SECONDARY SUBJECT OVERVIEW

Science

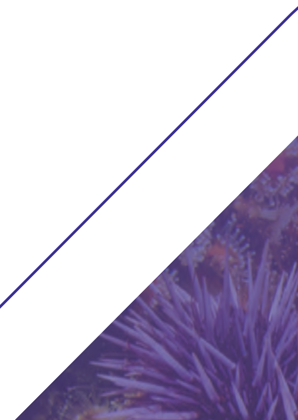
Contents

OUR VISION

To equip students to ethically engage in scientific inquiry, data analysis, and model-making so they will be able to solve real-world problems within the framework of a biblical worldview.

GOALS

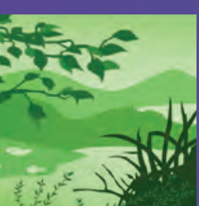
- To extend scientific knowledge and laboratory skills
- To guide students in applying scientific knowledge and skills in ethical ways to solve real-world problems, using activities that activities that include collaborative STEM experiences
- To enable students to create models that describe the natural world and use them to make predictions
- To equip students with the skills to interpret informational text and apply scientific knowledge in accordance with biblical teaching



PROGRAM APPROACH

The BJU Press secondary science program uses a lab-based approach to equip students to ethically engage in the work of science. Our program teaches science content from an ethical perspective based on a biblical worldview and explores what science can do through strategic modeling in inquiry labs and collaborative STEM experiences. We then direct students to use their critical-thinking and problem-solving skills to develop workable models that will help them find appropriate solutions. To that end, each chapter includes opportunities for extended study that will challenge students to harness and develop their scientific understanding and laboratory skills to serve God and to serve others. They will complete case studies, evaluate existing scientific models, and follow webquests that will require them to collect and analyze data. Ultimately, we want to equip teachers so that they can prepare a generation of student scientists who can use 21st century skills to solve real-world problems within the framework of a biblical worldview and who live in a way that's biblically faithful.

