *not* enter Bowman's capsule from the bloodstream?
1. water
  2. ions
  3. sugar
  4. plasma proteins
  5. amino acids
29. Which of the following choices lists structures in the order in which fluid flows through them?
1. proximal tubule; Bowman's capsule; loop of Henle; distal tubule; glomerulus
  2. Bowman's capsule; proximal tubule; loop of Henle; distal tubule; glomerulus
  3. Bowman's capsule; glomerulus; proximal tubule; loop of Henle; distal tubule
  4. glomerulus; Bowman's capsule; proximal tubule; loop of Henle; distal tubule
  5. glomerulus; proximal tubule; distal tubule; Bowman's capsule; loop of Henle

30. Ammonia ( $\text{NH}_3$ ) is produced from the breakdown of:
1. carbon dioxide.
  2. lipids.
  3. amino acids.
  4. carbohydrates.
31. Substances in our urine have been:
1. filtered and reabsorbed.
  2. filtered and/or secreted but not reabsorbed.
  3. secreted and reabsorbed but not secreted.
  4. reabsorbed but not secreted.
32. True or False: The movement of water through a plant (from roots to leaves) requires the expenditure of energy by the plant.
1. True
  2. False
33. When plants pump potassium ( $\text{K}^+$ ) ions into stomatal guard cells:
1. water flows out of the guard cells by osmosis.
  2. water flows into the guard cells by osmosis.
  3. water loss to the atmosphere is reduced.
  4. abscissic acid is produced.
34. True or False: Vessel elements are dead at maturity.
1. True
  2. False
35. Sodium is removed from a nerve cell:
1. by diffusion
  2. by osmosis
  3. during an action potential
  4. by active transport
  5. by exocytosis

36. A synapse is:
1. a junction between neurons.
  2. a short branch of a neuron.
  3. a protein lined channel across the membrane of a neuron.
  4. an electrical impulse along a neuron.
37. A molecule produced in one cell that affects the activities of another cell is:
1. a hormone.
  2. an enzyme.
  3. an mRNA molecule.
  4. a transport protein.
38. True or False: A neuron “at rest” does not have a voltage potential across its plasma membrane.
1. True
  2. False
39. True or False: The movement of an impulse (an action potential) along a neuron is called the “propagation” of an impulse.
1. True
  2. False
40. A resting neuron has:
1. more potassium ions inside the cell membrane than outside.
  2. more sodium ions inside the cell than outside.
  3. more sodium and more potassium ions outside the cell than inside.
  4. more sodium and more potassium ions inside the cell than outside.
41. True or False: All animal senses involve the creation of an impulse (an action potential).
1. True.
  2. False.
42. True or False: A mechanical force, such as pressure, can cause a channel in a nerve cell membrane to open and generate an impulse.
1. True
  2. False

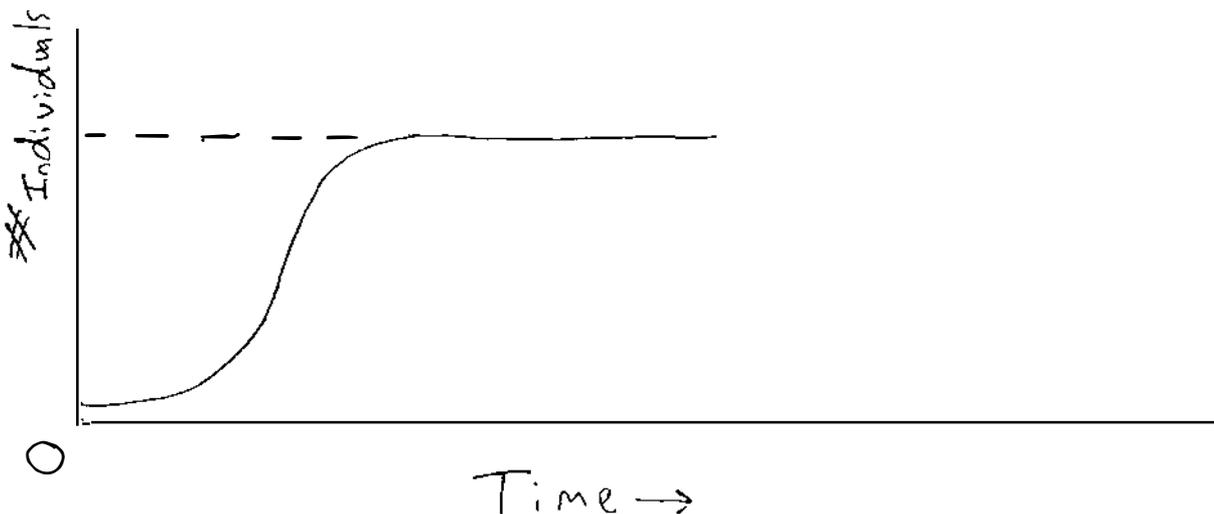
43. True or False: In muscle fibers, a myofibril consists of several contractile cells.
1. True.
  2. False.
44. Where is the calcium that triggers muscle contraction located between contractions?
1. in the motor neuron
  2. in the interstitial fluid
  3. in the synaptic vesicle
  4. in the endoplasmic reticulum (= sarcoplasmic reticulum)
  5. in the mitochondria
45. How does a muscle contract?
1. Actin filaments shorten.
  2. Myosin filaments shorten.
  3. Sarcomeres lengthen.
  4. Myosin filaments slide past actin filaments.

