BIOZONE

CLASSROOM GUIDE

AP ENVIRONMENTAL SCIENCE

Contents

CLASSROOM GUIDE

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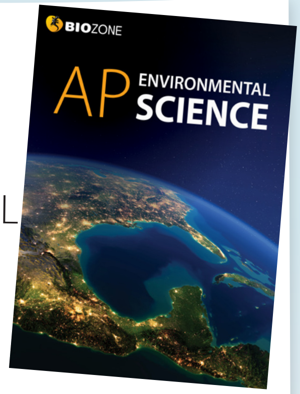

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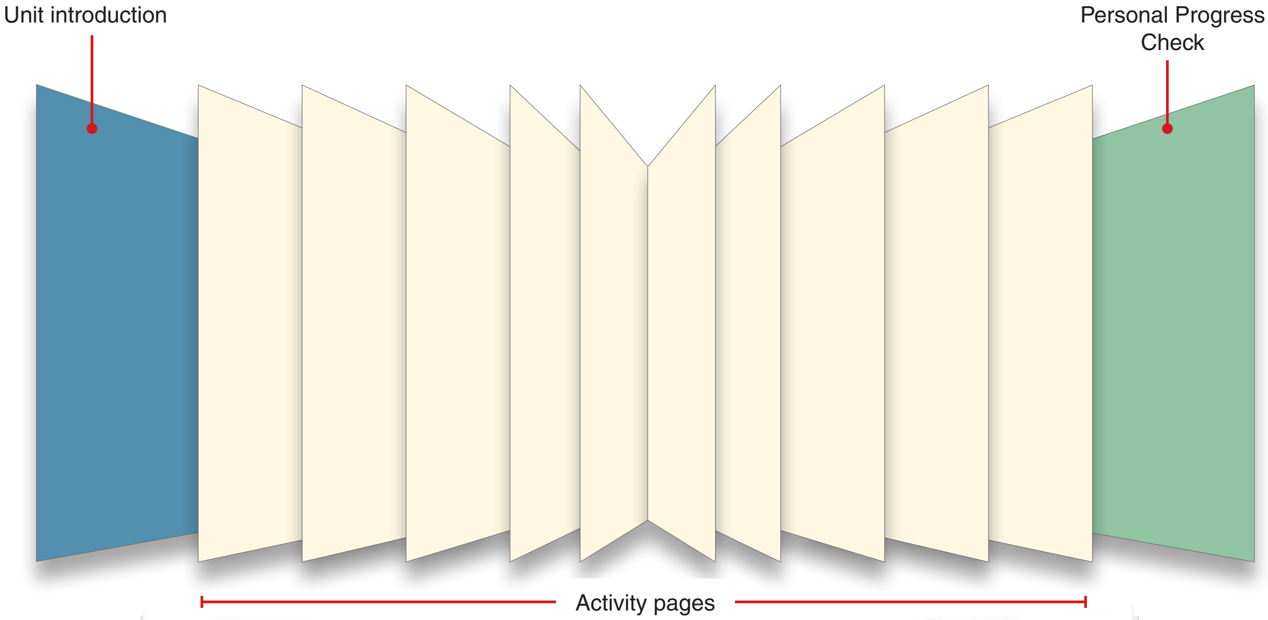
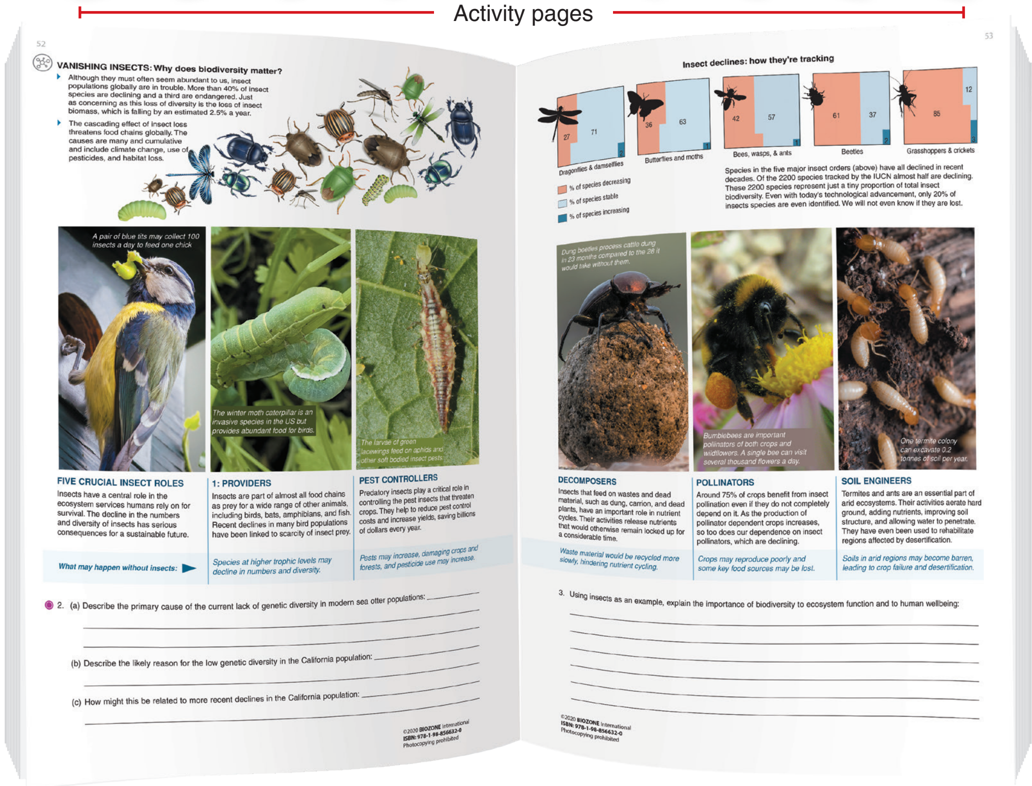
The Structure of the Book

