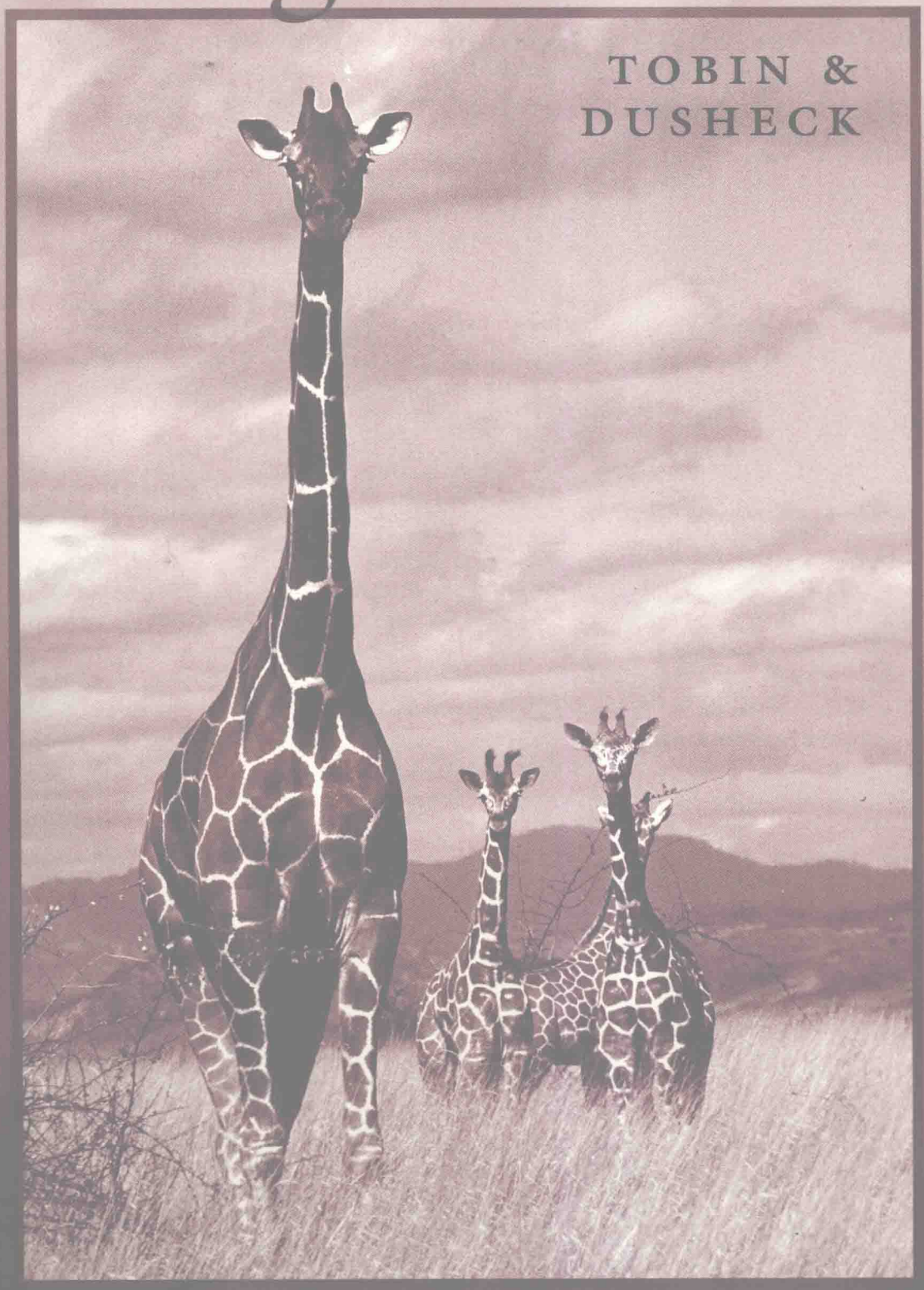
STUDY GUIDE
to accompany
Asking About Life



TOBIN & DUSHECK

GARRETT

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Asking About Life

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LORI K. GARRETT

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Preface

This study guide is designed to accompany ***Asking About Life***, by Allan Tobin and Jennie Dusheck, and is meant to be used in conjunction with, not instead of, the textbook. Each chapter in the study guide corresponds to a chapter in the text and has specific features designed to improve your comprehension.