Principles of Biology  
Exam IV

Name: \_\_\_\_\_

For each question, choose the *best* possible answer.

- The type of growth illustrated by the human race during the past 2000 years is \_\_\_\_\_ growth.
  - logistic
  - exponential
  - linear
  - arithmetic
  - equilibril
- On the below graph, the dashed line represents:
  - the  $r$  of the population.
  - the carrying capacity of the population's environment.
  - the point of exponential growth caused by the environment.
- The shape of this curve represents \_\_\_\_\_ growth.
  - logistic
  - exponential
  - linear
  - arithmetic
  - equilibril



4. If an island has a carrying capacity of 1000 individuals for a given species, and 2000 individuals of that species are present, the population:
  1. is at equilibrium.
  2. will decline dramatically.
  3. will increase slowly.
  
5. A newly mated queen ant finds an ant nest in an unoccupied patch of suitable habitat. Assuming that no disasters strike the nest, the initial growth of its population is likely to be:
  1. linear
  2. exponential
  3. logistic
  
6. A community is made up of :
  1. different kinds of living organisms.
  2. one species of organism.
  3. living organisms and their non-living environment.
  4. ecosystems.
  5. the factors that constitute an organism's niche.
  
7. The sum total of a population's interactions with its biotic and abiotic environment constitutes its:
  1. habitat.
  2. biotic potential.
  3. niche.
  4. community.
  5. ecosystem.
  
8. Which of the following best describes the interaction between two species that both require the same resources:
  1. mutualism.
  2. competition.
  3. predation.

9. For plants, all of the following are resources except:
1. sunlight
  2. nitrogen
  3. phosphorus
  4. temperature
10. The relationship between a cow (which can not digest cellulose) and the cellulose-digesting bacteria in its digestive tract would best be described as:
1. predation
  2. mutualism
  3. competition
  4. parasitism
11. In an intertidal zone, there are two species of mussels. Individuals of the first species are able to grow under and displace individuals of the second species. As a result the second species is found only in habitats where the first can not survive. This is an example of:
1. a keystone interaction
  2. predation
  3. the Hardy-Weinberg model
  4. competitive exclusion
  5. mutualism
12. True or False: The species diversity of a community is just the total number of species within the community.
1. True
  2. False
13. True or False: Hot air can hold more water vapor than can cold air.
1. True
  2. False
14. True or False: Cold air rises.
1. True
  2. False

15. In terms of global air circulation, the equatorial latitudes are a region where air:
1. descends and warms, dropping rain.
  2. descends and warms, creating an arid belt.
  3. rises and warms, creating an arid belt.
  4. rises and cools creating an arid belt.
  5. rises and cools, dropping rain.
16. Total annual solar radiation is greatest at:
1. the poles.
  2. higher latitudes.
  3. mid-latitudes.
  4. at the equator.
  5. horse latitudes.
17. Most of the world's deserts are located at latitudes where:
1. hot, dry air rises.
  2. hot, dry air descends.
  3. cold dry air rises.
  4. cold dry air descends.
18. True or False: A biome is characterized by a predominant type of vegetation and its distribution is determined by climate.
1. True
  2. False
19. True or False: An ecosystem has non-living (abiotic) and living (biotic) components.
1. True
  2. False
20. Of the energy that enters one trophic level, \_\_\_ percent becomes available to organisms at the next higher level.
1. nearly 100
  2. 50-75
  3. 25-50
  4. less than 25

