



BIOLOGY

for a
Changing
World

third edition

INSIDE:

SAMPLE CHAPTER 8 Genes to
Proteins: Bulletproof

SAMPLE CHAPTER 15 Evidence for
Evolution: A Fish with Fingers?

Michèle Shuster / Janet Vigna / Matthew Tontono



w. h. freeman
Macmillan Learning

From the preface...

Dear Student,

Thank you for opening this book! We hope that your journey through it will be as rewarding for you as our journey in writing it has been. When we first came together to collaborate on the development of this text, our biggest overarching goal was to get students interested in biology by showing its relevance to daily life. We wanted to create a textbook that students would actually want to read. Our model and partner in this process has been *Scientific American*, a visually stunning magazine that's been successfully bringing science to the public for more than 150 years. The result is a unique textbook that takes a novel approach to teaching biology, one that we think has the potential to greatly improve learning. We hope that this brief introduction will serve as a road map of the book, so that you can get the most out of your experience with it and be as captivated by the wonders of life as we are.

The main approach of each chapter is the presentation of key science concepts within the context of a relevant and engaging story—a story of discovery, of determination, of human interest, of adventure. From the search for life on Mars to the problem of antibiotic-resistant bacteria, we use stories to bring science to life and to show scientists in action. After all, science is not just a collection of facts, so why would we present it that way? We ask you, our students, to study biology so you can use knowledge to make choices in the real world. We value those stories that will lead you to ask questions about life and how it works and to see the relevance of biology to daily activity. We have seen how stories engage students in our classrooms, and we hope you will be similarly intrigued.

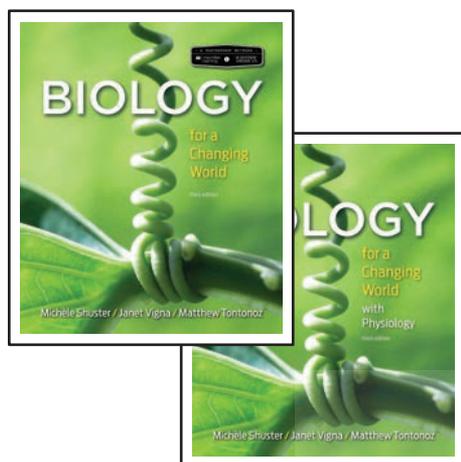
While gripped by a story, you may not even realize how much you are learning. To reinforce the basic learning process, we rely on several strategies:

- Each story is prefaced by a set of **Driving Questions**. By keeping these in mind as you navigate the story, you will have a good framework for learning the key science concepts.
- Eye-catching **Infographics** highlight and drill down into the science of each story. The set of Infographics in a chapter provides a science storyboard for that chapter, illustrating the key scientific concepts and linking them to the story.
- Each Infographic has a **question** to help you ensure that you have grasped the concept illustrated.
- **Key terms** are defined in the margins, making it easy to check a definition without having to leave the story.
- **Chapter summaries** provide a concise set of bullet points that distill the key scientific concepts.
- **Test Your Knowledge** questions at the end of each chapter reinforce basic facts and allow you to apply these facts through data interpretation and mini cases.

By taking full advantage of these resources, you will be better able to appreciate how biology affects each and every one of us as well as our close and distant relatives on this planet. We hope that you will talk about biology with your friends and family, and that what you learn here will be applicable to your life. We hope that you will think as critically about choices you make outside the classroom as we will ask you to do here in these pages.

Welcome to **Biology for a Changing World**. We hope that you enjoy your journey, and complete it more prepared for your life in a changing world.

Michèle Shuster
Janet Vigna
Matthew Tontonoz



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Real stories. Real biology.

Scientific American +

Biology for a Changing World, Third Edition

From the groundbreaking partnership of Macmillan Learning and *Scientific American* comes this one-of-a-kind introduction to the science of biology and its impact on the way we live.

In *Biology for a Changing World*, two experienced educators and a science writer explore the core ideas of biology through chapters written and illustrated in the style of a *Scientific American* article. Chapters don't just feature compelling stories of real people—each chapter *is* a newsworthy story that serves as a context for covering the standard curriculum for the non-majors biology course. Updated throughout, the new edition offers new stories, enhanced plant and diversity coverage, and an expanded media program.