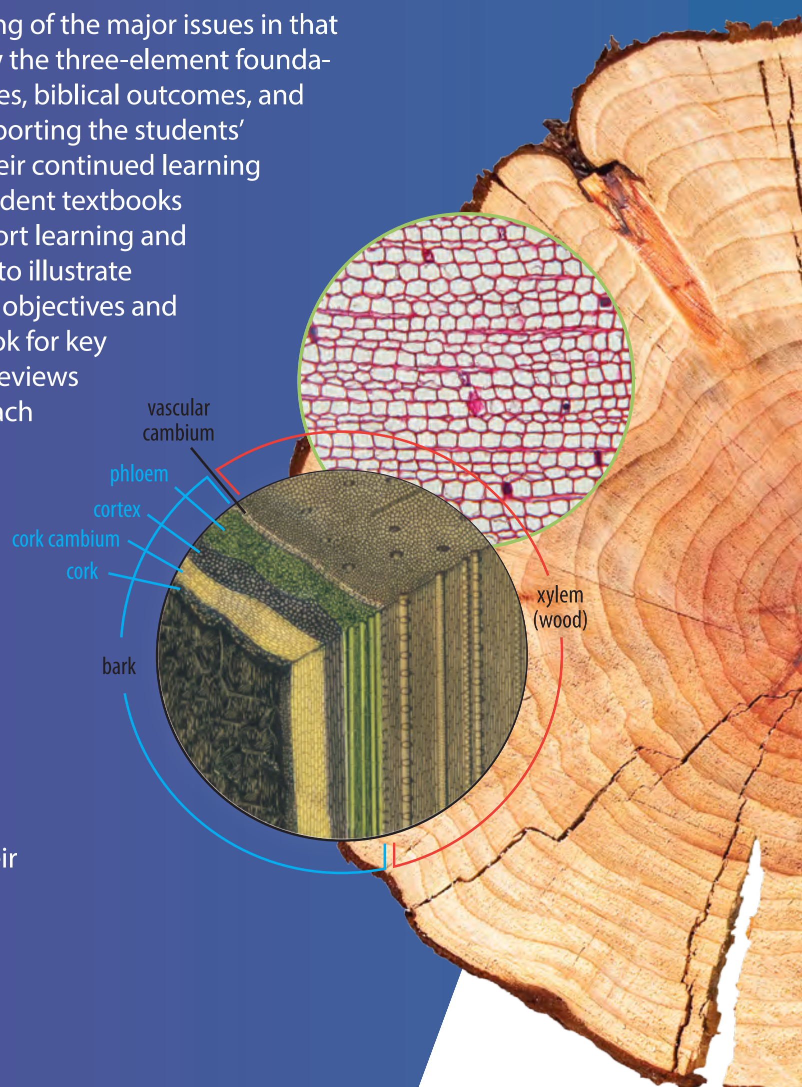
Extending Scientific Knowledge & Skills

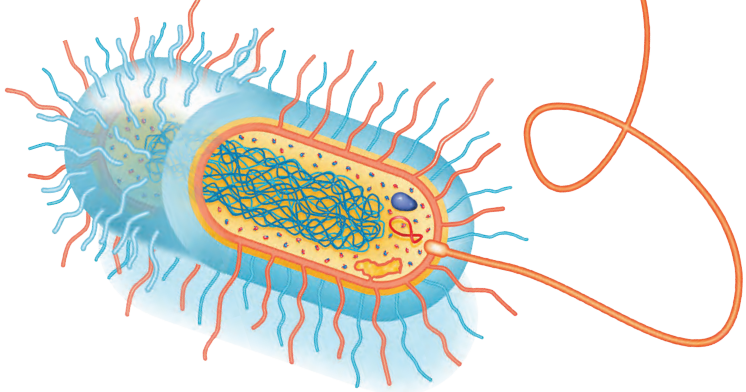


Students will be able to develop solutions to real-world problems only with a thorough understanding and knowledge of the sciences, scientific principles, and laboratory skills. Most elementary students will have had introductions to the sciences and valuable laboratory skills, but future science study will be more enjoyable and comprehensible if students continue to expand their understanding in each successive secondary science course.

BJU Press begins each middle school and high school science course with an overview of the work of science and foundational biblical themes that should shape a Christian's understanding of the major issues in that field. Students will also regularly review the three-element foundation of Christian ethics: biblical principles, biblical outcomes, and biblical motivations. In addition to supporting the students' worldview shaping, we also support their continued learning development. Our standards-based student textbooks use age-appropriate language to support learning and retention and include stunning visuals to illustrate concepts. Thoughtfully crafted chapter objectives and essential questions help students to look for key information as they read, and chapter reviews give easy-to-use bulleted reviews for each chapter.

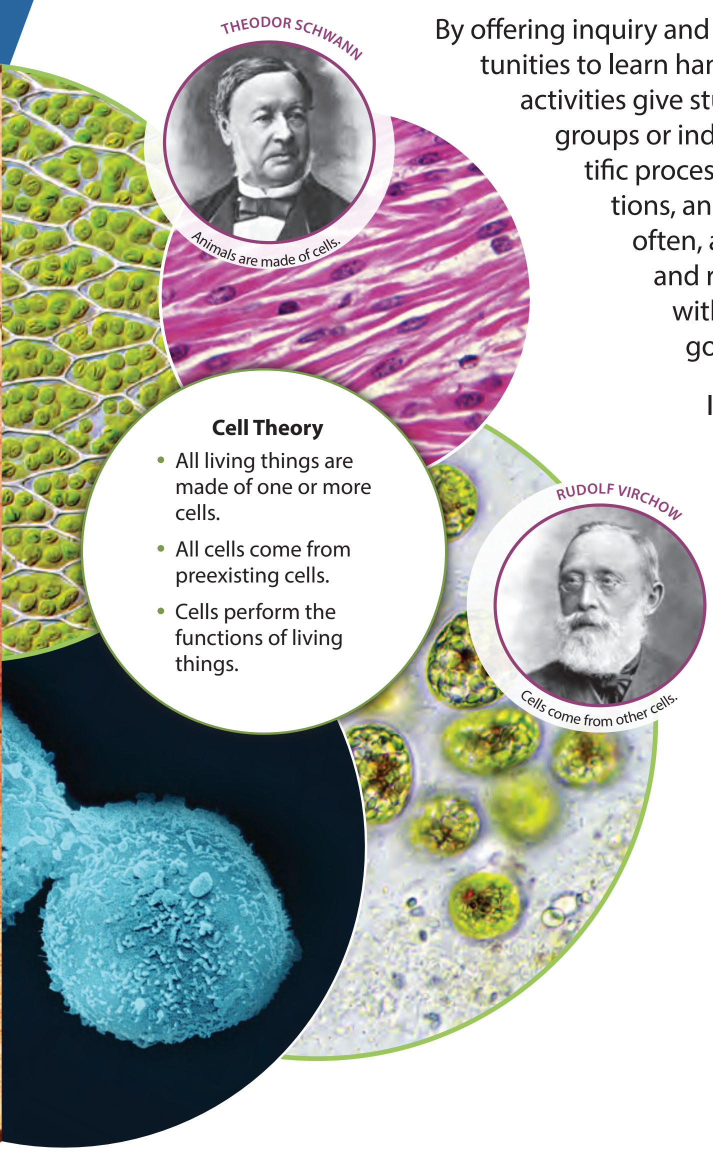
To prepare students for college and potential careers, we highlight scientific careers and interdisciplinary opportunities related to the sciences they study and provide direction on how to pursue a field that interests them. Students need to see every opportunity they have for continued study. God uses the experiences they have in their middle and high school courses to lead them to His plan for their lives.