The content of the *AP Environmental Science* is organized into 10 chapters. The first nine chapters are based on the units of study described in the *AP Environmental Science Course and Exam Description* (CED). The final chapter, *Science Practices for Environmental Science*, has been designed to provide support for each of the science practices identified in the CED. They can review or practice key skills and science practices before applying them to the activities in each of the units.

The structure of the book helps teachers apply the instructional model of plan, teach, and assess:

- Unit introductions summarize the key content, skills, and learning outcomes for each unit, providing a checklist for students and a record of progress for teachers. See more about these on page CG6.
- Activities make up the bulk of each chapter. The activities have been designed so that by the end of the program the students have covered the required content knowledge and skills specified in the *AP Environmental Science* CED. Activities have been designed to be engaging, informative, and (where appropriate) challenging. Data, annotated diagrams, and photographs, provide much of the information in context, and there are many topical and interesting case studies (e.g. the effect of the Covid-19 pandemic on air quality).The student's understanding of the information is evaluated through questions and/or tasks involving data handling and interpretation.
- Chapters 1-9 each conclude with a Personal Progress Check (PPC) to assess student understanding. These comprise both multiple choice free response questions.



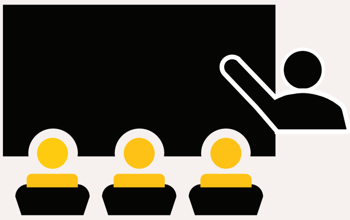


The AP Instructional Model

BIOZONE's *AP Environmental Science* has been designed so that teachers can deliver the essential components of the framework using the AP instructional model of **plan, teach, and assess**.

Plan

- The structure of *AP Environmental Science* follows the unit plan specified in the CED. Teachers can be assured that all of the essential components of the framework are covered, ensuring easy and efficient lesson planning with no content gaps.
- Use the unit introductions to assign students work for each lesson.
- Add interest to your lessons by utilizing the FREE resources on **BIOZONE's Resource Hub** in your planning. Resources for specific activities are identified on the Resource Hub, saving you having to locate your own resources.
- Want to refresh your knowledge before you teach, or extend gifted and talented students? Resources specifically set for teachers or gifted and talented students are identified on **BIOZONE's Resource Hub.** You can assign these to students as extension material as required.
- A green circle next to an activity in the contents identifies where a practical investigation is included. The full methodology is given in the activity, and the equipment list is provided (Appendix 3), making preparation and incorporation of practical work easy.



Teach

- Teach the content in the order presented in BIOZONE's *AP Environmental Science.* Content covered in the early chapters lays the foundation for more in-depth material and specific examples covered in later units.
- Have students complete a skills support activity in the final chapter (*Science Practices for Environmental Science*) before attempting the relevant unit activity. These can be assigned as homework or they can be completed in class if students need support.
- Assign students into groups of mixed abilities when carrying out group research projects or practical investigations to encourage peer-to-peer learning.
- Activities that manipulate data using formulae may be supported by spreadsheets on **BIOZONE's Resource Hub**. Assign these activities to students so they can develop a deeper understanding of the value of data manipulation. You can tailor how you use the spreadsheets. If time permits, have students graph the data themselves. Alternatively, have students analyze the completed data set (including graphs) to save time.
- Extend students' scientific vocabulary by encouraging them to look up words they are unfamiliar with in the glossary (Appendix 2).
- Add variation to your content delivery by utilizing BIOZONE's Presentation Media in your lesson. This fully editable digital resource can be adapted to complement your teaching plan. The Presentation Media includes extra examples not found in the Student Edition. They can be used to provide additional examples for the entire class or extension material for gifted and talented students.
- Use the Teacher's Digital Edition to review answers in class or on-line quickly and efficiently. Choose when and how you reveal the answers. To promote student discussion, reveal answers only once the students have shared their ideas. Reveal all the answers if you want the students to self mark their own work.

Assess

- Provide feedback (formative and summative) to students to update them on their progress. This can highlight areas they are strong in or areas needing work.
- Use formative assessment to identify areas the class needs to revisit before progressing to the next topic or unit. Methods of formative assessment include reviewing student answers on an activity page, observing students carrying out practical work, or evaluating their contribution and understanding in research projects.
- Use the personal progress checks at the end of each unit (chapter) to assess student understanding. This could be carried out as a form test in class. Alternatively, you can set personal progress checks as homework or open book assessments if you wish.
- Create additional practice opportunities by assigning students questions from the AP Question Bank (via AP Classroom).

The Contents: A Planning Tool

The contents pages are not merely a list of the activities in the student edition. Encourage your students to use them as a planning tool for their program of work. Students can identify the activities they are to complete and then tick them off when completed. Teachers can see at a glance how quickly the student is progressing through the assigned material.