21. Beef Cattle are:
1. producers
  2. primary consumers
  3. secondary consumers
  4. decomposers
22. Which of these nutrients goes from the atmosphere into organic molecules through photosynthesis:
1. carbon
  2. nitrogen
  3. phosphorus
23. Which of these nutrients lacks an atmospheric pool? (In other words, which of these nutrients is essentially not present in the atmosphere.)
1. carbon
  2. nitrogen
  3. phosphorus
24. Which of these nutrients goes from the atmosphere into organic molecules primarily due to the action of bacteria?
1. carbon
  2. nitrogen
  3. phosphorus
25. All of the following cycle within ecosystems except for:
1. carbon
  2. nitrogen
  3. phosphorus
  4. energy
26. Which phrase best describes evolution?
1. changing allele frequencies in gene pools.
  2. increasing genetic diversity in ecosystems.
  3. origin of mutations.
  4. all of the above are equally apt descriptions.

27. When a gene for a given trait comes in alternative versions that specify different forms of the trait (for example, purple-flower and white-flower versions of a flower-color gene), the versions of the gene are called:
1. loci
  2. supergenes
  3. chromosomes
  4. alleles
  5. gametes
28. The expressed or physical traits of an organism are referred to as its
1. phenotype
  2. genotype
  3. expressed form
  4. genetic heritage
  5. none of the above
29. An organism with two different alleles for a single trait is said to be
1. homozygous
  2. heterozygous
  3. genotypically similar
  4. segregated
  5. cross-fertilized
30. A \_\_\_\_\_ allele has no noticeable effect on the appearance of an organism unless the organism is homozygous for that allele.
1. dominant
  2. recessive
  3. codominant
31. The impact of a single gene on more than one trait is called
1. incomplete dominance
  2. codominance
  3. pleiotropy
  4. polygenic inheritance
  5. blending inheritance

32. A human couple has four children and all are daughters. What are the chances that their fifth child will be another daughter?
1. 1 in 32.
  2. 100%
  3. 1 in 2
  4. 31 to 1.
33. True or False: For a particular type of plant, there is a recessive allele that causes seeds to be wrinkled. Therefore, if you cross a plant with wrinkled seeds and a plant homozygous for smooth seeds, then all of the progeny will have smooth seeds.
1. True
  2. False
34. Which of the following terms refers to the situation where a single phenotypic characteristic is determined by the combined effects of two or more genes?
1. incomplete dominance
  2. codominance
  3. pleiotropy
  4. polygenic inheritance
  5. blending inheritance
35. In snapdragons, if you take a plant of a true breeding variety with red flowers and cross it with a plant of a true breeding variety with white flowers, the offspring have pink flowers. This is an example of:
1. incomplete dominance
  2. codominance
  3. counterdominance
  4. plasticity
  5. pleiotropy

36. The “D” allele is completely dominant for dark hair, and the allele for light hair, “d”, is completely recessive. Two dark haired parents have a light haired offspring. What is the genotype of each parent and of the offspring?
1. parents DD, offspring DD
  2. parents Dd, offspring DD
  3. parents Dd, offspring Dd
  4. parents Dd, offspring dd
  5. parents dd, offspring dd
37. What besides natural selection can result in changes in allele frequencies?
1. mutation
  2. migration
  3. genetic drift
  4. all of the above
38. True or False: A population that does not meet all of the assumptions of the Hardy-Weinberg model can not undergo evolution.
1. True
  2. False
39. The repeated use of insecticides may lead to insecticide resistant insects. What mechanism is involved?
1. phenotypic adaptation.
  2. natural selection.
  3. Hardy-Weinberg Equilibrium.
  4. genetic drift.
40. Pretend you have a salamander that has 50,000 genes in its genome and is homozygous for 49,997 of those genes. This salamander is capable of producing how many genetically distinct gametes?
1. 3
  2. 6
  3. 8
  4.  $49,997 \times 3 = 149,991$
  5.  $(49,997)^2 = 2,499,700,000$

In parakeets, green feather color (G) is dominant over yellow (g), and solid color (S) is dominant over spotted (s).