Applying Scientific Knowledge & Skills

Knowledge often means very little without experience. Lab activities provide a vital opportunity for students to get hands-on application of the skills they're learning in class. In a broader sense, students gain the critical-thinking skills they need to ask better questions and create strong hypotheses by completing lab activities. BJU Press secondary science lab manuals are designed to help guide students through hands-on activities that build critical-thinking skills and refine students' observational skills and their capacity to follow directions. Consistent lab work gives students an opportunity to develop and mature their way of thinking. Beyond critical thinking, each lab is also designed to accomplish specific science content learning objectives. Mini labs within the student edition and guided discovery labs in the lab manuals of BJU Press materials give students abundant opportunities for application and for practice with technology, including probeware technology.



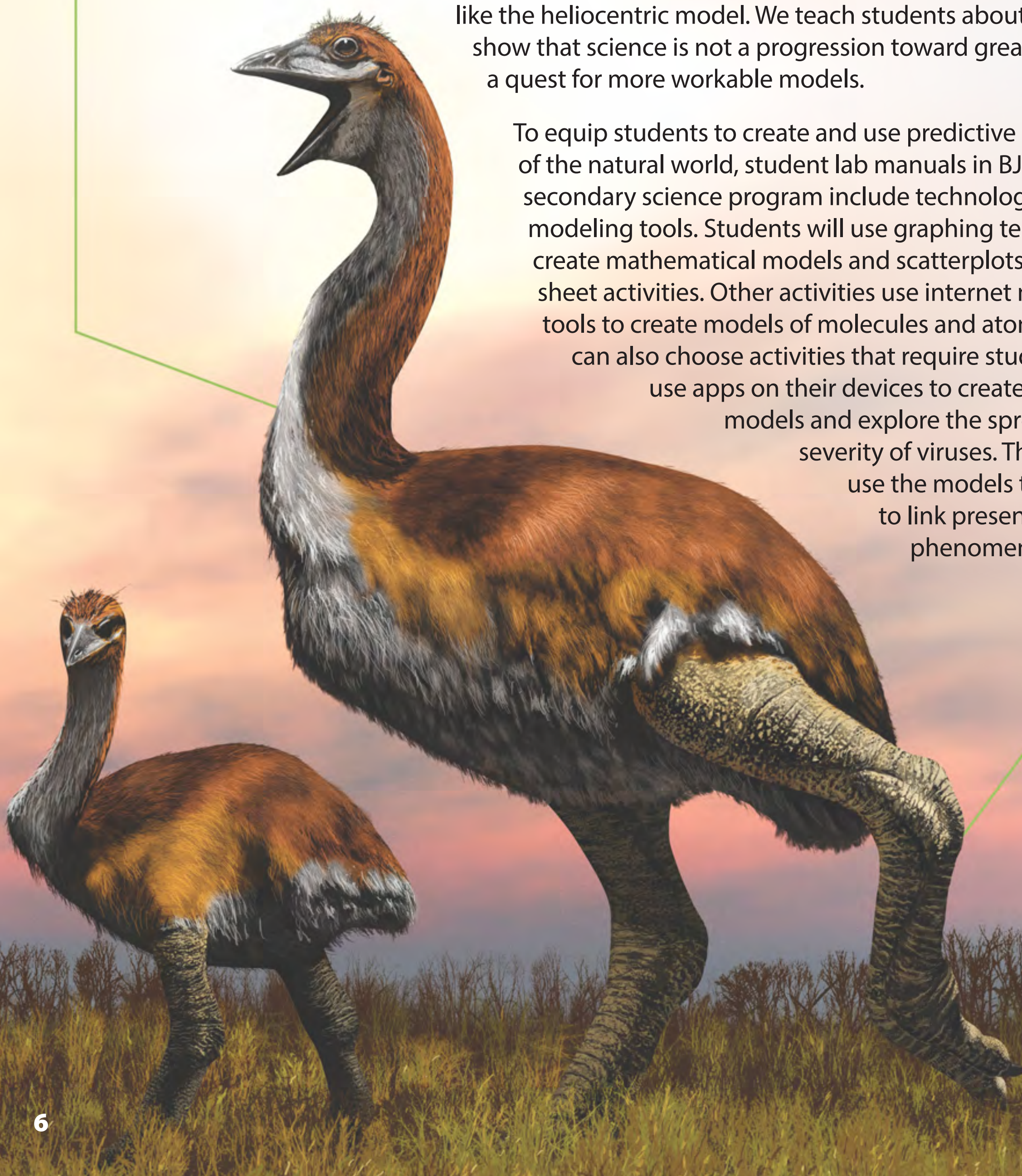
By offering inquiry and STEM activities, we give students even more opportunities to learn hands on and apply the skills from the classroom. These activities give students ownership over the creative process, whether in groups or individually. Inquiry labs require students to use the scientific process and ask questions, form hypotheses, design investigations, analyze data, draw conclusions, communicate results, and often, ask additional questions. These activities foster curiosity and require students to think more critically than they would with traditional activities that spell out procedures and goals for them.