Chapter Objectives. These allow you to judge your mastery of the chapter's material. Once you have a thorough understanding of the material, you should be able to address each of these.

Key Concepts. These are key points from throughout the text chapter.

Extended Chapter Outline. This presents major points from each section. The outline format makes it easy to locate material on which you need to concentrate and provides a concise summary of the entire chapter.

Vocabulary Building. This is a list of all Key Words from the chapter, with space provided for you to define each term. This section allows you to learn and practice the new, and perhaps intimidating, terminology.

Chapter Test. This consists of 4 parts:

Multiple Choice—to check your ability to recognize a correct answer;
True or False—to check your ability to assess the accuracy of certain statements;
Short Answer—to check your ability to recall material with no prompting; and
Essay/Thought Questions—to encourage use of critical thinking skills and application of the knowledge you have gained.

Answers to Chapter Tests. Answers to all parts of the Chapter Tests, except the Essay/Thought Questions, are provided at the end of this study guide. You should only consult the Answer section after you have completed the Chapter Test.

To gain the most knowledge from your studies of biology, read all parts of each chapter in the textbook before using this study guide. Do not skip any material unless instructed to do so. Examine each Figure and Table, and read all Boxes. Read and study when you are alert. Select a quiet location free of distractions (including television, talking, music, and people who are not studying) and take occasional study breaks. Many students benefit from taking notes while reading (thorough notes taken during class are essential). Schedule study time each day and stick to your schedule.

When you finish reading, answer the Review and Thought Questions in the text, then work through this study guide. Note any Chapter Objectives you have already mastered from reading the textbook, and come back to the Chapter Objectives when you finish studying to be sure you can address each of them. Read the Key Concepts for a quick review of major points, then review the material in the Extended Chapter Outline. If any part is not clear to you, return to the textbook and read that section again. If it remains unclear, jot down the problem area and ask your instructor for clarification.

Once you have reviewed the material, fill in the Vocabulary Building section. For the most benefit, try to define the terms from memory after reading the chapter, and always use your own words. Explain the term and, when possible, provide an example. Then check your definitions against the text and make corrections as needed for future reference.

Now you can complete the Chapter Test. Work through the entire test once, then go back to any questions you previously skipped. Mark any questions you are still unable to answer. Next, check your answers against the material in the textbook or in the Answer section at the end of this study guide. Mark any items you answered incorrectly, then look up the answers. Make corrections as needed.

Keep your study guide handy to help you prepare for quizzes and exams, and review the material often.

Biology is a fascinating area of study, but any science can be challenging. Use your study time wisely—there are no shortcuts to learning. The more effort you put forth, the more knowledge you will gain. As you study, constantly look for common themes and analogies that can help you comprehend the complex material. In time, you will find that your eyes are opening and you are seeing the world around you differently than you ever have before. You will start to see that simplicity and balance abound, and you will realize that, simply by living, you are a biologist.

Acknowledgments

I wish to express my sincere gratitude to Ms. Lee Marcott at Saunders College Publishing for inviting me to write this study guide. Lee's guidance, support, efficiency, organization, and patience were greatly appreciated. I also thank everyone else at Saunders who worked behind the scenes to help this project to fruition.

I extend special thanks to Kim Vallery and Donna Davis for their typing assistance, and to eagle-eyed Becky Barnes for her proofreading, wit, and friendship.

I thank my parents for supporting all of my endeavors, and for knowing that education is a necessity, not a luxury.

A truckload of gratitude goes to John Hoagland for thinking I can do anything, making work and life interesting, keeping me sharp and on my toes, and finding my real smile.

Finally, I thank my students, who are my continuing education.

Contents

Chapter 1
The Unity and Diversity Of Life

CHAPTER OBJECTIVES

1. Explain the scientific method and how it is used to answer questions.
2. Explain why a hypothesis can sometimes be proven incorrect, yet never be proven correct.
3. Describe the characteristics of a good experiment, and recognize flaws in bad experiments.
4. Explain why a control is necessary in all experiments, and be able to design one.
5. Design an experiment to test a given hypothesis.
6. Explain how models, hypotheses, and experimentation can lead to theories.
7. List and discuss ways in which organisms are both different and similar.
8. Demonstrate familiarity with the three domains of organisms and the four kingdoms of Eucarya.
9. List and give examples of each of the seven common characteristics shared by all living organisms.
10. Define homeostasis and how negative feedback is used to maintain it. Provide an example.
11. Differentiate between eukaryotic and prokaryotic organisms.
12. Explain how genes ensure continuity between generations, while giving rise to diversity.
13. Explain how genes and environment both contribute to phenotype.
14. Define natural selection. Explain how it is related to adaptations and how it leads to evolution.