Biology for a Changing World is supported by its own dedicated (and fully updated) version of LaunchPad, which fully integrates an interactive e-Book, all student media, a wide range of assessments, and course management features.

To request your review copy, contact your local Macmillan Learning representative or visit

macmillanlearning.com/learnmoreShuster3e

Science through Stories

Each chapter of *Biology for a Changing World* is written in the style of a *Scientific American* article. This story-based approach captures student interest immediately and teaches not only the fundamental concepts of the discipline but why understanding those concepts matters to students' lives and the world in general.

5

Energy and Photosynthesis

DRIVING QUESTIONS

1. What are the photosynthetic organisms on the planet, and why are they so important?
2. What are the different types of energy, and what transformations of energy do organisms carry out?
3. How do plants and algae convert the energy in sunlight into energy-rich organic molecules? (And why can't other organisms, including humans, do this?)
4. How do algal biofuels compare to other fuels in terms of costs, benefits, and sustainability?

the FUTURE of **FUEL?**

Scientists seek to make algae the next alternative energy source

AS AN ENGINEER WORKING FOR the Navy Seals in 1978, Jim Sears took a nighttime scuba dive off the coast of Panama City, Florida, one of many he took to do underwater research. The dive started out routinely, but then, suddenly, glowing phosphorescent algae appeared as if out of nowhere. When Sears put his hands out in front of him, sparkling streamers of microbes trickled off his fingertips. "It was magical," he recalls.

Sears is an inventor with many and varied devices to his credit. In the 1970s and 1980s, he built an underwater speech descrambler and a portable mine detector, among other gadgets. Later, he moved on to more creative technologies, including a "hump-o-meter" that could tell farmers when their animals were in heat or mating.

But the seeds of his real claim to fame weren't sown until 2004, when Sears was working in agricultural electronics. That's when he turned his attention toward what he felt was the world's biggest problem: dwindling fossil fuel reserves. After he did some thinking and a little research, the tiny, glowing organisms that had wowed him during his nighttime dive more than two decades earlier came to mind. He realized suddenly that they might be able to help.

Algae are perhaps best known as the layer of green scum coating the surfaces of ponds and swimming pools, but they have other claims to fame as well. Like plants, algae have the impressive ability to capture the energy of sunlight and convert it into a form that other organisms can use. Even more remarkable, algae trap much of this energy in the form of oils ideally suited to making fuel. The oil that

97

NEW CHAPTER STORIES

The Sitting Disease: Understanding the causes and consequences of obesity and Cellular Respiration

Bulletproof: Scientists hope to spin spider silk into the next indestructible superfiber

(Ch. 8, Genes to Proteins)

Can Rubber Save the Rainforest? A small state in Brazil aims to find out

(Ch. 18, Eukaryotic Diversity)

Plants 2.0: Is genetic engineering the solution to world hunger?

(Ch. 24, Plant Growth & Reproduction)