In addition, STEM activities require students to apply the engineering design process and use scientific inquiry, mathematical reasoning, and technology. To be successful in these activities, students must also develop 21st century skills, including collaboration, problem-solving, and communication. They learn what works, not just in the scientific process, but also with other people. BJU Press lab manual STEM activities present opportunities for students to refine their methods so that they discover more effective solutions and learn that many problems have more than one solution.

Enabling Students to Use & Create Models

Throughout the BJU Press science program, we show students how scientists use models to explain, describe, and represent the world more accurately. Models allow scientists to test their theories and apply predictions, especially when they're working with forces and structures that are too large or too small to be observed or that no longer exist today. For example, the double-helix model of DNA brought biology to the field of molecular genetics. The heliocentric model of the solar system more accurately answered the questions proposed by observations of the night sky. We explain how historical documents, eggs, and bones help us create models and study the behavior and habitats of extinct species such as the elephant bird or dinosaurs. When scientists proposed these models, they didn't have the resources or capabilities to prove their theories. They created their models to accurately describe the natural world and then made predictions based on their models. As we know, scientists have had to adjust existing models to accommodate new information and observations, like the heliocentric model. We teach students about models to show that science is not a progression toward greater truth. It's a quest for more workable models.

To equip students to create and use predictive models of the natural world, student lab manuals in BJU Press's secondary science program include technology-based modeling tools. Students will use graphing technology to create mathematical models and scatterplots in spreadsheet activities. Other activities use internet modeling tools to create models of molecules and atoms. Teachers can also choose activities that require students to use apps on their devices to create animated models and explore the spread and severity of viruses. They will then use the models they create to link presentations and phenomena.



Equipping Students to Interpret Informational Text & Apply Knowledge

One of the biggest challenges for secondary science students can be interacting with rich informational texts. Science-related informational texts use discipline-specific vocabulary and technical scientific diagrams. A prepared student can interpret scientific studies, engage with the information, evaluate it from a biblical worldview, and answer ethical questions presented in a study.

To properly prepare and equip students, we fill our textbooks with opportunities to engage with informational texts on a high level. Not only are the textbooks themselves informational texts, but the additional recommended ethics boxes and webquests will challenge students to find more informational texts to read and learn from. Our textbooks introduce students to the vocabulary they will need, and present scientific diagrams that give students an opportunity to practice visual-analysis skills. In assigned ethics boxes and webquests, students get to apply and further develop their informational-text reading skills to real-world situations, and then they will write responses to what they have learned.

