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**CliffsAP<sup>®</sup>**  
**5 Biology Practice Exams**

*by*

*Phillip E. Pack, Ph.D.*



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*To Mary and Megan*

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# Introduction

## How You Should Use This Book

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The Advanced Placement Program is designed to encourage students to take challenging courses in high school and receive college credit for their efforts. Many high schools offer classes especially designed for the AP program, but any course or program of study, whatever it is called, is appropriate as preparation for taking the AP exam if the content is college level. This book helps you to prepare for the Advanced Placement Examination in Biology by giving you five practice exams that are similar in content and format to actual AP exams. Taking these practice exams helps to improve your AP exam in three ways:

- You become aware of the topics you understand and the topics for which you need additional study.
- You learn more about each topic. Following each exam is a complete list of answers and explanations for each exam question. The explanations act as a study guide, providing you with a review of the material and helping you understand the concept tested by the question.
- You become more familiar with the format of the AP exam. Questions on the AP exam are presented in various ways. By taking the practice exams in this book you become more proficient at reading exam questions and determining the correct answer.

A companion book is also available. *CliffsAP Biology*, also by Phillip E. Pack, provides a detailed but compact review of each of the major topics. The review of each topic is followed by multiple-choice and essay questions specific to the topic. Complete answers and explanations are provided. In addition, a separate section provides a review of each of the 12 AP labs with relevant multiple-choice and essay questions. One practice exam is also provided. Altogether, the book provides almost 400 multiple-choice questions and 50 essay questions. All the questions in both books are unique. There is little overlap of questions among the practice tests of this book or between the questions of both books. Each question is designed to evaluate your understanding of a different aspect of a principle, a concept, or a word in the vocabulary of biology.

## Format

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The AP exam in biology consists of two parts. The first part is a 100-question multiple-choice test. You have 80 minutes to complete this section. The second part of the exam consists of four free-response, or essay, questions. First, you are given a 10-minute reading period to read the four questions, organize your thoughts, and record notes or create an outline on provided paper. Then you have 90 minutes to write your essay response to all four questions. The multiple-choice section counts for 60 percent of the exam, and the essay section counts for the remaining 40 percent. The exam is administered in May of each year along with AP exams in other subjects.

<b>Section I</b>	Multiple Choice	100 questions	80 minutes	60%
<b>Section II</b>	Reading Period		10 minutes	
	Writing Period	4 questions	90 minutes	40%

## Grading

Exams are graded on a scale of 1 to 5, with 5 being best. Most colleges will accept a score of 3 or better as a passing score. If you receive a passing score, colleges will give you college credit (applied toward your bachelor's degree), advanced placement (you can skip the college's introductory course in biology and take an advanced course), or both. You should check with the biology department at the colleges you're interested in to determine how they award credit for the exam.

The distribution of student scores for some recent AP exams in biology are as follows.

	<b>Exam Grade</b>	<b>Percentage of Students</b>		
		<b>2003</b>	<b>2004</b>	<b>2005</b>
Extremely well qualified	5	17.9	18.9	18.2
Well qualified	4	18.6	20.2	20.1
Qualified	3	22.4	21.9	22.9
Possibly qualified	2	26.1	24.6	23.3
No recommendation	1	14.9	14.4	15.5
<b>Mean Score (1 to 5)</b>		2.98	3.05	3.02

The multiple-choice section is designed with a balance of easy and difficult questions to produce a mean score of 50 out of 100 (on one recent test, the actual mean was 55 percent). Essay questions are also designed to obtain a 50 percent mean score, but scores vary significantly with individual questions and from year to year. On the 2005 exam, mean scores ranged from 2.78 to 4.88 (out of a possible 10 points) for the four questions. Clearly, both sections of the exam are difficult. They are deliberately written that way so that the full range of students' ability can be measured. In spite of the exam difficulty, however, 61 percent of the students taking the exam in 2005 received a score of 3 or better. Therefore, the AP exam is difficult, but most (prepared) students do well.

## What's on the Exam

The multiple-choice section of an AP exam is written with a certain number of questions from each area in biology. Generally, each of the major topics is represented by the percentages given in the following table. These same percentages were used to choose the questions for the five exams in this book. Since there are 100 questions on the exam, a topic with a 7 percent representation, such as chemistry, means there will be 7 questions for that topic. However, many questions address topics in more than one area, so the number of questions per topic may be higher than indicated here.