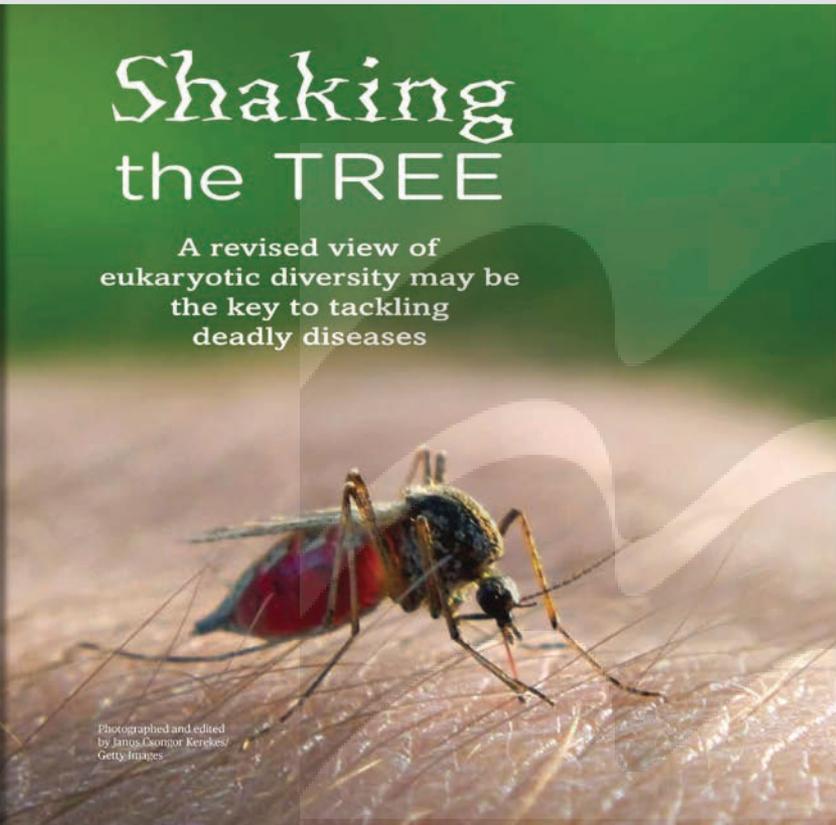
6

Milestones in Biology

Shaking the TREE

A revised view of
eukaryotic diversity may be
the key to tackling
deadly diseases

Photographed and edited
by Janos Orosz/ Kerekes/
Getty Images



DRIVING QUESTIONS

1. How has genetic evidence transformed the classification of protists?
2. Why is it important to classify protists accurately?
3. What are current challenges in preventing and treating malaria?

As the war in Vietnam raged, soldiers on both sides of the conflict faced an unrelenting enemy: malaria. This parasite-caused illness—transmitted through the bite of a mosquito—produces devastating fever, headache, chills, and vomiting in victims. If not treated within 24 hours, the condition can be fatal.

Malaria had traditionally been treated with drugs such as quinine, derived from the bark of the cinchona tree, and its synthetic derivative chloroquine. But increasingly, these drugs were unable to stem the tide of infection; the parasites had begun to evolve resistance.

Worried that a malaria-weakened army would be unable to fight off U.S.-backed military forces, the prime minister of North Vietnam, Ho Chi Minh, turned to Communist China for help. Recognizing their common interest in defeating a shared set of enemies, China's leader, Mao Zedong, launched a secret mission to find a malaria cure.

Project 523, as it was called—it was launched on May 23, 1967—enlisted hundreds of Chinese scientists and traditional Chinese healers. They were charged with screening thousands of known plant compounds for antimalarial effects and scouring traditional sources of Chinese medicine for leads on promising new medicines.

Taking their cue from an ancient medical text, the scientists homed in on one particular herb, called qinghao (known in the West as *Artemisia annua* or sweet wormwood). Qinghao had been used for centuries in treating “intermittent fevers,” a description that aptly describes a symptom of malaria. The scientists tested the herb against malaria-infected mice but the results proved inconsistent.

ALSO IN THIS EDITION

Enhanced Plant and Diversity Coverage

New two-chapter plant unit:

- Plant Growth & Reproduction (new chapter)
- Plant Physiology (new to the “without Physiology” version)

MILESTONES

These **mini-chapters on historically important discoveries** in biology teach students how we know what we know, prompting them to consider how future research will expand our understanding of biology.

NEW MILESTONE! Shaking the Tree: A revised view of eukaryotic diversity may be the key to tackling deadly diseases

Infographics

Engaging and informative **Infographics** are used throughout the book. These powerful pieces of art teach students how to learn from charts, graphs, and images, and add visual appeal to the science. Animated Infographics in LaunchPad are accompanied by assignable quiz questions.

INFOGRAPHIC 15.7 Related Organisms Share DNA Sequences

→ Related organisms share DNA sequences inherited from a common ancestor. Over time, the sequence in each species acquires **deleterious** mutations. The more time that has passed, the greater the number of sequence differences that will be present. Thus, the percentage of nucleotides that differ between two species gives an indication of the evolutionary distance between them.