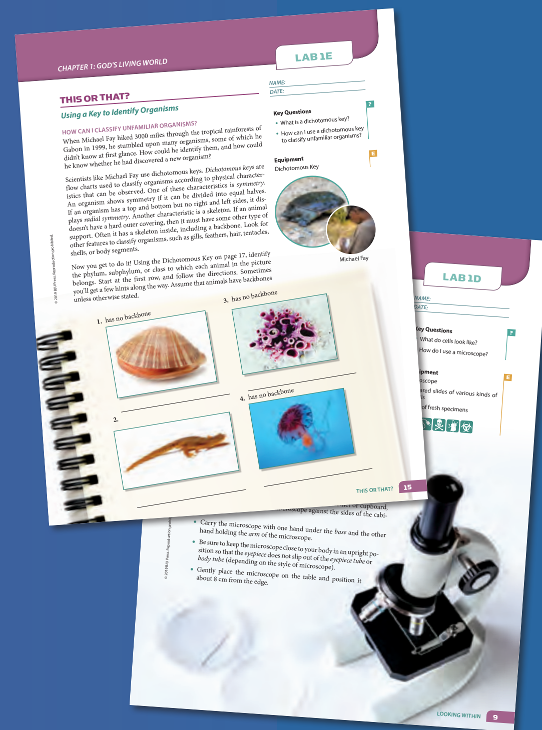
MATERIALS

Student Edition

Each student edition introduces students to a scientific field with a solid biblical worldview foundation and a focus on real-world applications. Students will explore discipline-specific terminology and existing models for each field as well as ethical issues presented. Extensive full-color and scientifically accurate illustrations, charts, and diagrams will help students to develop a visual understanding of the concepts they study. Case studies, worldview sleuthing activities, mini-labs, ethics boxes, and questions help students think like scientists and view each scientific field from a biblical perspective.

Teacher Edition

The teacher edition for each grade offers research-based strategies, teaching notes, and suggested activities to give teachers options for daily lessons. The strategies focus on explaining concepts to students by moving from concrete to abstract and by linking scientific concepts and processes with prior learning. Each teacher edition features a suggested teaching schedule, full-color reduced student pages, icon-coded items like weblinks and demonstrations, complete answers to review questions, background information to enhance classroom instruction, and a full-year lesson plan overview. Teachers will also find active learning opportunities, inquiry activities, group discussions, formative assessments, and intriguing chapter openers to add depth and variety to their daily teaching plan.



Student Lab Manual/ Student Activities

Each lab manual or student activities manual gives students opportunities to develop laboratory skills and apply what they have learned in real-world situations. Students will solidify their understanding of concepts by connecting the content with real-world problems. Discovery labs give guidance for exploring God's world; inquiry labs require students to use the scientific process to create their own activity; and STEM activities develop key science, engineering, and problem-solving skills through observing, recording, and analyzing samples and data to make models. Students then test those models to understand their workability.

Teacher Lab Manual/ Student Activities Answer Key

The teacher lab manual and answer key contains full-color, reduced-size lab manual pages with answers as well as additional instructions on preparation and the safe execution of lab exercises.

Assessments

The assessment packets provide summative assessment opportunities to measure students' knowledge and understanding of key concepts. The tests and quizzes include opportunities for students to infer information from images, and they assess students' recall and higher-order thinking skills. An assessments answer key is available for each grade.

THE FEATURES *Page Examples*

12C

SOIL

How does soil form?

12.13 WHAT IS SOIL?

You've learned how rock breaks down into sediments through weathering and erosion. Sediments can build up in one place or they can be transported to a different place. When you see fine sediments covering the ground, you might think, *soil*! But is it? For most earth materials, this is only the beginning of the makings of a good soil.

Pedologists—scientists who study soils, soil formation, and erosion—define **soil** as a layered formation at the surface of the earth made of inorganic earth materials combined with organic nutrients. Soil is also porous, allowing water and air to move through it.

So where did soils come from? On the third day of Creation, God created soil best suited to support and nourish the plants that He would create later the same day (Gen. 1:9–13). This original soil was the result of a supernatural creative act. It's possible it didn't even look like the soils we see today since today's soils come from weathering and erosion.

As biblical creationists, we can be fairly sure that there aren't any original soils remaining today as they were at Creation. After the Fall and God's curse on Adam's sin, all things changed, even soils. The new difficulty Adam had in farming likely resulted from soil quality and fertility (Gen. 3:7–19). People probably had to start using conservation methods to reduce soil erosion and replenish nutrients in the soil. Then the Flood *really* changed everything. In the upheaval, the floodwaters mixed up the original soil materials with other sediments. But God in His providence and mercy provided for His creation. Soils all over the world were quickly restored through

12C Objectives

After completing this section, you will be able to

- » describe how soil forms, including its horizons.
- » analyze how different factors affect soil.
- » evaluate ways for using and conserving soil.

O

pedologist (pe DAHL uh jist): ped- (Gk. *pedon*—ground, soil) + -ology (study of); soil scientist

According to the biblical model of the earth's history, all the soils of the world that exist today must have formed since the Flood, in much less than 5500 years.

I

ORIGINAL SOIL

It is interesting to conjecture about what Earth might have looked like before the Fall and the Flood. Take soil, for example. From our vantage point on this side of the Flood, we believe that soils take hundreds of years to form and that they are the products of gradual weathering and deposition. The original soils were not produced in this way. Therefore, it is not certain that they were similar in composition or appearance to today's soils.