<b>Area I.</b>	<b>Molecules and Cells</b>		<b>25%</b>
	Topic 1:	Chemistry	7%
	Topic 2:	Cells	6%
	Topic 3:	Photosynthesis	4%
	Topic 4:	Respiration	4%
	Topic 5:	Cell Division	4%

<b>Area II.</b>	<b>Genetics and Evolution</b>		<b>25%</b>
	Topic 6:	Heredity	8%
	Topic 7:	Molecular Genetics	9%
	Topic 8:	Evolution	8%
<b>Area III.</b>	<b>Organisms and Populations</b>		<b>50%</b>
	Topic 9:	Five-Kingdom Survey	8%
	Topic 10:	Plants	12%
	Topic 11:	Animal Structure and Function	10%
	Topic 12:	Animal Reproduction and Development	6%
	Topic 13:	Animal Behavior	4%
	Topic 14:	Ecology	10%

## Hints for Taking the Multiple-Choice Section

In the AP exam, questions for the multiple-choice section are provided in a booklet. While reading the questions in the booklet, feel free to cross out answers you know are wrong or underline important words. After you've selected the answer from the various choices, you carefully fill in bubbles, labeled A, B, C, D, or E, on an answer sheet. Mark only your answers on the answer sheet. Since unnecessary marks can produce machine-scoring errors, be sure to fill in the bubbles carefully and erase errors and stray marks thoroughly.

Some specific strategies for answering the multiple-choice questions follow.

- 1. Don't let easy questions mislead you.** The multiple-choice questions range from easy to difficult. On one exam, 92 percent of the candidates got the easiest question right, but only 23 percent got the hardest question right. Don't let the easy questions mislead you. If you come across what you think is an easy question, it probably is. Don't suspect that it's a trick question.
- 2. Budget your time by skipping hard questions.** You have 80 minutes to answer 100 questions, 48 seconds per question. If you come across a hard question that you can't answer quickly, skip it, and mark the question to remind you to return to it if time permits. If you can eliminate some of the answer choices, mark those also so that you can save time when you return. It's important to skip a difficult question, even if you think you can eventually figure it out, because for each difficult question you spend three minutes on, you could have answered three easy questions. If you have time at the end of the test, you can always go back. If you don't have time, at least you will have had the opportunity to try all the questions. Also, if you don't finish the test, don't be overly concerned. Since the test is designed to obtain a mean score of 50 percent, it is not unusual for a student to leave some answers blank.
- 3. Make only educated guesses.** If you're not sure of the answer to a question, don't guess unless you can make an "educated" guess. You make an educated guess when you can reduce the answer to two or three choices. If you get an answer right, you receive one point. If you leave it blank, you receive no points. *However, for each wrong answer, one-fourth point is deducted from your score.*
- 4. Avoid wrong answer penalties.** One-fourth point is deducted for each wrong answer. The one-fourth point deduction for wrong answers adjusts for random guessing. Since each question has five choices, there is a one-in-five chance that you can *randomly* select the correct answer. If you choose five answers randomly for five questions, probability predicts that you will guess one correct answer and four wrong answers. Your total score for the five guesses would be  $1 - \frac{1}{4} - \frac{1}{4} - \frac{1}{4} - \frac{1}{4} = 0$ . By deducting one-fourth point for each of the wrong answers, your total score would be zero. That's reasonable because you really didn't know any of the answers. But if you can reduce your choices to two or three, the odds are in your favor that the number of questions you get right will exceed the number of points deducted. That's also reasonable, because you knew some of the answer choices were wrong.

- 5. Carefully answer reverse multiple-choice questions.** In a typical multiple-choice question, you need to select the choice that is true. On the AP exam, you will find many reverse multiple-choice questions where you need to select the *false* choice. These questions usually use the word “EXCEPT” in sentences such as “All of the following are true EXCEPT . . .” or “All of the following occur EXCEPT. . . .” A reverse multiple-choice question is more difficult to answer than regular multiple-choice questions because it requires you to know four true pieces of information about a topic before you can eliminate the false choice. It is equivalent to correctly answering five true-false questions to get one point; and if you get one of the five wrong, you get them all wrong. Reverse multiple-choice questions are also difficult because half way through the question you can forget that you’re looking for the false choice. To avoid confusion, do the following: After reading the opening part of the question, *read each choice and mark a T or an F next to each one to identify whether it is true or false*. If you’re able to mark a *T* or an *F* for each one, then the correct answer is the choice marked with an *F*. Sometimes you won’t be sure about one or more choices, or sometimes you’ll have two choices marked *F*. In these cases, you can concentrate on the uncertain choices until you can make a decision.

## Hints for Taking the Essay Section

There are four questions on the essay section of the test. One of the questions is taken from Area I (molecules and cells), one from Area II (genetics and evolution), and two from Area III (organisms and populations). One of the four questions will also evaluate your ability to design experiments or to analyze experimental results. Each of the four questions can earn a maximum of 10 points. The 40 points on this section of the exam counts as 40 percent of your total test score.