Identifying Learning Intentions and Goals

BIOZONE's *AP Environmental Science* is a new resource written specifically to address the APES CED. Each unit is prefaced with a chapter introduction. The units are organized into topics, and these are aligned to specific activities. The key content, skills, and learning objectives for each unit are summarized here.

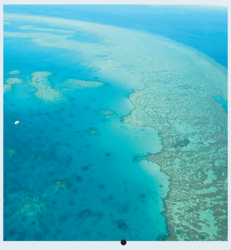
This identifies the unit to which this chapter applies.

Learning Objectives

1. The Living World: Ecosystems

1

Developing understanding



Content: This unit provides the base f... interdependent components, process... influences the interactions we see an... and aquatic biomes are determined b... Biogeochemical cycles are central to...

Skills: This unit emphasizes skills in d... relationships, using visual representa... practice your quantitative skills in ana...

Content summary
This statement outlines the main content points covered in the chapter.

Skills summary
An overview of the suggested skills for this unit are presented here.

Topic number: these are presented in the same order as the CED

1.1 **Introduction to ecosystems** ....activities 1 - 7

☐ 1. Identify the components of ecosystems, distinguishing between biotic and abiotic factors. Describe the ways in which species in ecosystems can interact over resources, distinguishing between predation, symbiosis, and competition and their characteristics.

☐ 2. Describe the nature of predator-prey interactions including the way in which these interactions are affected by changes in the availability of resources.

☐ 3. Describe the nature of symbiotic relationships to include mutualism, commensalism, and parasitism.

☐ 4. Distinguish between intraspecific and interspecific competition. Describe the role of resource limitation in determining the intensity of intraspecific competition and in regulating population size. Describe evidence for competitive exclusion in competing species and explain how naturally occurring species with similar resource needs reduce competition through resource partitioning.

1.2 **Terrestrial biomes** .... activities 8 - 11

☐ 5. Describe the global distribution and main environmental aspects of the major terrestrial biomes. Explain how the transport of heat around the globe accounts for the occurrence of certain biomes in particular regions.

☐ 6. Explain how the combination of climate, geography, latitude and altitude, nutrient availability, and soil type influence the global distribution of non-mineral terrestrial resources such as water, wood, coal, peat, soil, and gravel.

...ution ...on

The learning objectives for each activity within the unit are listed here. Students can tick off each activity as they complete it.

..... activity 12

☐ ... ...atures of the major aquatic biomes, including the role of freshwater ecosystems in providing drinking water.

☐ 9. Describe the role of algae and cyanobacteria as producers in marine biomes, including their role in supplying oxygen and removing and storing atmospheric carbon.

☐ 10. Where is most of marine life located? Explain how the physical conditions in oceans vary globally and how these differences can be related to the distribution of non-mineral marine natural resources such as fish and shellfish.

1.4 **The carbon cycle** .... activity 14

☐ 11. Explain how carbon cycles between the biotic and abiotic environments, identifying different reservoirs and comparing the relative time that carbon spends in each.

☐ 12. Explain how the decomposition of organisms has led to the storage of carbon over millions of years and describe the processes by which this stored carbon is being rapidly moved into the atmospheric reservoir.

1.5 **The nitrogen cycle** .... activity 15

☐ 13. Explain how nitrogen cycles between the biotic and abiotic environments, with emphasis on the role of bacteria in nitrogen transformations, including nitrogen fixation. Identify the main reservoir of nitrogen and explain how humans intervene in the nitrogen cycle by altering the amount of nitrogen that is stored in the biosphere.

1.6 **The phosphorus cycle** ....activity 16

The activity in the book addressing the learning objectives for this topic.

☐ 14. Identify the main reservoirs for phosphorus and explain how it cycles between the b... environments. Explain why the pho... relative to other biogeochemical cy... the consequences of this to biologi...

1.7 **The hydrologic (water) cycl...**

☐ 15. Identify the main reservoirs for wat... cycles through the biotic and abiotic environments, identifying its different states and describing the processes involved in the transformations between states.

1.8 **Primary productivity**.................... activities 18 - 19

☐ 16. Distinguish between gross and net primary productivity and compare the Earths ecosystems in terms of their productivity. What factors limit productivity and how are they different in aquatic and terrestrial environments?

1.9 **Trophic levels** .... activities 13, 20

☐ 17. Explain how energy flows and matter cycles through trophic levels in ecosystems. Explain the role of biogeochemical cycles in moving nutrients within and among ecosystems (matter is conserved).

1.10 **Energy flow and the 10% rule** ...... activities 21 - 22

☐ 18. Use quantitative analysis to determine how the amount of energy available decreases as it is transferred from one trophic level to the next. How is this energy lost? Interpret energy flow diagrams and ecological pyramids to provide evidence for the 10% rule.

1.11 **Food chains and webs** .... activities 23 - 24

☐ 19. Describe food chains and webs and identify the organisms in them by trophic level. Describe how the organisms in ecosystems are connected through their feeding relationships and predict the effects of adding or removing organisms to a specific food web.