41. A cross of GgSs with ggss would produce the phenotypic ratio:
1. 9:3:3:1
  2. 1:1:1:1
  3. 1:2:1
  4. 3:1
  5. 3:3:1:1
42. A cross of GgSs with Ggss would produce the phenotypic ratio:
1. 9:3:3:1
  2. 1:1:1:1
  3. 1:2:1
  4. 3:3:1:1
  5. none of the above
43. The change in allele frequencies resulting from a disaster that drastically reduces population size is called:
1. natural selection
  2. gene flow
  3. a bottleneck effect
  4. nonrandom mating
  5. a founder effect
44. A biological species is defined as:
1. a group of phenotypically indistinguishable organisms.
  2. a group of phenotypically similar organisms that share a high proportion of genes.
  3. a geographically contiguous group of organisms
  4. a group of organisms that can interbreed and produce fertile offspring.

45. The evolution of a new species is called:
1. speciation
  2. macroevolution
  3. geographic isolation
  4. reproductive isolation
46. \_\_\_\_\_ is when species derived from a common ancestor diversify into different niches.
1. An adaptive radiation
  2. Competitive exclusion
  3. Evolution
  4. Trophic dispersion
47. True or False: Sterility or reduced viability of hybrid offspring are the only mechanisms of reproductive isolation of two species.
1. True
  2. False
48. True or False: An adaptation increases an organism's survival and reproduction in a particular environment.
1. True
  2. False

## Principles of Biology

Final Exam Spring 1997

Version 1

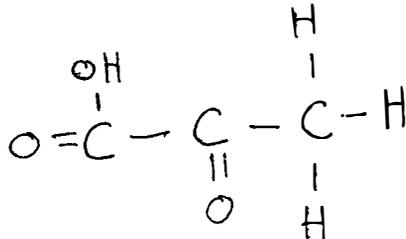
Name: \_\_\_\_\_

1. True or False: Water is a non-polar molecule.

1. True
2. False

2. Below is a diagram of a molecule's structure. This molecule is a:

1. protein
2. nucleic acid
3. lipid
4. carbohydrate



3. The sub-units of proteins are:

1. amino acids
2. nucleic acids
3. carbohydrates
4. lipids

4. Which of the following is not a polymer?

1. protein.
2. starch.
3. DNA in chromosomes.
4. amino acids.

5. True or False: There are some proteins in membranes.
  1. True
  2. False
  
6. True or False: The golgi apparatus can produce vesicles.
  1. True
  2. False
  
7. Membranes are composed of:
  1. a single layer of lipid molecules
  2. two layers of lipid molecules
  3. a mosaic of several layers of lipid molecules
  4. one to several layers of lipid molecules
  
8. Ribosomes are directly involved in:
  1. DNA synthesis
  2. carbohydrate synthesis
  3. protein degradation
  4. protein synthesis
  
9. Osmosis is:
  1. the active transport of water across a semi-permeable membrane.
  2. the facilitated transport of water across a semi-permeable membrane.
  3. the diffusion of water across a semi-permeable membrane.
  4. the diffusion of solutes across a semi-permeable membrane.
  
10. Which of the following substances would have the most trouble crossing a biological membrane by diffusing across the lipid bilayer?
  1. Water
  2. O<sub>2</sub>
  3. Na<sup>+</sup>
  4. The small non-polar molecule butane (C<sub>4</sub>H<sub>10</sub>)

11. You are given a special balloon that is permeable to water but not to sucrose. (Sucrose cannot cross into or out of the balloon.) The balloon is filled with a solution of 60% sucrose and 40% water. You place the balloon in a beaker that is filled with a solution of 50% sucrose and 50% water. Which of the following will occur?
1. Water will leave the balloon.
  2. Water will enter the balloon.
  3. Water will not enter or leave the balloon.
  4. Sucrose will enter the balloon.
12. Most of a cell's enzymes are:
1. lipids
  2. proteins.
  3. amino acids.
  4. nucleic acids.
  5. carbohydrates.
13. Which of the following sequences best describes the flow of information that takes place when a gene directs the synthesis of a protein?
1. RNA → DNA → RNA → Protein
  2. DNA → RNA → Protein
  3. Protein → RNA → DNA
  4. DNA → Amino Acid → RNA → Protein
  5. DNA → tRNA → mRNA → Protein
14. Between DNA strands, nucleotide bases pair (hydrogen bond) in specific combinations, one of which is:
1. adenine with cytosine
  2. cytosine with guanine
  3. adenine with guanine
  4. cytosine with thymine
15. All transfer RNA:
1. contain at least one stop and one start codon.
  2. contain thymine.
  3. are composed of two strands held together by hydrogen bonds.
  4. have a site to which an amino acid attaches.