The essay questions are provided in a green (or lavender) booklet. During the 10-minute reading period, read the questions thoroughly, circling key words. Next, write a brief outline using key words to organize your thoughts. When the writing period begins, begin writing your answer on the answer sheets that are provided separately. If for some reason you don’t write an outline, go back and re-read the question half way through writing your answer. Make sure that you’re still answering the question. It’s easy to get carried away, and by the end of your response, you might be answering a different question.

Strategies for answering the essay questions follow.

- 1. Don’t approach the essay section with apprehension.** Most students approach the essay section of the exam with more anxiety than they have when approaching the multiple-choice section. However, in terms of the amount of detail in the knowledge required, the essay section is easier. On essay questions, *you* get to choose what to write. You can get an excellent score without writing every relevant piece of information. Besides, you don’t have time to write an entire book on the subject. A general answer that addresses the question with a limited number of specifics will get a good score. Additional details may (or *may not*) improve your score, but the basic principles are the most important elements for a good score. In contrast, a multiple-choice question focuses on a very narrow and specific body of knowledge, which you’ll either know or you won’t. The question doesn’t let you select from a range of correct information. This isn’t true for the essay questions.
- 2. Give specific information in your answer.** You need to give specific information for each essay question. Don’t be so general that you don’t really say anything. Give more than just terminology with definitions. You need to use the terminology to explain biological processes. It’s the combination of using the proper terminology and explaining processes that will convince an AP exam reader that you understand the answer. Give some detail when you know it—names of processes, names of structures, names of molecules—and then tell how they’re related. The reader is looking for specific information. If you say it, you get the points. You don’t have to say everything, however, to get the maximum 10 points.
- 3. Answer each part of an essay question separately.** Many of the AP essay questions ask several related questions. A single question, for example, might have two or three parts, each requesting specific information. You should answer each part of the question in a separate paragraph. This will help the reader recognize each part of your answer. Some questions are formally divided into parts, such as a, b, c, d. Again, answer these questions separately, in paragraphs labeled a, b, c, and d.
- 4. Answer all parts of an essay question.** When you answer the essay questions, it is extremely important that you give a response for each part of the question. Don’t overload the detail on one part at the expense of saying nothing in another part because you ran out of time. Each part of the question is apportioned a specific number of points. If you give abundant information on one part and nothing on the remaining parts, you receive only the maximum

number of points allotted to the part you completed. In a four-part question, that's often only 2.5 points. You won't get any extra points above the maximum 2.5, even if what you write is Nobel-prize quality.

5. **Budget your time.** You have 90 minutes for four questions, about 23 minutes each. Just as it's most important to answer all parts of a question, it's best to respond to all the essay questions rather than to answer two or even three of them extremely well, with no response on the last one or two. You'll probably know *something* about every question, so be sure you get that information written for each question. If you reach the last question with five minutes remaining, for example, use that time to write as much information as possible. One or two points is a lot better than zero.
6. **Don't worry if you make a factual error.** What if you write something that is incorrect? The AP exam readers look for correct information. They search for key words and phrases and award points when they find them. If you use the wrong word to describe a process, or identify a structure with the wrong name, there is no formal penalty (unlike the deduction for guessing on the multiple-choice test). If you're going to get any points, however, you need to write correct information.
7. **Don't be overly concerned about grammar, spelling, punctuation, or penmanship.** The AP exam readers don't penalize for incorrect grammar, spelling, or punctuation or for poor penmanship. They are interested in *content*. However, if your grammar, spelling, or penmanship impairs your ability to communicate, then the readers cannot recognize the content, and your score will suffer.
8. **Don't write a standard essay.** Don't spend your time writing a standard essay with introduction, support paragraphs, and conclusion. Just dive right into your outline and answer the question directly. On the other hand, your essay response cannot be an outline; it must have complete sentences written in paragraph form.
9. **Drawings can improve your score.** Drawings and diagrams may sometimes add up to 1 point to your essay score. But the drawings must be explained in your essay, and the drawings must be labeled with supporting information. If not, the AP exam reader will consider them doodles, and you will get no additional points.
10. **Pay attention to direction words.** A direction word is the first word in an essay question that tells you how to answer the question. The direction word tells you what you need to say about the subject matter that follows. Here are the most common direction words found on the AP exam:
  - *Discuss* means to consider or examine various aspects of a subject or problem.
  - *Describe* means to characterize or give an account in words.
  - *Define* means to give a precise meaning for a word or phrase.
  - *Explain* means to clarify or make understandable.
  - *Compare* means to discuss two or more items with an emphasis on their *similarities*.
  - *Contrast* means to discuss two or more items with an emphasis on their *differences*.