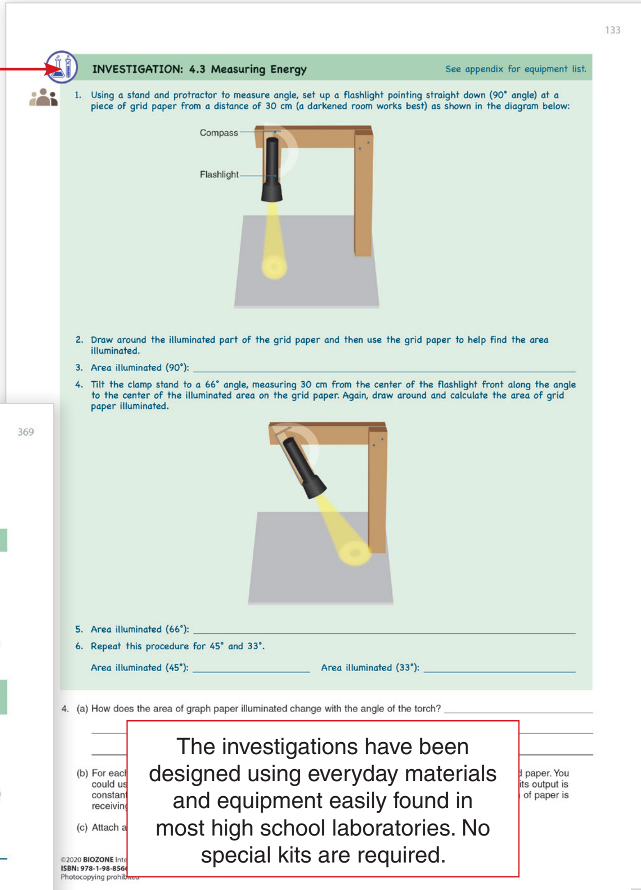
Practical Investigations

Throughout *AP Environmental Science*, students are given opportunities to practice and develop their practical skills through experimentation and field work. These investigations are opportunities for students to develop competency in laboratory procedures and field studies, to practice and refine skills in observation and analysis, and to manipulate data.

The investigations provide an excellent opportunity for collaborative work and will stimulate discussion and the sharing of ideas. You may wish to pair students of different abilities together. Confident students can guide and encourage less able students and, in this relaxed environment, striving students will be encouraged to share their own observations and thoughts. Collaboration through paired practical work provides an excellent opportunity for students to interact in meaningful ways to extend their scientific vocabulary and improve communication skills.

Each investigation is clearly numbered (sequentially through the chapter).

- Ensure your students read through the procedure fully *before beginning* the investigation.
- Highlight any hazardous or important steps, and make sure the students follow your directions.



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INVESTIGATION: 4.3 Measuring Energy — See appendix for equipment list.

1. Using a stand and protractor to measure angle, set up a flashlight pointing straight down (90° angle) at a piece of grid paper from a distance of 30 cm (a darkened room works best) as shown in the diagram below:

2. Draw around the illuminated part of the grid paper and then use the grid paper to help find the area illuminated.
3. Area illuminated (90°): ______
4. Tilt the clamp stand to a 66° angle, measuring 30 cm from the center of the flashlight front along the angle to the center of the illuminated area on the grid paper. Again, draw around and calculate the area of grid paper illuminated.
5. Area illuminated (66°): ______
6. Repeat this procedure for 45° and 33°.

Area illuminated (45°): ______ Area illuminated (33°): ______

4. (a) How does the area of graph paper illuminated change with the angle of the torch?

(b) For each ... could us... constan... receivin... paper. You ... its output is ... of paper is

(c) Attach a ...

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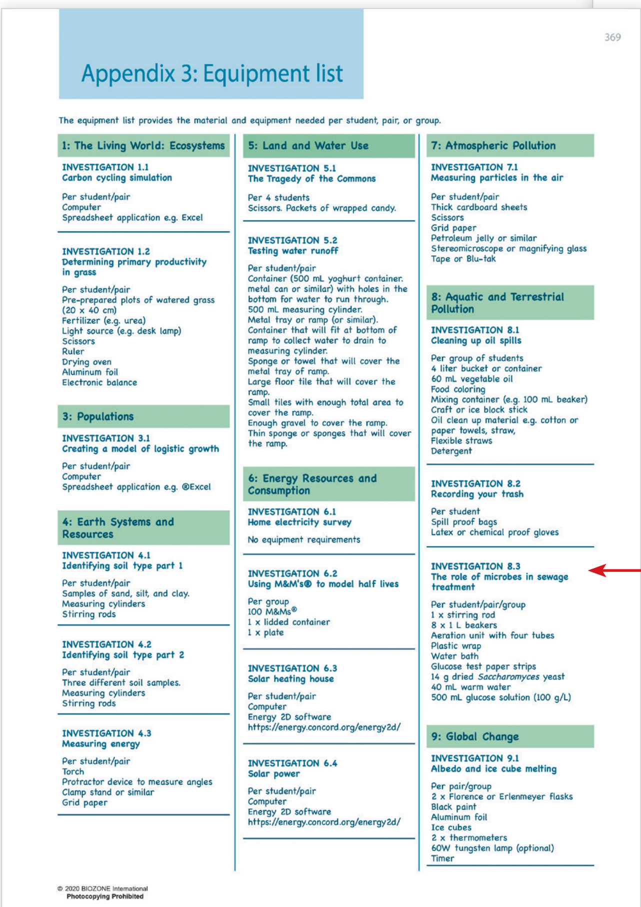
The investigations have been designed using everyday materials and equipment easily found in most high school laboratories. No special kits are required.



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Appendix 3: Equipment list

The equipment list provides the material and equipment needed per student, pair, or group.