Sequence homology between species

Species A GGTATCGAGGTTCTACATTGCAACTTCTAC
 Close relative GGA~~A~~A~~C~~GAGGTTCTACATTG~~C~~C~~A~~CTTCTAC
 Distant relative GGA~~A~~A~~C~~GAGGTT~~C~~GACAT~~A~~G~~C~~C~~A~~CTTCTAC

3 differences in 30 nucleotides
 $3/30 = 10\%$; or 90% similarity

5 differences in 30 nucleotides
 $5/30 = 17\%$; or 83% similarity

Similarity to human DNA sequences for the CFTR region



Pufferfish
65% similarity



Mouse
85% similarity



Chimpanzee
99% similarity



Human
100% similarity

Common ancestor of pufferfish, mice, chimpanzees, and humans, about 420 mya.

Common ancestor of mice, chimpanzees, and humans, about 60–100 mya.

Common ancestor of chimpanzees and humans, about 5–7 mya.

Data from Thomas, J.W. et al. (2003) Nature 424:788–793

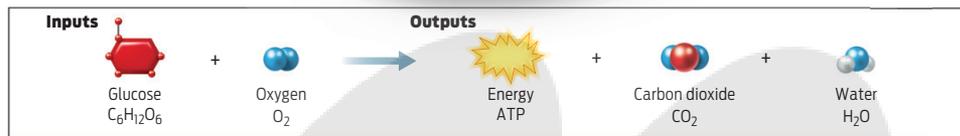
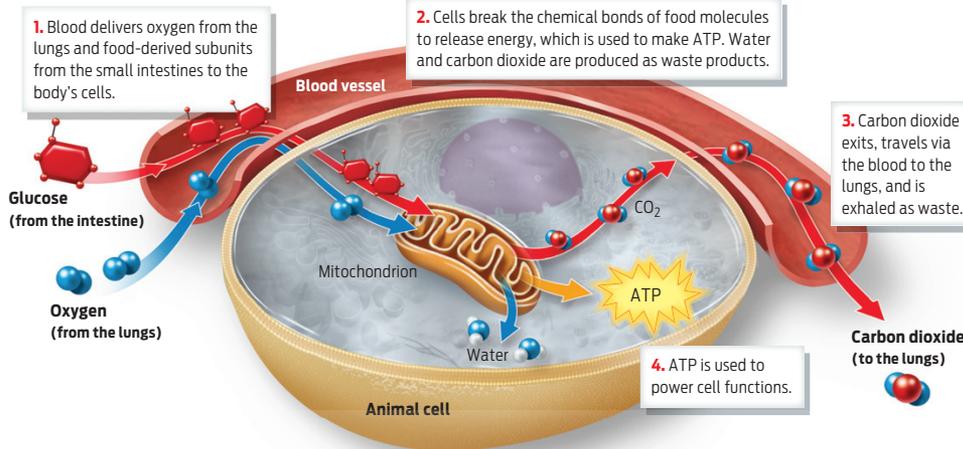
? What is the percent similarity between the close relative and the distant relative shown in the top panel?

NEW INFOGRAPHIC QUESTIONS

Each Infographic now includes a thought-provoking question at the end to encourage students to think critically about the information presented in the figure.

INFOGRAPHIC 6.6 Aerobic Respiration Transfers Food Energy to ATP

➔ During aerobic respiration, our cells use the oxygen we inhale to help extract energy from food. Cells convert the energy stored in food molecules into the bonds of ATP, the cell's energy currency.



? What is the source of the glucose and the oxygen used in aerobic respiration?

ADDITIONAL PEDAGOGICAL FEATURES

Driving Questions provide the pedagogical framework for the chapter content by prompting students to consider the questions they need to be able to answer to have a full understanding of the material.

End-of-chapter questions, written by Michèle Shuster, are framed around the chapter's **Driving Questions**. Each question set includes **Interpreting Data**, **Mini-Case**, and **Bring It Home** questions to help students develop higher-order thinking skills. Selected questions are also assignable online through LaunchPad.