16. A mutation in a gene, where one base is substituted for another, sometimes has no effect on the structure of the protein the gene codes for. Which of the following factors could account for this?
1. The redundancy of the genetic code.
  2. The rarity of such mutations.
  3. A correcting mechanism that is part of every mRNA molecule.
  4. The fact that such mutations are usually accompanied by a complementary deletion.
17. Which of the following statements is not true:
1. An enzyme increases the rate of reactions.
  2. An enzyme is not permanently altered by the reaction it catalyzes.
  3. An enzyme has an active site to which the reactant(s) bind.
  4. An enzyme typically catalyzes several different reactions.
18. In aerobic respiration, most ATP are produced through:
1. glycolysis.
  2. the Calvin cycle.
  3. the Krebs cycle.
  4. the electron transport chain.
19. A process that occurs in muscle cells during periods of oxygen deprivation (such as during heavy exercise) is:
1. the electron transport system.
  2. the Krebs cycle.
  3. neither of these.
20. In respiration and photosynthesis, a proton ( $H^+$ ) gradient across a membrane is used to produce:
1. ATP
  2. NADH and NADPH
  3.  $H_2O$
  4. glucose

21.  $C_6H_{12}O_6 + 6 O_2 + 6 H_2O \rightarrow 6 CO_2 + 6 H_2O$  is the formula for:
1. photosynthesis.
  2. respiration.
  3. glycolysis.
  4. anaerobic respiration.
22. The function of a chloroplast is:
1. cellular respiration
  2. intracellular transport of proteins.
  3. lipid synthesis.
  4. photosynthesis.
  5. intracellular digestion.
23. Water molecules are split into hydrogen ions and oxygen molecules during:
1. photosynthesis.
  2. respiration.
  3. both respiration and photosynthesis.
  4. none of the above.
24. Material which appears to be blue to human vision:
1. absorbs blue wavelengths of light.
  2. reflects blue wavelengths of light.
  3. neither of the above.
25. If  $10^{-3}$  were written as a decimal number it would be:
1. 0.01
  2. 0.001
  3. 0.0001
26. If  $10^6$  were written as a decimal number it would be:
1. 100,000.0
  2. 1,000,000.0
  3. 10,000,000.0

27. On a microscope, if your ocular lens has a magnification of 10X and your objective lens has a magnification of 20X, then an object will be magnified:

1. 2 times
2. 10 times
3. 20 times
4. 30 times
5. 200 times

28. In the cell cycle, which of the following processes occur(s) during interphase?

1. growth of the aster
2. duplication of the chromosomes
3. cell growth
4. all of the above
5. both 2 and 3

29. True or False: The products of mitosis are genetically identical cells.

1. True
2. False

30. True or False: The products of meiosis are genetically identical cells.

1. True
2. False

31. In the nucleus of a diploid cell, two \_\_\_\_\_ chromosomes have genes coding for essentially the same proteins and have these genes in the same positions along each chromosome.

1. homologous
2. heterozygous
3. complementary
4. polyploid

32. In a fruit fly in which the diploid number of chromosomes is 8, the chromosome number in each gamete is normally:
1. 2.
  2. 4.
  3. 8.
  4. 16.
33. During meiosis, the chromosomes of homologous pairs often twist around each other, break, exchange segments, and rejoin. This process usually contributes to:
1. reduction from  $2N$  to  $1N$ .
  2. non-disjunction of homologous chromosomes.
  3. increased variability among offspring.
  4. the formation of polyploid (more than  $2N$ ) offspring.
34. What distinguishes a haploid cell from a diploid one?
1. The number of mitochondria.
  2. The number of chromosomes
  3. The number of types of genes.
  4. Whether a cell divides by mitosis or by meiosis
  5. Whether a cell is prokaryotic or eukaryotic.
35. Independent assortment of chromosomes means that:
1. each chromosome is placed in a separate gamete.
  2. during meiosis chromosomes from the maternal parent are sorted into separate gametes from the paternal chromosomes.
  3. chromosomes inherited from the paternal parent can wind up in the same gamete as chromosomes from the maternal parent.
  4. homologous chromosomes are inherited as a pair, each pair of homologs independently entering one of the two gametes.
36. In which kind of vessel is blood under the greatest pressure?
1. arteries
  2. arterioles
  3. capillaries
  4. veinules
  5. veins