1: The Living World: Ecosystems

INVESTIGATION 1.1 Carbon cycling simulation
Per student/pair
Computer
Spreadsheet application e.g. Excel

INVESTIGATION 1.2 Determining primary productivity in grass
Per student/pair
Pre-prepared plots of watered grass (20 x 40 cm)
Fertilizer (e.g. urea)
Light source (e.g. desk lamp)
Scissors
Ruler
Drying oven
Aluminum foil
Electronic balance

3: Populations

INVESTIGATION 3.1 Creating a model of logistic growth
Per student/pair
Computer
Spreadsheet application e.g. ®Excel

4: Earth Systems and Resources

INVESTIGATION 4.1 Identifying soil type part 1
Per student/pair
Samples of sand, silt, and clay.
Measuring cylinders
Stirring rods

INVESTIGATION 4.2 Identifying soil type part 2
Per student/pair
Three different soil samples.
Measuring cylinders
Stirring rods

INVESTIGATION 4.3 Measuring energy
Per student/pair
Torch
Protractor device to measure angles
Clamp stand or similar
Grid paper

5: Land and Water Use

INVESTIGATION 5.1 The Tragedy of the Commons
Per 4 students
Scissors. Packets of wrapped candy.

INVESTIGATION 5.2 Testing water runoff
Per student/pair
Container (500 mL yoghurt container, metal can or similar) with holes in the bottom for water to run through.
500 mL measuring cylinder.
Metal tray or ramp (or similar).
Container that will fit at bottom of ramp to collect water to drain to measuring cylinder.
Sponge or towel that will cover the metal tray of ramp.
Large floor tile that will cover the ramp.
Small tiles with enough total area to cover the ramp.
Enough gravel to cover the ramp.
Thin sponge or sponges that will cover the ramp.

6: Energy Resources and Consumption

INVESTIGATION 6.1 Home electricity survey
No equipment requirements

INVESTIGATION 6.2 Using M&M's® to model half lives
Per group
100 M&Ms®
1 x lidded container
1 x plate

INVESTIGATION 6.3 Solar heating house
Per student/pair
Computer
Energy 2D software
https://energy.concord.org/energy2d/

INVESTIGATION 6.4 Solar power
Per student/pair
Computer
Energy 2D software
https://energy.concord.org/energy2d/

7: Atmospheric Pollution

INVESTIGATION 7.1 Measuring particles in the air
Per student/pair
Thick cardboard sheets
Scissors
Grid paper
Petroleum jelly or similar
Stereomicroscope or magnifying glass
Tape or Blu-tak

8: Aquatic and Terrestrial Pollution

INVESTIGATION 8.1 Cleaning up oil spills
Per group of students
4 liter bucket or container
60 mL vegetable oil
Food coloring
Mixing container (e.g. 100 mL beaker)
Craft or ice block stick
Oil clean up material e.g. cotton or paper towels, straw,
Flexible straws
Detergent

INVESTIGATION 8.2 Recording your trash
Per student
Spill proof bags
Latex or chemical proof gloves

INVESTIGATION 8.3 The role of microbes in sewage treatment
Per student/pair/group
1 x stirring rod
8 x 1 L beakers
Aeration unit with four tubes
Plastic wrap
Water bath
Glucose test paper strips
14 g dried *Saccharomyces* yeast
40 mL warm water
500 mL glucose solution (100 g/L)

9: Global Change

INVESTIGATION 9.1 Albedo and ice cube melting
Per pair/group
2 x Florence or Erlenmeyer flasks
Black paint
Aluminum foil
Ice cubes
2 x thermometers
60W tungsten lamp (optional)
Timer