INTERPRETING DATA

20 The gene responsible for hairlessness in Mexican hairless dogs is called *corneodesmosin (CDSM)*. This gene is present in other organisms. Look at the sequence of a portion of the *CDSM* gene from pairs of different species, given below. For each pair, determine the number of differences. From the variations in this sequence, which organism appears to be most closely related to humans? Which organism appears to be least closely related to humans?

Species	Sequence
<i>Homo sapiens</i> (human)	ACTCCGGCCCTACATCCCCAGTCCCA
<i>Canis lupus familiaris</i> (dog)	ATTCTGGCTCCTACATTTCCAGTCCCA
<i>Homo sapiens</i> (human)	ACTCCGGCCCTACATCCCCAGTCCCA
<i>Pan troglodytes</i> (chimpanzee)	ACTCCGGCCCTACATCCCCAGTCCCA
<i>Homo sapiens</i> (human)	ACTCCGGCCCTACATCCCCAGTCCCA
<i>Sus scrofa</i> (pig)	AGTCTGGCTCCTACATCTCCAGTCCCA
<i>Homo sapiens</i> (human)	ACTCCGGCCCTACATCCCCAGTCCCA
<i>Macaca mulatta</i> (rhesus monkey)	ACTCTGGCCCTACATCCCCAGTCCCA

apply YOUR KNOWLEDGE

MINI CASE

21 Fossils allow us to understand the evolution of many lineages of plants and animals. They therefore represent a valuable scientific resource. What if *Tiktaalik* (or an equally important transitional fossil) had been found by amateur fossil hunters and sold to a private collector? Do you think there should be any regulation of fossil hunting to prevent the loss of valuable scientific information from the public domain?

apply YOUR KNOWLEDGE

BRING IT HOME

7 Do an Internet search to find out about fossils discovered in your home state. Determine what kinds of organisms they represent, how old they are, and where in your state you would need to go in order to have a chance of finding fossils in the field.

apply YOUR KNOWLEDGE

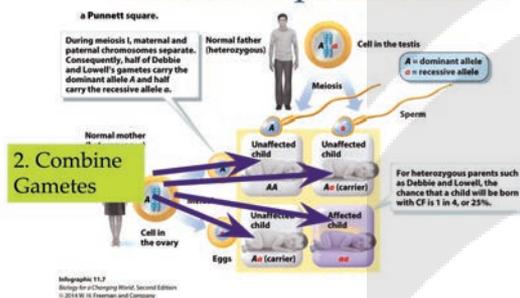
DRIVING QUESTION 2 What features make *Tiktaalik* a transitional fossil, and what role do these types of fossils play in the fossil record?

Expanded Media Program in LaunchPad

Built to address the biggest classroom issues instructors face, **LaunchPad** gives students everything they need to prepare for class and exams, while giving instructors everything they need to quickly set up a course, shape the content to their syllabus, craft presentations and lectures, assign and assess homework, and guide the progress of individual students and the class as a whole.

Use a Punnett Square to determine probabilities

11.7



Simple Inheritance Worksheet

Activity Guide

Chapter 11: Simple Inheritance and Meiosis

Introduction

This activity gives students the opportunity to practice genetics problems in class, either individually or with a partner/group.

Learning Objectives

After completing this activity, students should be able to:

- Determine the genotypes and phenotypes of individuals from information given
- Determine possible gametes
- Predict genotypes and phenotypes of individuals

Materials

- Activity guide and Answer Key
- Student Handout
- Activity PowerPoint presentation with introductory slides and clicker questions

Simple Inheritance Worksheet

Answer Key

- In humans, normal skin pigmentation (B) is a dominant trait and albinism (b) is recessive.
 - Two people with normal pigmentation have an albino child. Use a Punnett square to demonstrate how the child could have a different phenotype than the parents.

Both parents have to be heterozygous for any offspring to be white.

	B	b
B	BB	Bb
b	Bb	bb

- If the mom had normal pigmentation and the dad was albino, how many of each phenotype would you expect out of 4 children? What are the phenotypic and genotypic ratios of the offspring? (hint: there may be more than one answer).