There are also specialized direction words for the laboratory essays. These words include *design* (an experiment), *calculate* (a value), and *construct* and *label* (a graph). These words have specific meanings for laboratory analyses and are discussed separately in the following section.

## Laboratory Essay Questions

The College Board provides 12 laboratory exercises for use in AP Biology courses. Completing these labs, or similar labs that your teacher may substitute, provides the laboratory experience typical of a first-year college course in biology. One essay question and approximately 10 percent of the multiple-choice questions are based on these lab exercises.

The laboratory essay question is usually one of two types.

1. **Experimental analysis.** In this type of essay question, you are given some experimental data and asked to interpret or analyze the data. The question usually includes several parts, each requesting specific interpretations of the data. In addition, you are usually asked to prepare a graphic representation of the data. Graph paper is provided. Guidelines for preparing a graph are given in the following section.
2. **Experimental design.** This type of essay question asks you to design an experiment to answer specific questions about given data or an experimental situation. Guidelines for designing an experiment are given later in this introduction.

Although the data or situation in both of these types of questions will be somewhat different from those you encountered in your AP labs, you will be able to draw from your AP lab experience to analyze data or design experiments.

## How to Graph Data

The laboratory question in the essay part of the AP exam will often ask you to create a graph using data provided in the question. Include the following in your graph.

1. **Label each axis.** Indicate on each axis what is being measured and in what unit of measurement. For example “Time (minutes),” “Distance (meters),” and “Water Loss (ml/m<sup>2</sup>)” are appropriate labels.
2. **Provide values along each axis at regular intervals.** Select values and spacing that will allow your graph to fill as much of the graphing grid as possible.
3. **Use the x-axis for the independent variable and the y-axis for the dependent variable.** The dependent variable is the value you are measuring as a result of an independent variable imposed by the experiment. If the graph is plotting the progress of an event, then time is the independent variable, and the data you collect that measures the event (such as weight change, distance traveled, or carbon dioxide released) is the dependent variable.
4. **Connect the plotted points.** Usually, straight lines are used to connect the points. Smooth curves are also used, but that usually implies knowledge about intermediate points not plotted or a mathematical equation that fits the experimental results. If the question asks you to make predictions beyond the data actually graphed, extrapolate, or extend, the plotted line with a different line form (for example, dotted or dashed).
5. **In graphs with more than one plot, identify each plot.** If you plot more than one set of data on the same graph, identify each plot with a short phrase. Alternatively, you can draw the points of each plot with different symbols (for example, circles, squares, or triangles) or connect the plotted points using different kinds of lines (solid line, dashed line, or dash-dot line) and then identify each kind of symbol or line in a legend.
6. **Provide a title for the graph.** Your title should be brief but descriptive.

## How to Design an Experiment

The laboratory essay question may ask you to design an experiment to test a given hypothesis or to solve a given problem. In most cases, the question will ask you not only to design an experiment but also to discuss expected results. Since the form of these questions can vary dramatically, it is not possible to provide a standard formula for preparing your answer. However, the following list provides important elements that you should include in your answer if they are appropriate to the question.

1. **Identify the independent and dependent variables.** The independent variable is the variable you are manipulating to see how the dependent variable changes.
  - You are investigating how the crustacean *Daphnia* responds to changes in temperature. You expose *Daphnia* to temperatures of 5°C, 10°C, 15°C, 20°C, and 30°C. You count the number of heartbeats/sec in each case. Temperature is the independent variable (you are manipulating it), and number of heartbeats/sec is the dependent variable (you observe how it changes in response to different temperatures).
  - You design an experiment to investigate the effect of exercise on pulse rate and blood pressure. The physiological conditions (independent variable, or variable you manipulate) include sitting, exercising, and recovering at various intervals following exercise. You make two kinds of measurements (two dependent variables) to evaluate the effect of the physiological conditions—pulse rate and blood pressure.
2. **Describe the experimental treatment.** The experimental treatment (or treatments) is the various values that you assign to the independent variable. The experimental treatments describe how you are manipulating the independent variable.
  - In the *Daphnia* experiment, the different temperature values (5°C, 10°C, 15°C, 20°C, and 30°C) represent five experimental treatments.
  - In the experiment on physiological conditions, the experimental treatments are exercise and recovery at various intervals following exercise.