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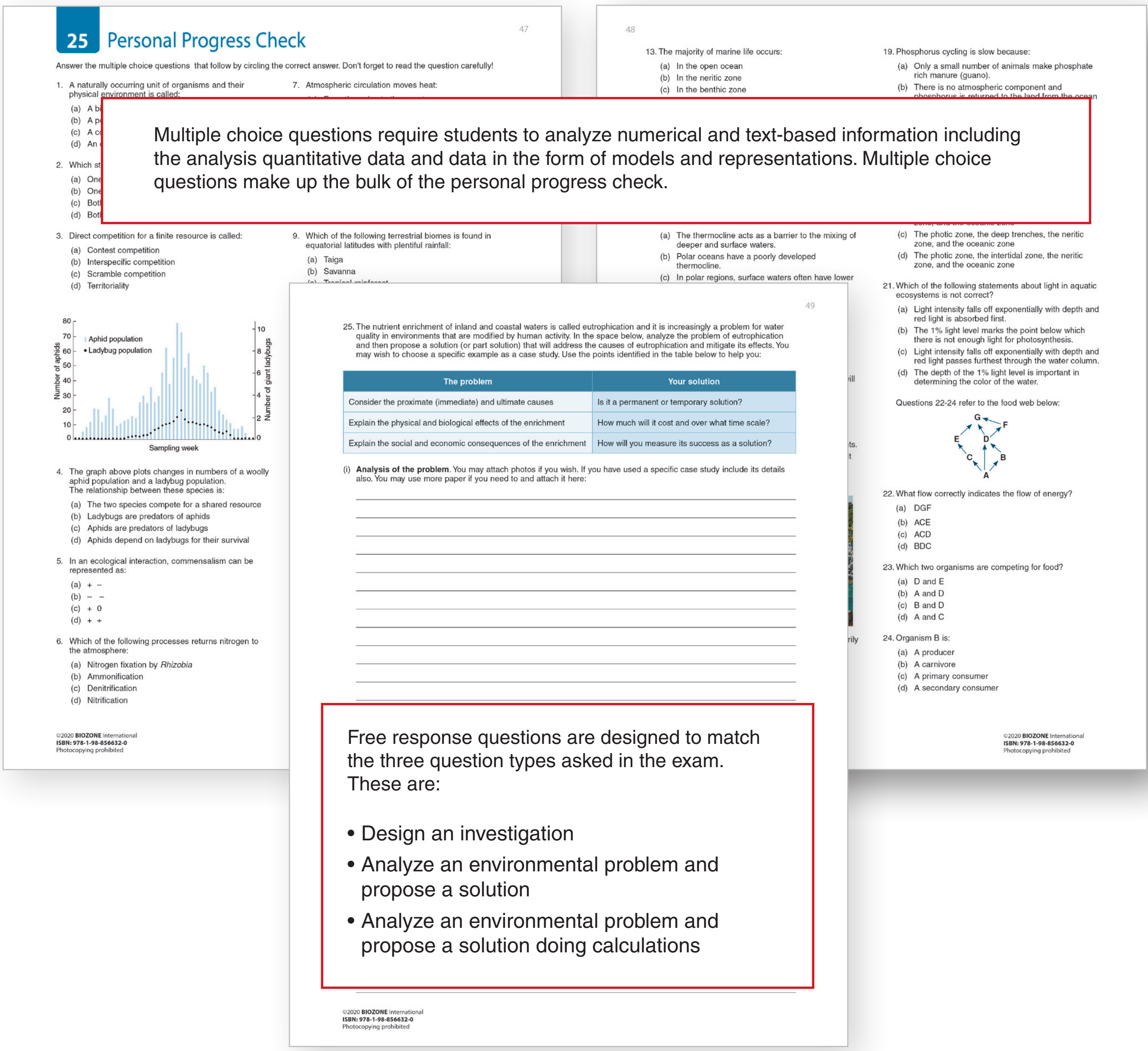
A list of the equipment and reagents required for each investigation is provided in appendix 3. Only standard equipment is used (no special kits are required).

Evaluating Student Performance

Personal Progress Checks conclude each of the units (1-9). Each one comprises 20-35 multiple choice questions followed by a free response question, simulating the types of questions students encounter in the AP Environmental Science exam. Teachers may assign these as formal assessments to gauge student understanding (e.g. taken in class under test conditions) or they can be given as formative assessments providing opportunities for exam practice before students sit the online tests provided in the AP classroom. We have followed the format stipulated in the AP Environmental Science CED when designing these assessments.

PERSONAL PROGRESS CHECK								
UNIT 1 The Living World: Ecosystems	UNIT 2 The Living World: Biodiversity	UNIT 3 Populations	UNIT 4 Earth Systems & Resources	UNIT 5 Land & Water Use	UNIT 6 Energy Resources & Consumption	UNIT 7 Atmospheric Pollution	UNIT 8 Aquatic & Terrestrial Pollution	UNIT 9 Global Change
24 multiple choice Analyze an environmental problem and propose a solution	21 multiple choice Design an investigation	24 multiple choice Analyze an environmental problem and propose a solution doing calculations	15 multiple choice Design an investigation	22 multiple choice Analyze an environmental problem and propose a solution	28 multiple choice Analyze an environmental problem and propose a solution doing calculations	28 multiple choice Design an investigation	26 multiple choice Analyze an environmental problem and propose a solution doing calculations	23 multiple choice Analyze an environmental problem and propose a solution

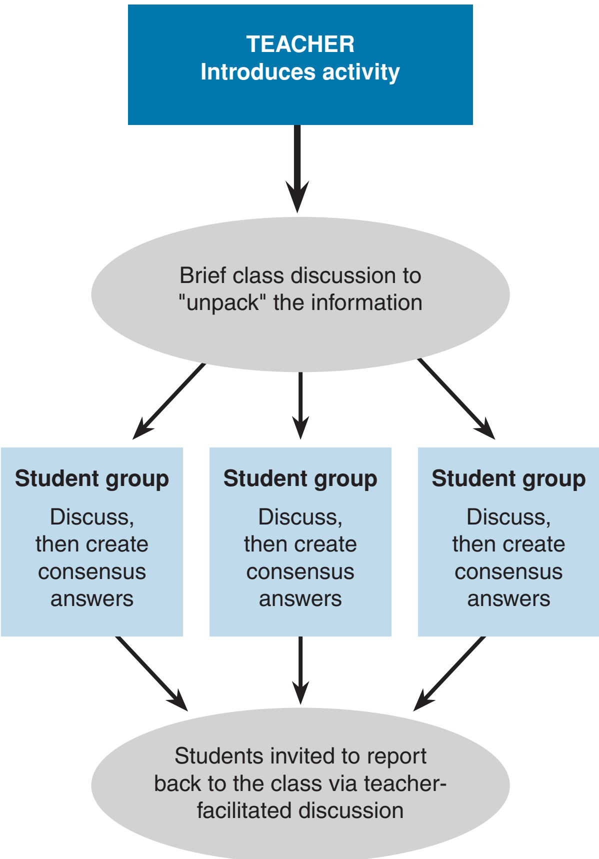


Teaching Strategies for Classroom Use

Achieving effective differential instruction in classes is a teaching challenge. Students naturally have mixed abilities, varying backgrounds in the subject, and different language skills. Used effectively, BIOZONE's student books and supporting resources can make teaching a mixed ability class easier. Here, we suggest some approaches for differential instruction.