Either 2 normal and 2 albino (the mother is heterozygous); 1:1

	B	b
b	Bb	bb
b	Bb	bb

Simple Inheritance Activity

Because we know that one copy of each allele is inherited from each parent, we can figure out the possible genotypes and phenotypes of offspring. Working individually or with a partner, answer the following questions.

- In humans, normal skin pigmentation (B) is a dominant trait and albinism (b) is recessive.
 - Two people with normal pigmentation have an albino child. Use a Punnett square to demonstrate how the child could have a different phenotype than the parents.
 - If the mom had normal pigmentation and the dad was albino, how many of each phenotype would you expect out of 4 children? What are the phenotypic and genotypic ratios of the offspring? (hint: there may be more than one answer).

Active Learning Lesson Plans Curated and customizable, these sets of lecture slides, instructor guides, and student activities provide instructors with an easy-to-use framework for including active learning in their lectures, deepening student engagement with the text. They are available for all chapters and organized by each chapter's Driving Questions.

Back to Study Plan Score: 9/100 Question Value: 15 points

Looking at Infographic 24.3, which country seems to have a similar ecological footprint per capita as the United States?

Australia
 Russia
 Mexico

Need help on this question?
 Read about this topic (no points) | Get a hint (fewer points) | Show answer (no points)

LearningCurve

Putting “testing to learn” into action, LearningCurve is the perfect tool to get students to engage before class, and review after. With game-like quizzing, it creates individualized activities for each student, selecting questions—by difficulty and topic—according to their performance.

Home Animation 8.9 Cancer Notes Assign Edit Previous Next

Translation: A Closer Look

In gene expression, the code in the messenger RNA is copied from a gene and serves to relay the information in this code from the nucleus to the cytoplasm. The process of translation begins when a complex cellular machine called the ribosome attaches to the newly transcribed mRNA.

1. Identify the role that tRNA plays in translation.

- tRNA carries mRNA out of the nucleus and into the cytoplasm.
- tRNA binds to the DNA molecule to begin translation.
- tRNA molecules carry amino acids to the ribosome.
- tRNA breaks down protein chains to release amino acids.

2. Identify the part of the mRNA molecule and tRNA molecules that correspond with one another in translation.

- codon and anticodon
- codon and ribosome
- protein and ribosome
- DNA and chromosome

144 Go to... Score: 1 of 5

Infographic Animations with Questions

Animated Infographics include assignable questions that encourage students to think critically about the information presented in the figure.

Home Chapter 8 and 15 Summative Quiz Assign Edit Previous Next

Basic Info Search Questions Review & Modify Settings Assign Due Date

Search Questions

Apply Filters Clear All

Chapter: 8, 15

Key Concept: [Select]

Learning Outcome: [Select]

Bloom's Level: [Select]

Cognitive Level: [Select]

Question Type: [Select]

Source: Test Bank

Search Results

Click on a question below to preview the question.

Showing 25 questions out of 135 results. Expires At Add Question

Why is crossbreeding Asian chestnuts with American chestnuts not an ideal...

Question Type: Multiple Select | Source: Test Bank | Chapter: 8 | Section: 8.1 | Bloom's Level: Understanding | Cognitive Level: L2C | Question Order: 10014

Genes from what species were introduced to American chestnuts to confer...

Question Type: Multiple Select | Source: Test Bank | Chapter: 8 | Section: 8.1 | Bloom's Level: Remembering | Cognitive Level: L2C | Question Order: 10015

Select examples of transgenic organisms from the following. Select the TWO...

Question Type: Multiple Select | Source: Test Bank | Chapter: 8 | Section: 8.1 | Bloom's Level: Remembering | Cognitive Level: L2C | Question Order: 10016

How might the specialized hearing ability of ancient hominins have influenced...

Question Type: Multiple Select | Source: Test Bank | Chapter: 15 | Section: 15.1 | Bloom's Level: Understanding | Cognitive Level: L2C | Question Order: 10017

What did the reconstruction of the inner ear of early hominins reveal?

Question Type: Multiple Select | Source: Test Bank | Chapter: 15 | Section: 15.1 | Bloom's Level: Understanding | Cognitive Level: L2C | Question Order: 10018

Question Preview

To ask a question you must add it to your assessment first. Once you add a question you will be taken to your question bank to edit the question. To see the question in context, click to preview.