3. **Identify a control treatment.** The control treatment, or control, is the independent variable at some normal or standard value. The results of the control are used for comparison with the results of the experimental treatments.
  - In the *Daphnia* experiment, you choose the temperature of 20°C as the control because that is the average temperature of the pond where you obtained the culture.
  - In the experiment on physiological conditions, the control is sitting, when the subject is not influenced by exercising.
4. **Use only one independent variable.** Only one independent variable can be tested at a time. If you manipulate two independent variables at the same time, you cannot determine which is responsible for the effect you measure in the dependent variable.
  - In the physiological experiment, if the subject also drinks coffee in addition to exercising, you cannot determine which treatment, coffee or exercise, causes a change in blood pressure.
5. **Random sample of subjects.** You must choose the subjects for your experiments randomly. Since you cannot evaluate every *Daphnia*, you must choose a subpopulation to study. If you choose only the largest *Daphnia* to study, it is not a random sample, and you introduce another variable (size) for which you cannot account.
6. **Describe the procedure.** Describe how you will set up the experiment. Identify equipment and chemicals to be used and why you are choosing to use them. If appropriate, provide a labeled drawing of the setup.
7. **Describe expected results.** Use graphs to illustrate the expected results, if appropriate.
8. **Provide an explanation of the expected results in relation to relevant biological principles.** The results you give are your expected results. Describe the biological principles that led you to make your predictions.
  - In the experiment on physiological conditions, you expect blood pressure and pulse rate to increase during exercise in order to deliver more O<sub>2</sub> to muscles. Muscles use the O<sub>2</sub> for respiration, which generates the ATP necessary for muscle contraction.

## Must-Know Essay Questions

Some AP Biology teachers try to predict which essay questions will be on the next AP test. For example, reviewing old AP exams might reveal some questions that haven't been asked in a while. A new scientific discovery, or research that receives a Nobel prize, might suggest an AP question. Unfortunately, guessing questions in this way is very unreliable.

Here is a better way. Questions on the essay section of the AP exam generally address fundamental principles or processes in biology. Here is a list of the most important principles—the ones on which questions keep reappearing on AP exams. Being able to answer these questions is an absolute requirement for being prepared. So, at the very least, know this material. Sample responses to questions on these topics appear in the answer sections following each practice exam in this book. Additional responses appear at the end of each topic section in the companion *CliffsAP Biology*.

1. Section 2: Cells: Cell structure, especially structure and function of the plasma membrane
2. Section 3: Photosynthesis: Photosynthesis and chloroplasts
3. Section 4: Respiration: Respiration and mitochondria
4. Section 5: Cell Division: Mitosis and meiosis
5. Section 7: Molecular Genetics: DNA structure and replication
6. Section 7: Molecular Genetics: Protein synthesis
7. Section 8: Evolution: Natural selection
8. Section 8: Evolution: Speciation
9. Section 10: Plants: Reproduction in flowering plants
10. Section 10: Plants: Plant tropisms and hormones (especially auxin)
11. Section 11: Animal Structure and Function: Nerve transmission
12. Section 11: Animal Structure and Function: Muscle contraction
13. Section 12: Animal Reproduction and Development: Menstrual cycle
14. Section 14: Ecology: Succession
15. Section 14: Ecology: Biogeochemical cycles

There's no guarantee that questions on these topics will appear on your AP exam, but these topics appear so often that you should be prepared. In any case, the multiple-choice section of the exam will certainly include questions on these topics. So you can't lose by focusing on these areas.

## Some Final Suggestions

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Each of the exams in this book is followed by an answer key for the multiple-choice questions, a scoring template for the exam, explanations for the multiple-choice questions, and scoring standards for the free-response questions (often called a rubric).

To get the full benefit of simulating a real AP exam, set aside at least three hours for each of the 5 exams. Begin the multiple-choice section and after 80 minutes, stop and move on to the essay section. Spend 10 minutes outlining your answers to each essay question and then allow yourself 90 minutes to write out your full answers. By using the actual times that the real AP exam allows, you will learn if the time you spend on each multiple-choice and each essay question is appropriate.

When you're done taking the exam, score your exam using the multiple-choice answers that follow the exam and the free-response scoring standards that follow the multiple-choice answer explanations. Then, go back and answer any multiple-choice questions that you were unable to complete in the allotted 80 minutes. When you are done, read all of the multiple-choice explanations, even those for questions you got right. The explanations are thorough and provide you with information and suggestions. Even if you know the answers, reviewing the provided explanations is good review.

Although you've heard it so many times, practice *will* improve your test performance (although it's unlikely to make you perfect). So be sure to complete all the tests and review all the answers. Good luck.



# Answer Sheet for Practice Exam 1

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- 2 A B C D E
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- 4 A B C D E
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- 6 A B C D E
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- 100 A B C D E

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# Practice Exam 1

## Section I (Multiple-Choice Questions)

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Time: 80 minutes

100 questions

**Directions:** Each of the following questions or statements is followed by five possible answers or sentence completions. Choose the one best answer or sentence completion.