37. Oxygen is mostly transported through the body
1. dissolved in the blood
  2. dissolved in red blood cells
  3. bound to hemoglobin
  4. bound to dissolved iron
  5. bound to carbon
38. The blood vessels that are close enough to all cells for diffusion to be an effective means of exchange are called
1. arteries
  2. arterioles
  3. capillaries
  4. venules
  5. veins
39. True or False: Arteries carry blood from the heart to capillaries.
1. True
  2. False
40. Which of the following is an essential macronutrient for plants and is obtained directly from the atmosphere?
1. manganese
  2. cobalt
  3. magnesium
  4. hydrogen
  5. carbon
41. The main function of our large intestine is:
1. protein digestion.
  2. lipid digestion.
  3. absorption of water and ions.
  4. absorption of glycogen.
42. Most digested food material is absorbed into the blood stream from the:
1. stomach.
  2. small intestine.
  3. large intestine.
  4. pancreas.

43. True or False: Bile is produced in the pancreas.
1. True
  2. False.
44. Which of the following choices lists the organs of the human digestive system in the correct order?
1. oral cavity, esophagus, stomach, large intestine, small intestine.
  2. oral cavity, esophagus, stomach, small intestine, large intestine
  3. esophagus, stomach, small intestine, large intestine
  4. esophagus, stomach, large intestine, small intestine
45. Which of the following nutrients does *not* begin undergoing digestion until it reaches the small intestine?
1. fat
  2. protein
  3. starch
  4. complex carbohydrate
  5. polypeptide
46. Absorption of water is one major function of which of the following structures?
1. cecum
  2. small intestine
  3. colon
  4. rectum
  5. appendix
47. An ideal surface for exchanging gases with the atmosphere would be:
1. small and wet.
  2. large and wet.
  3. small and dry.
  4. large and dry.

48. Which of the following does *not* leave the bloodstream and enter the Bowman's capsule?
1. water
  2. ions
  3. sugar
  4. plasma proteins
  5. amino acids
49. Which of the following choices lists structures in the order in which fluid flows through them?
1. proximal tubule; Bowman's capsule; loop of Henle; distal tubule; glomerulus
  2. Bowman's capsule; proximal tubule; loop of Henle; distal tubule; glomerulus
  3. Bowman's capsule; glomerulus; proximal tubule; loop of Henle; distal tubule
  4. glomerulus; Bowman's capsule; proximal tubule; loop of Henle; distal tubule
  5. glomerulus; proximal tubule; distal tubule; Bowman's capsule; loop of Henle
50. Ammonia (NH<sub>3</sub>) is produced from the breakdown of:
1. carbon dioxide.
  2. lipids.
  3. amino acids.
  4. carbohydrates.
51. Substances in our urine have been:
1. filtered and reabsorbed.
  2. filtered and/or secreted but not reabsorbed.
  3. secreted and reabsorbed but not filtered.
  4. filtered and sometimes reabsorbed, but not secreted.
52. True or False: The movement of water through a plant (from roots to leaves) requires the expenditure of energy by the plant.
1. True
  2. False

53. When plants pump potassium ( $K^+$ ) ions into stomatal guard cells, and the stoma is opened:
1. water flows out of the guard cells by osmosis.
  2. water flows into the guard cells by osmosis.
  3. water loss to the atmosphere is reduced.
  4. abscissic acid is produced.
54. Which type of vascular tissue cell in a plant is dead at maturity?
1. vessel elements
  2. cells in sieve tubes
  3. Both 1 and 2
  4. Neither 1 or 2
55. In complex animals, which of the following organ systems would you *not* expect to have a large epithelial surface area?
1. digestive system
  2. excretory system
  3. circulatory system
  4. respiratory system
  5. muscular system
56. Homeostasis is best defined as the tendency of organisms to
1. vary their internal environment to match their metabolic needs
  2. tailor their inner environment to the specific spot in which they live
  3. keep critical aspects of their internal environment nearly constant despite differences in the external environment
  4. keep aspects of their internal environment matched to the external environment
57. The main waste product that is generated when food molecules are split apart during aerobic respiration is:
1. water
  2. ammonia
  3. hydrogen peroxide
  4. carbon dioxide
  5. energy-poor electrons