1. Get Match the Scientific American Podcast called "What Genes Could Bring Back Chestnut?"

How is artificial selection different from genetic modification? Select the TWO answers that are correct.

- Artificial selection involves humans picking desirable traits and breeding genetically compatible organisms with those traits to perpetuate the traits over generations.
- Genetic modification involves inserting the genes for desirable traits directly into the genome of an organism in a lab.
- Artificial selection describes the process by which human-selected organisms are more likely to survive and reproduce.
- Genetic modification and artificial selection are synonymous terms that describe human selection of desirable traits, while the other term refers to nature. They do not differ from each other.

Question Type: Multiple Select
 Source: Test Bank
 Chapter: Chapter 8 | Section: 8.1 | Bloom's Level: Understanding
 Cognitive Level: L2C

Add Question

Assignable End-of-Chapter Questions

Selected from Michèle Shuster's question sets, these include Interpreting Data activities that ask students to analyze data in tables, charts, or graphs and draw their own conclusions about their meaning.

SCIENTIFIC AMERICAN

THE SCIENCES | MIND | HEALTH | TECH | SUSTAINABILITY | EDUCATION | VIDEO | PODCASTS | BLOGS | STORE

HEALTH

How do antibiotics kill bacterial cells but not human cells?

1. Identify the antibiotics among the following. Select the TWO answers that are correct.

- ciprofloxacin
- tetracycline
- penicillin
- mitochondrion

2. How do sulfonamides treat bacterial infections without harming human cells? Select the TWO answers that are correct.

human cells, eukaryotes must the environment, easy for proper rystes, t, but do not similarly

Erarry Shidley, chair of the department of microbiology and immunology at the University of Michigan Medical School.

Protein

Amino Acids

1. What is the dietary source of tryptophan?

- The protein from both meat and vegetable sources contains tryptophan.
- Only protein from meat sources contains tryptophan while vegetables contains none.
- Only protein from vegetable sources contains tryptophan while meat contains none.
- The source of tryptophan depends on the meat that is consumed.

SCIENTIFIC AMERICAN

THE SCIENCES | 40 SECOND SCIENCE

Wheat Genes Could Bring Back Chestnut

By Sarah Kessler on May 4, 2018

1. How did chestnut blight arrive in the US?

- It evolved from a widespread but non-lethal blight found on American chestnuts.
- It was imported on blight-resistant Asian chestnuts.
- It resulted from a GM blight that was accidentally released to the wild in North America.
- It was imported on blight-resistant Italian chestnuts.

2. Why is crossbreeding Asian chestnuts with American chestnuts not an ideal solution to protect American chestnuts from chestnut blight? Select the TWO answers that are correct.

- Crossbreeding is time consuming.
- Desirable traits specific to the American chestnut are lost.

Content from Scientific American

Assignable activities that integrate *Scientific American* content—including articles, podcasts, and videos—are available for each chapter in LaunchPad.

Contents

Unit 1 : What Is Life Made Of? Chemistry, Cells, Energy

1 Process of Science

JAVA REPORT

Making sense of the latest buzz in health-related news

2 Chemistry of Life

MISSION TO MARS

Prospecting for life on the red planet

3 Cell Structure and Function

WONDER DRUG

How a chance discovery in a London laboratory revolutionized medicine

M1 Milestones in Biology

SCIENTIFIC REBEL

Lynn Margulis and the theory of endosymbiosis

4 Nutrition, Enzymes, Metabolism

THE PEANUT BUTTER PROJECT

One doctor's crusade to end malnutrition in Africa, one spoonful at a time

5 Energy and Photosynthesis

THE FUTURE OF FUEL?