Have your students consider other natural features that we intuitively believe take long periods of time to form and then consider what they might have looked like at the end of Creation Week. Some features, such as canyons, rocky seashores, sand bars, deltas, and the like, may not have existed at all in the earliest days of the earth.

Suggested strategies available for quick lesson planning

Special features listed as a quick preview

12-18
We don't know what the soil composition at Creation looked like, but it is likely that soil was not made up of the products of erosion and decomposition since these processes had not occurred yet.

293

Icons identify additional teaching resources and teaching strands

TEACHING THE MATERIAL

ESSENTIAL QUESTION

How does soil form?

OBJECTIVES

12C1 Describe how soil forms, including its horizons.

12C2 Analyze how different factors affect soil.

12C3 Evaluate ways for using and conserving soil. Bi

RESOURCES

Life Connection: Living Soil

Info Box: Controlling Erosion

Careers: Serving God as a Pedologist

Mount St. Helens Eruption video, USDA's National Resources Conservation Service website

Mount St. Helens, Chapter 12 Map Exercises

STRATEGIES

Class Opener: Start class by asking your students how earth science and biology are connected. Use the Life Connection on page 294 (Living Soil) to show how truly connected these two sciences are.

Graph Reading: Use the soil classification graph (p. 295) to have your students work on graph reading skills. Give students the percentages and have them determine the type of soil. Alternatively, give them the type of soil and have them determine the percentages of clay, silt, and sand.

(continued)

Essential question and section objectives for easy planning

TEACHER EDITION

Guiding questions or section objectives to highlight key concepts

11A

ENERGY

How do animals get and use energy?

11.1 DIGESTION

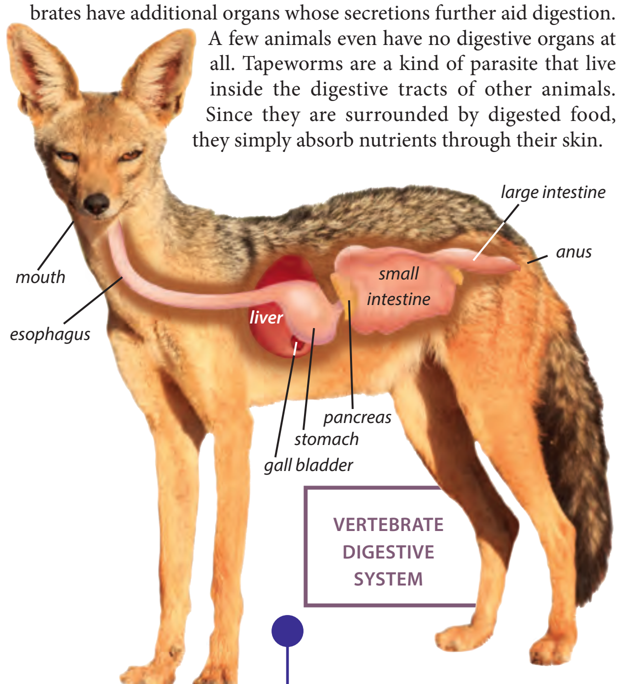
Like all living things, animals need energy to live, grow, and reproduce. Animals are consumers. They cannot make their own food as plants do, so they must get their energy from an outside source. They do this by eating other organisms. They have a **digestive system** that breaks down food and absorbs nutrients. Such systems often begin with a mouth for taking in food. An animal's mouth may have special structures, such as jaws and teeth, for crushing and grinding food into small particles. This is called **mechanical digestion**. Animals without teeth, such as earthworms and birds, may have a muscular organ called a *gizzard* that performs the grinding and crushing. During **chemical digestion**, the stomach and intestines use chemicals to break down food molecules into nutrients. The nutrients are then absorbed into the bloodstream by the *intestines*. The leftover matter that can't be digested is expelled through an *anus*. The complete path from mouth to anus is often called a *complete digestive system*. An *incomplete digestive system* has only a single opening for both taking in food and expelling wastes.

As you can see in the diagrams, not all animals have the same parts and pieces to their digestive system. The digestive tracts of vertebrates have additional organs whose secretions further aid digestion. A few animals even have no digestive organs at all. Tapeworms are a kind of parasite that live inside the digestive tracts of other animals. Since they are surrounded by digested food, they simply absorb nutrients through their skin.