MAKING A START

Regardless of which activity you might be attempting in class, a short introduction to the task by the teacher is a useful orientation for all students. For collaborative work, the teacher can then divide the class into appropriate groups, each with a balance of able and less able students. Depending on the activity, the class may regroup at the end of the lesson for discussion.



Using collaboration to maximize learning outcomes

- The structure of *AP Environmental Science* allows for a flexible approach to unpacking the content with your students.
- The content can be delivered in a way to support collaboration, where students work in small groups to share ideas and information to answer and gain a better understanding of a topic, or design a solution to a problem.
- By working together to ask questions and evaluate each other's ideas, students maximize their own and each other's learning opportunities. They are exposed to ideas and perspectives they may not have come up with on their own.
- Collaboration, listening to others, and voicing their own ideas is valuable for supporting English language learners and developing their English and scientific vocabularies.
- Use a short, informal collaborative learning session to get students to exchange ideas about the answer to a question. Alternatively, collaboration may take a more formal role that lasts for a longer period of time (e.g. assign groups to work together for a practical activity, to research an extension question, or design a solution to a problem).

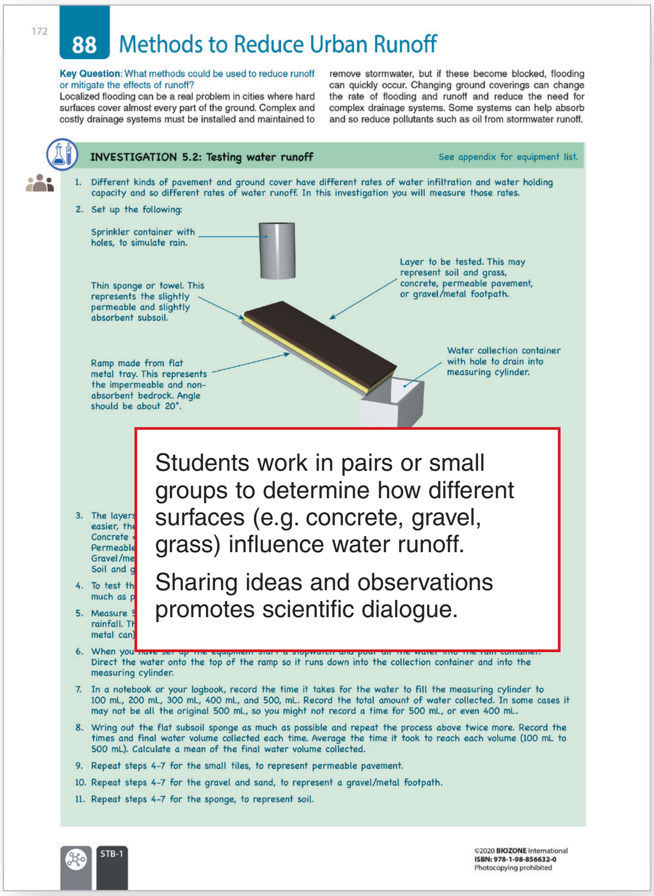
The teacher introduces the topic. They provide structure to the session by providing background information and setting up discussion points and clear objectives. Collaboration is emphasized to encourage participation from the entire group. If necessary, students in a group can be assigned specific tasks.

Students work in small groups so everyone's contribution is heard. They collaborate, share ideas, and engage in discourse. The emphasis is on discussing questions and formulating a consensus answer, not just sharing ideas.

At the end of the session, students report back on their findings. Each student should have enough knowledge to report back on the group's findings. Reporting consists primarily of providing answers to questions, but may involve presenting a report, model, or slide show, or contributing to a debate.

Peer to peer support

- **Peer-to-peer learning** is emphasized throughout the book, and is particularly valuable for more challenging activities in which the content is more complex or the questions require students to draw on several areas of their knowledge to solve a problem.
- **Practical investigations** and **group research projects** are an ideal vehicle for peer-to-peer learning. Students can work together to review and discuss their results, ask and answer questions, and describe phenomena.



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88 Methods to Reduce Urban Runoff

Key Question: What methods could be used to reduce runoff or mitigate the effects of runoff?

Localized flooding can be a real problem in cities where hard surfaces cover almost every part of the ground. Complex and costly drainage systems must be installed and maintained to remove stormwater, but if these become blocked, flooding can quickly occur. Changing ground coverings can change the rate of flooding and runoff and reduce the need for complex drainage systems. Some systems can help absorb and so reduce pollutants such as oil from stormwater runoff.

INVESTIGATION 5.2: Testing water runoff — See appendix for equipment list.

1. Different kinds of pavement and ground cover have different rates of water infiltration and water holding capacity and so different rates of water runoff. In this investigation you will measure those rates.
2. Set up the following:

Students work in pairs or small groups to determine how different surfaces (e.g. concrete, gravel, grass) influence water runoff.

Sharing ideas and observations promotes scientific dialogue.