58. Which of the following is *not* a source of water loss in humans?
1. urination
  2. defecation
  3. perspiration
  4. circulation
  5. respiration
59. What is the name of the basic functional unit of the kidney?
1. renal unit
  2. Bowman's capsule
  3. nephron
  4. glomerulus
  5. tubule
60. Which of the following types of plant cells functions in large part to limit a plant's loss of water vapor?
1. guard cells
  2. root hairs
  3. endodermal cells
  4. xylem
  5. companion cells
61. Which phrase *best* describes evolution?
1. changing allele frequencies in gene pools.
  2. increasing genetic diversity in ecosystems.
  3. origin of mutations.
  4. all of the above are equally apt descriptions.
62. When a gene for a given trait comes in alternative versions that specify different forms of the trait (for example, purple-flower and white-flower versions of a flower-color gene), the versions of the gene are called:
1. loci
  2. supergenes
  3. chromosomes
  4. alleles
  5. gametes

63. The impact of a single gene on more than one trait is called
1. incomplete dominance
  2. codominance
  3. pleiotropy
  4. polygenic inheritance
  5. blending inheritance
64. True or False: For a particular type of plant, there is a recessive allele that causes leaves to be reddish. Therefore, if you cross a plant with reddish leaves and a plant homozygous for green leaves, then all of the progeny will have reddish leaves.
1. True
  2. False
65. Which of the following terms refers to the situation where a single phenotypic characteristic is determined by the combined effects of two or more genes?
1. incomplete dominance
  2. codominance
  3. pleiotropy
  4. polygenic inheritance
  5. blending inheritance
66. In snapdragons, if you take a plant of a true breeding variety with red flowers and cross it with a plant of a true breeding variety with white flowers, the offspring have pink flowers. This is an example of:
1. incomplete dominance
  2. co-dominance
  3. counter-dominance
  4. plasticity
  5. pleiotropy
67. What besides natural selection can result in changes in allele frequencies?
1. mutation
  2. migration
  3. genetic drift
  4. all of the above

68. True or False: A population that meets all of the assumptions of the Hardy-Weinberg model can undergo evolution.

1. True
2. False

69. Pretend you have a lily that has 20,000 genes in its genome and is homozygous for 19,998 of those genes. This lily is capable of producing how many genetically distinct gametes?

1. 2
2. 4
3. 8
4.  $49,997 \times 3 = 149,991$
5.  $(49,997)^2 = 2,499,700,000$

In cocker spaniels, black coat color (B) is dominant over red (b), and solid color (S) is dominant over spotted (s).

70. A cross of BbSs with Bbss would produce the phenotypic ratio:

1. 9:3:3:1
2. 1:1:1:1
3. 1:2:1
4. 3:3:1:1
5. none of the above

71. A cross of BbSs with bbss would produce the phenotypic ratio:

1. 9:3:3:1
2. 1:1:1:1
3. 1:2:1
4. 3:1
5. 3:3:1:1

72. The change in allele frequencies resulting from a disaster that drastically reduces population size is called:
1. natural selection
  2. gene flow
  3. a founder effect
  4. nonrandom mating
  5. a bottleneck effect
73. A biological species is defined as:
1. a group of phenotypically indistinguishable organisms.
  2. a group of phenotypically similar organisms that share a high proportion of genes.
  3. a geographically contiguous group of organisms
  4. a group of organisms that can interbreed and produce fertile offspring.
74. \_\_\_\_\_ is when species derived from a common ancestor diversify into different niches.
1. Evolution
  2. Competitive exclusion
  3. An adaptive radiation
  4. Trophic dispersion
75. True or False: Sterility or reduced viability of hybrid offspring are not the only mechanisms of reproductive isolation of two species.
1. True
  2. False
76. Life has been present on earth for approximately:
1. 4 million years
  2. 40 million years
  3. 400 million years
  4. billion years
  5. 40 billion years
77. True or False: The first life was not photosynthetic.
1. True
  2. False

78. True or False: The ancestors of humans developed much larger brains (relative to other apes) prior to developing erect posture.

1. True
2. False

79. True or False: The genus of human beings (*Homo*) includes two extinct species of “humans” and our species (*H. sapiens*)

1. True
2. False

80. Our species (*Homo sapiens*) has existed for:

1. 3000 years
2. 300,000 years
3. 3 million years
4. 30 million years
5. 300 million years

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