KEY CONCEPTS

1. The scientific method is a formal set of rules that guide scientists in formulating and testing hypotheses to answer their questions. It includes the following steps:
   a) asking a narrowly focused question about some phenomenon;
   b) observing the phenomenon to gather information;
   c) evaluating that information by using previous knowledge and experience;
   d) developing a model, based on the evaluation, that might describe the phenomenon;
   e) formulating a testable hypothesis that attempts to explain the phenomenon; and
   f) designing and conducting experiments to test the hypothesis.
2. A hypothesis is an informed guess about how a process works that allows a scientist to predict outcomes of different situations. A hypothesis is only valuable if it is testable.
3. When tested, hypotheses may be proven false, but they can never be proven true.
4. Hypotheses are tested by carefully designed experiments which must include:
   a) carefully designed controls that eliminate all variables except the one being tested; and
   b) statistical analysis to evaluate the validity of the results (vs. chance).
5. A set of related hypotheses that seem valid after repeated attempts to disprove them may become recognized as a theory.

6. All living things share some common characteristics. They:
   a) are organized into parts,
   b) perform chemical reactions,
   c) obtain energy from their surroundings,
   d) change with time,
   e) respond to their environments,
   f) reproduce, and
   g) share a common evolutionary history.
7. Homeostasis is maintenance of a relatively stable internal environment by being able to:
   a) detect changes away from that stable state, and
   b) counteract such changes.
8. Negative feedback is the most common strategy used to maintain homeostasis.
9. All cells can be classed as either eukaryotic, which have membrane-bound nuclei and organelles, or prokaryotic, which lack membrane-bound organelles.
10. Organisms are more alike at the molecular level than at the structural level.
11. Genes, made of DNA, ensure continuity between generations.
12. Characteristics that define an individual (the phenotype) are determined by interactions between the individual's genes and the environment.
13. Natural selection leads to the accumulation of changes in a species; the process is evolution.

EXTENDED CHAPTER OUTLINE

HOW DO BIOLOGISTS ASK QUESTIONS?

Do scientists use the scientific method?

1. All scientific inquiry begins with curiosity, but the curiosity is controlled and carefully directed.
2. The scientific method is a set of formal rules used for formulating, testing, and eliminating ideas. All scientists use this method of inquiry, but few adhere rigidly to the rules—most scientists follow the rules loosely and subconsciously. Here is an overview of the process:
   a) *Focus on a single question or a small set of questions.* This is the problem to be addressed. Although many kinds of questions can be asked, scientists try to limit themselves to questions that can be answered.
   b) *Observe.* This is when information is gathered.
   c) *Evaluate the information.* This relies on comparing the information gathered with previous knowledge and experience to arrive at possible explanations.
   d) *Develop a model.* This is a simplified view of how the phenomenon being observed might occur. It is consistent with previous knowledge and offers new insight.
   e) *Formulate a testable hypothesis.* A hypothesis is an informed guess about how the phenomenon occurs. It allows prediction of future outcomes in different situations. The hypothesis must be testable, meaning that an experiment can be designed that will disprove the hypothesis if it is incorrect.
   f) *Design and conduct experiments.* This is done to test the hypothesis.

3. A scientist can sometimes prove that a hypothesis is incorrect, but it is never possible to prove a hypothesis correct. When experiments support a hypothesis, the scientist gains confidence in the hypothesis but cannot say with certainty that it is true. If an experiment fails to support the hypothesis, the hypothesis may still be correct—the prediction or experiment may be faulty.
4. An experiment must be carefully designed so the outcome depends only on the proposed cause. All possible variables must be considered and accounted for.
5. A valid experiment must include a control—a version of the experiment in which everything is the same except for the single variable being tested. The design of a control is critical and may be difficult—it is hard to conceive of all variables that might affect the experimental outcome.
6. Designing an experiment, including the control, is usually the scientist's most difficult task, but may also be the most enjoyable and creative part of the research. It requires both creativity and logic.
7. Experimental results must be analyzed using statistics, which allow the scientist to determine:
    a) if the experiment produces a result that is really different than the control response;
    b) if the result is truly due to the variable being tested, or merely due to chance; and
    c) if new questions or hypotheses should be considered.
8. Individual responses during an experiment will vary, so studies should be conducted with groups, not individuals. Larger groups give more accurate results.