---

- A scientist chemically analyzes the plasma membrane of a cell. He determines that it is an animal cell because he finds that it contains
  - cholesterol molecules
  - phospholipids
  - proteins
  - cellulose
  - chitin
- During interphase, chromosomes are not visible because
  - they condense and form small circular bodies
  - they move into the cytoplasm and attach to ribosomes
  - they attach to the nuclear envelope
  - they move into the cytoplasm to form the endoplasmic reticulum
  - they unwind for replication and transcription
- The plant cells responsible for increases in the length of roots are located in the
  - apical meristem
  - vascular cambium
  - cork cambium
  - secondary xylem
  - primary phloem
- Natural selection occurs for all of the following reasons EXCEPT:
  - Resources are limited.
  - Traits are inherited.
  - There is variation in traits among individuals in a population.
  - Individuals change in order to adapt.
  - Individuals compete for resources.
- In the hydrological cycle, plants transfer most of their water to the environment through
  - photosynthesis
  - respiration
  - denitrification
  - nitrification
  - transpiration
- Asci, perithecia, and hyphae characterize which of the following groups?
  - algae
  - bacteria
  - cyanobacteria
  - slime molds
  - fungi
- Which of the following correctly describes DNA polymerase activity?
  - It can operate in either the  $3' \rightarrow 5'$  or  $5' \rightarrow 3'$  direction.
  - It can initiate DNA replication.
  - It operates continuously without interruption on either DNA strand.
  - It can copy a mutation from the template strand to the replicate strand.
  - It requires no other enzymes to assemble DNA.

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8. During photosynthesis, the pH *inside* a thylakoid
- A. decreases as O<sub>2</sub> enters the thylakoid
  - B. decreases as H<sup>+</sup> accumulates inside the thylakoid from photolysis
  - C. only decreases in the dark
  - D. is always greater than the pH of the stroma
  - E. decreases as ATP is generated across the thylakoid membrane
9. Seeds are produced by all of the following EXCEPT:
- A. ferns
  - B. angiosperms
  - C. gymnosperms
  - D. flowering plants
  - E. conifers
10. The Krebs cycle occurs
- A. in the matrix
  - B. in the stroma
  - C. in the cytoplasm
  - D. between the crista membrane and the mitochondrial membrane
  - E. outside the thylakoids
11. Which of the following describes a correct order of events for the germination and early growth of a dicotyledon seedling?
- A. cotyledon digestion → imbibition → root growth → shoot growth
  - B. imbibition → cotyledon digestion → root growth → shoot growth
  - C. imbibition → root growth → shoot growth → cotyledon digestion
  - D. root growth → shoot growth → imbibition → cotyledon digestion
  - E. root growth → imbibition → shoot growth → cotyledon digestion
12. Compared to a person who is physically unfit, a person who is fit
- A. pumps a smaller volume of blood with each heart beat
  - B. takes longer to reach a maximum heart rate
  - C. delivers the same amount of oxygen to the circulatory system with each heart beat
  - D. requires more oxygen for the same amount of muscle contraction
  - E. is more likely to skip heart beats
13. Both cyclic and noncyclic photophosphorylation
- A. require H<sub>2</sub>O
  - B. generate NADP
  - C. generate oxygen
  - D. generate PGAL
  - E. generate ATP
14. All of the following involve membrane transport by passive or active transport processes EXCEPT the
- A. large intestine
  - B. postsynaptic membranes of a neuron
  - C. loop of Henle
  - D. alveolus
  - E. urethra
15. Which of the following is a characteristic that differentiates the domains Archaea and Bacteria? Of the two domains,
- A. only members of Archaea have a nuclear envelope
  - B. only members of Archaea have a circular chromosome
  - C. only members of Bacteria have peptidoglycans in their cell walls
  - D. only members of Bacteria have membrane-enclosed organelles
  - E. only members of Bacteria have plasma membranes with lipids
16. All of the following are true about energy in an ecosystem EXCEPT:
- A. Energy flows in one direction: from producers to primary consumers, to secondary consumers, to tertiary consumers.
  - B. Most of the energy transferred out of one trophic level is lost before passing into the next higher trophic level.
  - C. The ultimate source of most energy entering an ecosystem is the sun.
  - D. Heat generated by organisms represents a loss of energy to the ecosystem.
  - E. Energy is recycled in an ecosystem.