11A Questions

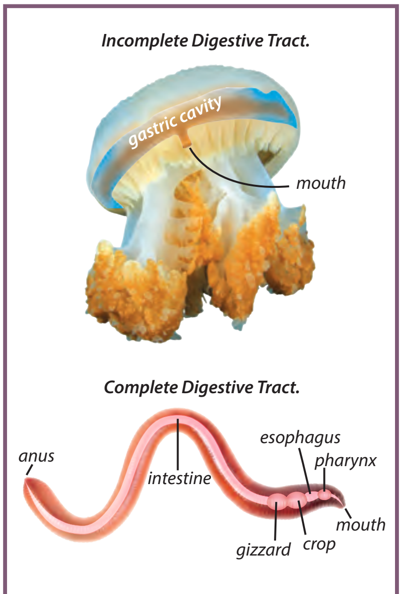
- How do animals get energy from their food?
- What kinds of foods do animals eat?
- How do animals maintain homeostasis?
- How do animals eliminate wastes?

Bolded terms defined in the glossary



VERTEBRATE DIGESTIVE SYSTEM

INVERTEBRATE DIGESTIVE SYSTEM



Grade-level appropriate text with full-color illustrations

STUDENT EDITION

Full page teaching guides provide essential information for presenting and conducting inquiry labs

LAB 7B

TEACHER GUIDE

IT'S IN THE BAG: *INQUIRING INTO CHEMICAL REACTIONS*

There are two main ideas behind Lab 7B. We want students to actually see for themselves some examples of evidences for chemical reactions. We also want them to realize the importance of limiting variables in experiments.

Part 1: Observing the Reaction

Question 1 is given so that students will have a point of reference. They must first be familiar with the physical properties of the reactants in order to know later whether any change in those properties has occurred.

There are other ways of mixing the chemicals other than the procedure described in Steps C–F. It is, for instance, not absolutely necessary that the two solids be kept separate. (But if the solids mix prior to starting the initial reaction, *the students will know that this combination doesn't do anything*.) It is also possible to grasp the bag in such a manner that the reactants are separated into pockets formed between one's fingers. Some teachers prefer to set the bag with the powders upright and then measure out the phenol red into a small container, such as a medicinal measuring cup. Then the entire cup can be added to the bag, the bag sealed, and the contents of the cup tipped out.

Part 2: Identifying the Culprits

WRITING SCIENTIFIC QUESTIONS

As you have seen in previous tasks, this inquiry lab activity places the responsibility on students for planning a procedure that will reach the desired end result. Many students may not like this at first—after all, it's hard work! But it is also what real scientists must do. Students at this grade level will probably need some coaching during the planning phase.

DESIGNING SCIENTIFIC INVESTIGATIONS

A critical aspect of this task rests on the fact that students need to specifically identify which combinations of chemicals cause which of the effects that they observe. In order to do this, they will need to start by testing pairs of reactants. They also need to realize that the water in the phenol red solution is a possible reactant, which means that there are actually four chemicals to consider, not just three.

Be alert to students who suggest procedures that may inadvertently be testing more than one variable at a time. Some timely probing questions may make students aware of aspects of their procedure that they haven't thought through thoroughly.

Strategies for directing students as they conduct an inquiry lab

CONDUCTING THE INVESTIGATION

Once all the groups have good procedures, allow them to collect their data. They will need some way to track their tests and results, and the Student Lab Manual suggests that they use a table to do this. A sample table is shown on the next page.

Results

Both calcium chloride and sodium bicarbonate are soluble in water, so mixing either of them with water alone or with the phenol red solution will cause them to dissolve. The dissociation of calcium chloride is exothermic (feels hot), while that of sodium bicarbonate is endothermic (feels cool). In the Part 1 reaction, dissolving the two together results in a bag that is warm, but not as warm as a bag of dissolved calcium chloride by itself.

Phenol red is a pH indicator. It does not change color in the presence of calcium chloride, though it may appear paler. But as sodium bicarbonate dissolves in water, the bicarbonate ions partially dissociate into free hydrogen ions and carbonic acid, slightly lowering the pH of the solution, so some students may notice a slight change in the color of the sodium bicarbonate-phenol red solution. The color change is much more vivid and obvious when calcium chloride and sodium bicarbonate are combined, as the reaction produces carbon dioxide gas (CO_2). The indicator will change from red through bright orange to yellow. The presence of CO_2 is responsible for the acidification of the solution via the production of carbonic acid by the gas in an aqueous solution.

Because CO_2 is only slightly soluble in water (1.45 g/L), most of what is produced by the reaction comes out of solution, causing the inflation of the bag.

75 Lab 7B

Teacher guides highlight potential areas of difficulty and opportunities to encourage thinking skills

Key questions define lab objectives

12A SQUEAKY CLEAN

BACTERIA GROWTH AND HANDWASHING

How do different methods of handwashing affect bacteria count?