What is a theory?

1. A theory is a system of statements and ideas that explain a group of facts or phenomena. To the scientist, a theory is a set of interconnected, rigorously tested hypotheses that are generally accepted.
2. The term "theory" is often used by nonscientists in reference to speculation.

Biologists ask many different kinds of questions

1. The scope of biology is enormous.
2. Each biologist has a unique view of the field, and this individual view will color the scientist's approach to inquiries.
3. Biology is, above all else, a human endeavor. People ask the questions. People have the insights. People solve the problems.

WHAT DO WE KNOW ABOUT LIFE?

How are organisms different from one another?

1. Life is enormously diverse.
2. All organisms can be categorized into one of three domains:
    a) Eubacteria—one distinct group of bacteria
    b) Archaea—another distinct group of bacteria
    c) Eucarya—eukaryotic organisms, which are further divided into four kingdoms:
        1) Animalia—animals
        2) Plantae—plants
        3) Fungi—which include yeasts and mushrooms
        4) Protista—mostly single-celled organisms
3. Listed within the three domains are about 1.4 million species of organisms.

4. Most living species have yet to be named.
5. Less than 1% of the organisms that have ever lived are still alive today.

How are organisms alike?

1. All living organisms share some common characteristics.
   a) *Organisms are organized.* They are made of organized parts.
   b) *Organisms perform chemical reactions.* They modify the molecules in their environment. Some reactions produce building materials; others produce energy. Metabolism refers to all chemical reactions that occur within an organism.
   c) *Organisms obtain energy from their surroundings.* Energy is needed to maintain organization. For most organisms (but not all), sunlight is the ultimate source of energy.
   d) *Organisms change with time.* They develop and grow.
   e) *Organisms respond to their environments.* All organisms react to changes in their surroundings. Homeostasis refers to maintenance of a constant internal environment.
   f) *Organisms reproduce.*
   g) *Organisms share a common evolutionary history.* All organisms use the same basic chemical building blocks, put together in similar ways, and pass information to offspring in the same ways. All organisms are related and share a single common ancestor.
2. The shared history among all organisms is a major theme in biology.
3. Organisms are made of cells, and cells are amazingly alike.
4. All cells can be classed into one of two types:
   a) Eukaryotic cells contain membrane-bound nuclei and organelles. All eukaryotic cells have the same internal parts and organization. All organisms in the kingdoms Animalia, Plantae, Fungi, and Protista are made of eukaryotic cells.
   b) Prokaryotic cells do not contain any membrane-bound organelles. Organisms in the domains Archaea and Eubacteria are prokaryotic.
   c) All eukaryotes are descended from prokaryotes.
5. In multicellular organisms, cells function independently of the whole organism. Individual cells are normally lost and replaced with no impact on the organism.
6. Cells are more alike than are the organisms in which they are contained.
7. Cells are made almost entirely from water and four other molecules:
   a) Sugars join to form polysaccharides.
   b) Amino acids join to form proteins.
   c) Fatty acids join to form lipids and fats.
   d) Nucleotides join to form DNA and RNA.
8. Species change very little from one generation to the next.
9. Genes ensure continuity from generation to generation. Genes are transmitted in the DNA, which is composed of nucleotides. Each gene is a sequence of nucleotides.
10. Most genes provide information the cells use to build particular proteins. This information is needed to build and maintain the organism.
11. Offspring receive half of their genes from each parent. Thus, sexual reproduction allows new combinations of genes, which makes each individual unique.
12. Mutations, which are changes in the DNA, create new variations that can be inherited.

13. An individual's phenotype is the collection of all of his or her observable characteristics. It is determined by complex interactions between the organism's genes and its environment.
14. Variations in either the genes or the environment can lead to diversity among the individuals within a single species.

How do organisms become different from one another?