17. During development of an embryo, a cleavage refers to
- a cell division
  - the disposal of embryonic waste products
  - the merging of two adjacent cells
  - the formation of the neural groove
  - the invagination of cells to form the gastrula
18. New alleles appear in an isolated population as a result of
- genetic drift
  - natural selection
  - mutation
  - nonrandom mating
  - a small population size
19. Sugar and CO<sub>2</sub> are dissolved in water to make soft drinks. Which of the following is the solute?
- only the water
  - only the CO<sub>2</sub>
  - only the sugar
  - both the sugar and the CO<sub>2</sub>
  - both the sugar and the water
20. Which of the following would most likely provide examples of *mitotic* cell divisions?
- cross section of muscle tissue
  - cross section of an anther
  - longitudinal section of a shoot tip
  - endosperm of a dormant seed
  - cross section of a leaf
21. All of the following support the endosymbiotic theory that ancestors of mitochondria and chloroplasts were once independent, free-living prokaryotes EXCEPT:
- Mitochondria and chloroplasts divide independently of the eukaryotic host cell by a process similar to binary fission.
  - Mitochondria and chloroplasts carry on protein synthesis separately from the eukaryotic host cell.
  - Mitochondria and chloroplasts have ribosomes that more closely resemble those of bacteria than of eukaryotic cells.
  - Mitochondria and chloroplasts function independently of the eukaryotic host cell.
  - Mitochondria, chloroplasts, and bacteria have a single, circular chromosome without histones or proteins.
22. The electrons that leave chlorophyll and are passed to the electron transport chain in photosynthesis are replaced by electrons from
- light
  - H<sub>2</sub>O
  - NADH
  - NADPH
  - oxygen
23. The most fit individual in a population is defined as
- the strongest individual
  - the individual with an appearance most attractive to the opposite sex
  - the individual who produces the greatest number of fertile offspring
  - the individual who is able to acquire the most food
  - the individual who lives the longest
24. Which of the following connects the two hemispheres of the brain?
- anterior pituitary
  - medulla oblongata
  - optic chiasma
  - corpus callosum
  - cerebral cortex
25. Which of the following animal structures provides a function that most closely resembles the function of plasmodesmata in plants?
- tight junctions
  - gap junctions
  - blastopores
  - synaptic clefts
  - desmosomes
26. Which of the following nutrients most commonly limits plant growth?
- calcium
  - carbon
  - nitrogen
  - phosphorus
  - potassium

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- 27.** All of the following structures or mechanisms have contributed to the ability of plants to make the transition from water to land EXCEPT:
- A. a cuticle
  - B. a vascular system
  - C. seasonal dormancy
  - D. wind pollination
  - E. flagellated sperm
- 28.** Which of the following reactions occurs in the forward direction during the Krebs cycle but in the reverse direction during fermentation?
- A. pyruvate  $\leftrightarrow$  acetyl CoA
  - B. pyruvate  $\leftrightarrow$  lactate
  - C. pyruvate  $\leftrightarrow$  ethanol
  - D.  $\text{NAD}^+ + \text{H}^+ + 2\text{e}^- \leftrightarrow \text{NADH}$
  - E.  $\text{ADP} + \text{P}_i \leftrightarrow \text{ATP}$
- 29.** A typical virus, without modification by mutation, can usually infect
- A. any cell in a wide variety of species
  - B. any cell, but only in a single species
  - C. only specific kinds of cells in a single species or in closely related species.
  - D. only cells with protein coats
  - E. only bacteriophages
- 30.** Which of the following is found within the unfertilized, mature embryo sac of a flowering plant?
- A. the egg
  - B. the microspore mother cell
  - C. the endosperm
  - D. the fruit
  - E. the seed
- 31.** All of the following are necessary for a DNA virus to complete a lytic cycle EXCEPT:
- A. chromosomes of the host cell
  - B. replication enzymes of the host cell
  - C. ribosomes of the host cell
  - D. amino acids of the host cell
  - E. nucleotides of the host cell
- 32.** Energy extracted by cellular respiration can originate from
- I. carbohydrates
  - II. fats
  - III. proteins
- A. I only
  - B. II only
  - C. III only
  - D. I and II only
  - E. I, II, and III
- 33.** Two atoms with strongly unequal electronegativity would most likely form
- A. an ionic bond
  - B. a hydrogen bond
  - C. a polar covalent bond
  - D. a nonpolar covalent bond
  - E. a radioactive molecule
- 34.** In the final steps of photosynthesis, glyceraldehyde-3-phosphate (G3P or PGAL), the energy-rich product of the Calvin cycle, is used to make
- A. ATP
  - B.  $\text{NADP}^+$
  - C. NADPH
  - D. Glucose
  - E.  $\text{O}_2$
- 35.** A biologist is examining chromosomes from various people. She observes many different cells, including cells with extra X chromosomes. When she counts the number of Barr bodies, she is likely to find all of the following EXCEPT:
- A. no Barr bodies in an XO individual (Turner syndrome)
  - B. one Barr body in an XX individual
  - C. one Barr body in an XY individual
  - D. two Barr bodies in an XXX individual
  - E. three Barr bodies in an XXXX individual
- 36.** All deuterostomes
- A. are bilateral
  - B. are segmented
  - C. possess a coelum
  - D. have one gut opening
  - E. have spiral cleavages during embryonic development