Scientists seek to make algae into the next alternative energy source

6 Dietary Energy and Cellular Respiration

NEW STORY! THE SITTING DISEASE

Understanding the causes and consequences of obesity

Unit 2 : How Does Life Reproduce? Cell Division and Inheritance

7 DNA Structure and Replication

BIOLOGICALLY UNIQUE

How DNA helped free an innocent man

M2 Milestones in Biology

THE MODEL MAKERS

Watson, Crick, and the structure of DNA

8 Genes to Proteins

NEW STORY! BULLETPROOF

Scientists hope to spin spider silk into the next indestructible superfiber

M3 Milestones in Biology

SEQUENCE SPRINT

Venter and Collins race to decode the human genome

9 Cell Cycle and Cell Differentiation

GROW YOUR OWN

Is regenerative medicine the solution to organ transplantation?

10 Mutations and Cancer

FIGHTING FATE

When cancer runs in the family, ordinary measures are not enough

11 Simple Inheritance and Meiosis

CATCHING BREATH

One woman's mission to outrun a genetic disease

M4 Milestones in Biology

MENDEL'S GARDEN

An Austrian monk lays the foundation for modern genetics

12 Complex Inheritance

Q&A: GENETICS

Complexities of human genetics, from sex to depression

Unit 3 : How Does Life Change over Time? Evolution and Diversity

13 Natural Selection and Adaptation

BUGS THAT RESIST DRUGS

Drug-resistant bacteria are on the rise. Can we stop them?

M5 Milestones in Biology

ADVENTURES IN EVOLUTION

Charles Darwin and Alfred Russel Wallace on the trail of natural selection

14 Nonadaptive Evolution and Speciation

URBAN EVOLUTION

How cities are altering the fate of species

15 Evidence for Evolution

A FISH WITH FINGERS?

A transitional fossil fills a gap in our knowledge of evolution

16 Life on Earth

Q&A: EVOLUTION

From moon rocks to DNA, clues to the history of life on Earth

17 Prokaryotic Diversity

LOST CITY

Exploring life's origins at the bottom of the sea

18 Eukaryotic Diversity

NEW STORY! CAN RUBBER SAVE THE RAINFOREST?

A small state in Brazil aims to find out

M6 Milestones in Biology

NEW! SHAKING THE TREE

A revised view of eukaryotic diversity may be the key to tackling deadly diseases

19 Human Evolution

SKIN DEEP

Science redefines the meaning of racial categories

Unit 4 : How Do Organisms Interact? Ecology

20 Population Ecology

ON THE TRACKS OF WOLVES AND MOOSE

Ecologists learn big lessons from a small island

21 Community Ecology

WHAT'S HAPPENING TO HONEY BEES?

A mysterious ailment threatens a vital link in the food chain

22 Ecosystem Ecology

THE HEAT IS ON

From migrating maples to shrinking sea ice, signs of a warming planet

M7 Milestones in Biology

PROGRESS OR POISON?

Rachel Carson, pesticides, and the birth of the environmental movement

23 Sustainability

THE MAKINGS OF A GREEN CITY

One Kansas town reinvents itself sustainable

About the Authors

Unit 5 : What Makes Plants Unique? Plant Biology

NEW CHAPTER!

24 Plant Growth and Reproduction

NEW STORY! PLANTS 2.0

Is genetic engineering the solution to world hunger?

25 Plant Physiology

Q&A: PLANTS

Exploding seeds, carnivorous flowers, and other colorful adaptations of the plant world

Unit 6 : How Do Animals Work? Physiology

26 Overview of Physiology

MAN VS MOUNTAIN

Physiology explains a 1996 disaster on Everest

27 Digestive System

DRASTIC MEASURES

For the morbidly obese, stomach-shrinking surgery is a last resort

M8 Milestones in Biology

STUMBLING ON A CURE

Banting, Best, and the discovery of insulin

28 Cardiovascular System

DEATH IN BOGALUSA

From tragic deaths in a southern town, insight into heart disease

29 Respiratory System

PEAK PERFORMANCE

An inside look at altitude training among elite athletes

30 Central Nervous System

SMOKE ON THE BRAIN

Neuroscience explains why nicotine and other drugs are hard to kick

31 Reproductive System

TOO MANY MULTIPLES

The birth of octuplets raises questions about the fertility business

32 Immune System

THE FORGOTTEN PLAGUE

After nearly a century, scientists learn what made the 1918 influenza virus so deadly



Michèle Shuster, Matthew Tontonoz, and Janet Vigna

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