"Make sure you wash your hands with soap and warm water." If you had a dollar for every time you heard these words, you'd probably be rich! But do you know why you need to wash your hands this way?

People haven't always had medical reasons to justify handwashing. Though some cultures, such as the Jews (Matt. 15:1–2), practiced ritual handwashing, it didn't become widespread for medical purposes until the 1800s.

Handwashing saves people's lives. In 1845, Hungarian physician Ignaz Semmelweis pioneered the practice of doctors washing their hands before working with patients after he observed that handwashing greatly reduced the occurrence of dangerous infections in new mothers. Although many doctors rejected his practices, they eventually became standard, and they were vindicated years after Semmelweis's death by the formation of the germ theory of disease.

Since the bacteria on your hands are too small to see, in this lab you will be growing a colony that will be large enough for you to see without a microscope. To do this, you will use a *petri dish*, a large flat dish with a lid (see Appendix B), containing a gel-like substance called *nutrient agar*. Nutrient agar is a mixture of beef extract, a protein called *peptone*, water, and a gel derived from algae. Nutrient agar provides both the structure and the nutrients that bacteria need to grow into a colony.

Key Questions

- How dangerous is it when I don't wash my hands?
- What does water do in handwashing?
- What does soap do in handwashing?

Equipment

microscope
ruler
marker
sterile petri dish with cover
nutrient agar
sterile cotton swabs
hand soap
hand sanitizer
large plastic bags (3)
autoclave disposal bag

Background information and equipment requirements

PROCEDURE

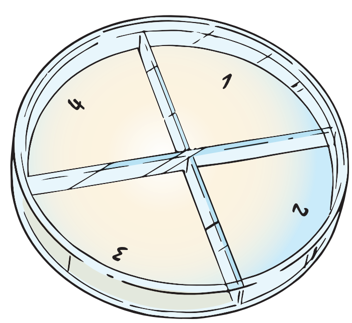
Starting Bacterial Cultures

Your teacher will provide you with a prepared, sterilized petri dish containing solidified nutrient agar.

1. Turn the petri dish over. Divide the circle into quarters using a marker on the bottom of the petri dish. Label quarters 1, 2, 3, and 4.
2. Shake hands with two other people in your group. You will be testing the bacteria count on each person's hands in a different way.
3. Swab one of your group member's hands with a sterile cotton swab. Without putting the swab on the benchtop, open the dish only partway. Now swab Area 2 of your petri dish, using a

Quarters of Your Petri Dish

1—Nothing applied to agar
2—Dirty hand applied to agar
3—Hand washed only with water applied to agar
4—Hand washed with both soap and water applied to agar



Procedure notes and questions to guide students through conducting lab experiments and applying thinking skills

STUDENT LAB MANUAL

Teacher Tools Online™

TeacherToolsOnline.com

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Teacher Tools Online is the premier resource for teachers using BJU Press materials. It encourages teachers in their efforts to expand their lessons, enables them to reach struggling students in new ways, and enhances their teaching strategies for greater depth. Teacher Tools Online provides teacher resources at the touch of a button, freeing up valuable time for teachers. Teachers will find educational articles, editable lesson plan overviews, PowerPoint presentations, an electronic assessments generator, and much more in the Teacher Tools Online database!

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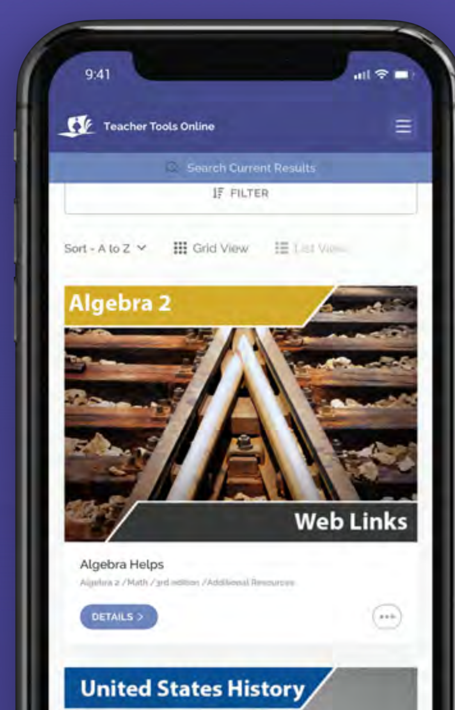

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Lesson Plan Overviews—Editable Word documents with an overview of each day's objectives, content and materials needed to plan ahead.

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