- 37.** The final electron acceptor for oxidative phosphorylation is
- A.  $\text{NAD}^+$
  - B.  $\text{NADH}$
  - C. ATP
  - D.  $\text{O}_2$
  - E.  $\text{H}_2\text{O}$
- 38.** All of the following are associated with microtubules EXCEPT:
- A. centrioles
  - B. basal bodies
  - C. muscle contraction
  - D. separation of chromosomes into chromatids
  - E. motion of flagella
- 39.** White matter in the central nervous system is associated with
- A. multinucleated neurons
  - B. myelinated axons of neurons
  - C. areas involved in speech
  - D. motor neurons
  - E. sensory neurons
- 40.** Cell types of phloem tissue include
- A. sieve tube members and companion cells
  - B. tracheids and vessel elements
  - C. tracheids and companion cells
  - D. fibers and sclereids
  - E. fibers and companion cells

*Questions 41–42 refer to the following.*

Female mosquitoes are bloodsucking insects that find their hosts by locating sources of carbon dioxide and lactic acid.

- 41.** Which of the following describes the method used by mosquitoes to find their hosts?
- A. Kinesis
  - B. Taxis
  - C. Migration
  - D. Habituation
  - E. Pheromones

- 42.** All of the following contribute to the effectiveness of both carbon dioxide and lactic acid as a signal for mosquitoes to locate hosts EXCEPT:
- A. The atmosphere contains large amounts of carbon dioxide.
  - B. The largest sources of both carbon dioxide and lactic acid are large animals.
  - C. Plants do not produce both carbon dioxide and lactic acid.
  - D. Mammals produce carbon dioxide as a product of aerobic respiration.
  - E. Mammals produce lactic acid as a product of the anaerobic respiration.

*Questions 43–44 refer to the following.*

Female Belding's ground squirrels are social animals that sound alarm calls to warn members of their extended family of the approach of a predator. The alarm-call behavior benefits the group as a whole but is a risk to the caller because the alarm call attracts the attention of the predator.

- 43.** A squirrel that produces an alarm call is displaying which of the following?
- A. dominance
  - B. territoriality
  - C. agonistic behavior
  - D. submissive behavior
  - E. altruistic behavior
- 44.** A squirrel that produces an alarm call is twice as likely to be eaten by predators as noncallers. Which of the following explains why this behavior is adaptive?
- A. It increases the number of offspring that the caller can personally leave to the next generation.
  - B. It increases the inclusive fitness of the caller.
  - C. A squirrel is more likely to attract a mate while sounding an alarm call.
  - D. Squirrels that produce alarm calls produce more offspring.
  - E. Alarm call behavior is not adaptive.

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**Directions:** The following questions consist of a phrase or sentence. Each question is preceded by five lettered choices. Select the one lettered choice that best matches the phrase or sentence. Each lettered choice may be used once, more than once, or not at all.

Questions 45–49 refer to the following processes.

- A. transcription
- B. transduction
- C. transformation
- D. translocation
- E. transpiration

- 45. Absorption and assimilation of DNA by bacteria from the environment.
- 46. Carried out by RNA polymerase.
- 47. End product is a polypeptide.
- 48. Genetic variation introduced into bacteria by viruses.
- 49. Transfer of DNA between nonhomologous chromosomes.

Questions 50–53 refer to the following structures.

- A. Ganglion
- B. Flame cell
- C. Crop
- D. Hemocoel
- E. Spiracle

- 50. Associated with the respiratory system of insects.
- 51. Associated with the circulatory system of insects and mollusks.
- 52. Associated with the excretory system of flatworms (Platyhelminthes).
- 53. Associated with the digestive system of birds, insects, and annelid worms.

Questions 54–57 refer to the following ratios.

- A. 3:1
- B. 1:2:1
- C. 9:3:3:1
- D. 1:1:1:1
- E. 4:0

For the genetic cross  $Aa \times Aa$ , identify for  $F_1$  offspring

- 54. the phenotypic ratio if inheritance was by complete dominance.
- 55. the genotypic ratio if inheritance was by complete dominance.
- 56. the phenotypic ratio if inheritance was by incomplete dominance.
- 57. the genotypic ratio if inheritance was by incomplete dominance.

Questions 58–61 refer to the following.

- A. Parasitism
- B. Commensalism
- C. Mutualism
- D. Interspecific competition
- E. Intraspecific competition

- 58. Lichens.
- 59. Mycorrhizae.
- 60. Tapeworms live, eat, and reproduce inside the human digestive tract, robbing the host of nutrients.
- 61. In deserts, where water is scarce, individuals of creosote bush rarely grow more closely than five meters from each other.



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