1. Each species has a unique set of adaptations that enable it to live and function well in its particular environment. Although individuals are different, all members of a species share similar adaptations.
2. Fossil records strongly suggest that organisms much different from those alive today once lived on Earth.
3. Evolution is the process by which species have arisen and changed as they descended from common ancestors.
4. Charles Darwin proposed his theory of natural selection, which involves a type of selective breeding in which individuals with certain inherited traits are more likely to survive and reproduce. Through time, the traits common in the species will gradually change.
5. Gregor Mendel formulated the laws of heredity—the basis for the science of genetics.
6. By Mendel's principle of segregation, two copies of each gene segregate (separate) during production of gametes (eggs and sperm) so that each parent contributes just one copy of each gene to the offspring. By the principle of independent assortment, the genes are distributed into the gametes randomly, independent of one another.
7. Sexual reproduction unites half the genes from each parent into a unique combination in the offspring, allowing continuity of traits between generations while ensuring individual variation.

VOCABULARY BUILDING

In your own words, first write a brief definition, then a full explanation for each of the following terms. Include examples where appropriate. Complete this section from your memory—you will not learn the terms by simply copying definitions from the textbook. Once you have finished, check your responses against the information in the chapter and make any necessary corrections.

biology —

scientific method —

model —

reductionism —

emergent property —

hypothesis —

control —

testable —

statistics —

metabolism —

theory —

Eubacteria —

Archaea —

Eucarya —

Animalia —

Plantae —

Fungi —

Protista —

homeostasis —

negative feedback —

eukaryotic —

prokaryotic —

organelles —

mitochondria —

nucleus —

sugars —

amino acids —

lipids —

nucleotides —

genes —

deoxyribonucleic acid —

mutations —

phenotype —

adaptations —

fossils —

evolution —

natural selection —

principle of segregation —

gametes —

principle of independent assortment —

CHAPTER TEST

The following test has five parts. Complete as much of the exam as you can from memory. If you cannot answer a question, skip it. Once you complete all that you can, try to answer any questions you skipped. If you still cannot answer them, consult your textbook for the answers. Once you have completed all sections of the test, check your answers for Parts 1 - 4 against those in the back of this book. Highlight any incorrect answers then review that material in your textbook. Correct your answers for future reference.

Part 1: Multiple Choice

For each of the following, select all correct responses—more than one may be correct.

1. A hypothesis is best defined as:
   a) an educated or informed guess
   b) a proven idea
   c) an experimental result
   d) an informed observation

2. A "control" is:
   a) the first trial of an experiment
   b) a version of the experiment in which all subjects are treated exactly alike
   c) a version of an experiment in which the only variable that is different is the one being tested
   d) a version of an experiment in which the subjects are allowed to control the variables

3. Which of the following is not a testable hypothesis?
   a) Crop yields are higher when crops are rotated—corn in a field one year, but beans the next year
   b) Students perform better on biology exams if they read the text and use this study guide
   c) Plastic pink flamingos in a yard are an indicator that the residents have a high IQ
   d) The universe is finite and has boundaries

4. Which of the following is not one of the three domains into which organisms are grouped?
   a) Animalia
   b) Archaea
   c) Eucarya
   d) Eubacteria

5. All chemical reactions occurring within an organism are collectively referred to as:
   a) metabolism
   b) maintenance
   c) homeostasis
   d) energy production

6. For most organisms, the *ultimate* source of all energy is:
   a) heat
   b) the sun
   c) chemical energy gained from the environment
   d) chemical energy gained from conversion of molecules within the organism

7. Homeostasis is defined as:
   a) maintenance of a relatively constant internal environment
   b) a response to a change in the external environment
   c) continuity of traits from generation to generation
   d) all chemical reactions occurring within an organism

8. Which of the following is an example of a prokaryotic organism?
   a) yeast
   b) bacterium
   c) dandelions
   d) an otter

9. Which of the following molecules join together to form proteins?
   a) nucleic acids
   b) amino acids
   c) lipids
   d) sugars

10. DNA is built by joining together:
   a) nucleic acids
   b) amino acids
   c) lipids
   d) sugars

11. Genes contain information mostly for:
   a) making energy
   b) making new organisms
   c) making new cells
   d) making proteins

12. Phenotype—those characteristics that define an individual—is determined primarily by:
   a) genes
   b) environment
   c) interaction between genes and environment
   d) none of these

13. Mendel's principle of segregation states that:
   a) The two copies of each gene separate during gamete production so each gamete contains only one copy
   b) All genes separate randomly during gamete production, independent of each other
   c) Phenotype is determined primarily by genes
   d) Natural selection tends to increase separation, or diversity, within a family