3. The layers easier, the Concrete Permeable Gravel/me Soil and g
4. To test th much as p
5. Measure rainfall. Th metal can)
6. When you ... Direct the water onto the top of the ramp so it runs down into the collection container and into the measuring cylinder.
7. In a notebook or your logbook, record the time it takes for the water to fill the measuring cylinder to 100 mL, 200 mL, 300 mL, 400 mL, and 500, mL. Record the total amount of water collected. In some cases it may not be all the original 500 mL, so you might not record a time for 500 mL, or even 400 mL.
8. Wring out the flat subsoil sponge as much as possible and repeat the process above twice more. Record the times and final water volume collected each time. Average the time it took to reach each volume (100 mL to 500 mL). Calculate a mean of the final water volume collected.
9. Repeat steps 4-7 for the small tiles, to represent permeable pavement.
10. Repeat steps 4-7 for the gravel and sand, to represent a gravel/metal footpath.
11. Repeat steps 4-7 for the sponge, to represent soil.

STB-1

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4. (a) Which surface produced the **least** water runoff? ______
   (b) How would this affect the way water enter gutters, stormwater drains and rivers? ______

Students work in groups to debate the pros and cons of creating green spaces in urban areas. During this process, students draw on their own knowledge and can carry out additional research so they can contribute to the debate.

This provides an opportunity for peer discussion and sharing ideas.

Reducing water runoff

Reducing the need to remove water runoff from hard city surfaces can be achieved using a variety of methods.

Public transport can reduce water runoff in two ways. Use of public transport requires fewer roads and so fewer hard surfaces. The rail system of trains usually has bedding and grass strips which are permeable and allow water to infiltrate.

Sidewalks that are built using pavers rather than poured concrete create gaps through which water can escape. Planting trees also give spaces for water to infiltrate. The trees help by absorbing any excess water that enters the ground.

Building up rather than out (creating urban sprawl) can allow more area for green space and increase the surface area for water infiltration and groundwater recharge. This greatly reduces runoff and the need for complex stormwater systems.

6. Why would reducing stormwater runoff be of benefit to a city? ______
7. Look at the picture of the pavement above center carefully. Explain why this method of reducing water runoff has its own set of problems:
8. Creating green spaces has both advantages an disadvantages. Divide the class into two groups. One group will discuss and summarize the benefits of green spaces. The other group will discuss and summarize the potential disadvantages of green spaces. You can draw on what you have learned so far and do your own research if you wish.

   Summarize your discussion in point form and have one member of your group present the group's summary to the class. Keep a summary of the arguments from both sides and attach it to this page (organize the summary as a table if you wish). Do you think the advantages of green spaces outweigh the disadvantages?

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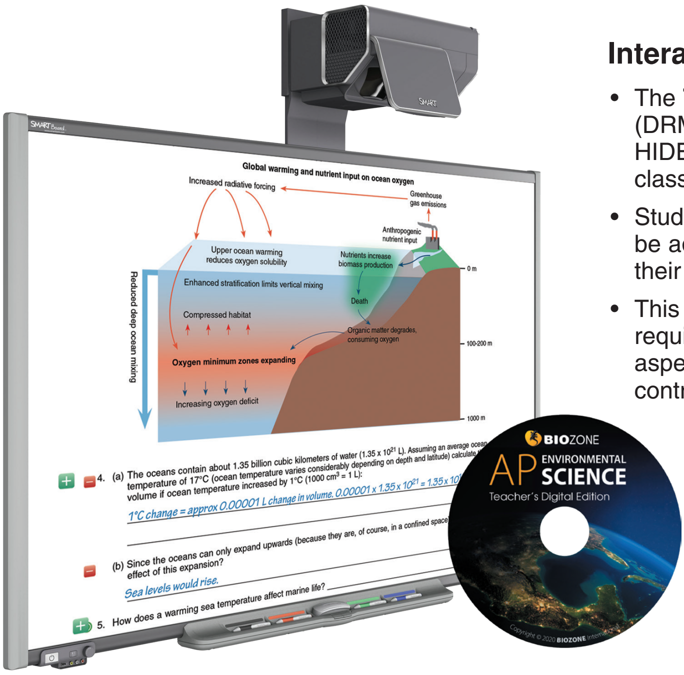
Collaboration and discovery

- BIOZONE's *AP Environmental Science* provides multiple chances for collaboration and discovery. By working together and sharing ideas, students are exposed to different perspectives and levels of knowledge about environmental concepts.
- BIOZONE's *AP Environmental Science* uses the CED framework to develop student understanding by providing a range of activities. These include getting students to think about and share what they already know and then build on this knowledge by exploring and explaining phenomena.

Student A is capable. He helps to lead the discussion and records the discussion in a structured way.

Students B and C are also capable but less willing to lead discussion they will add ideas to the discussion but need a little direction from A to do so.

Student D is less able but gains ideas and understanding from the discussion of students A, B, and C. She may add to the discussion as she gains confidence in the material being studied.

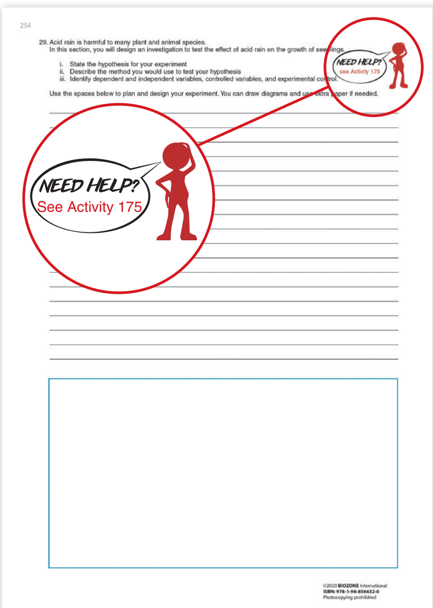


Interactive revision of tasks in class

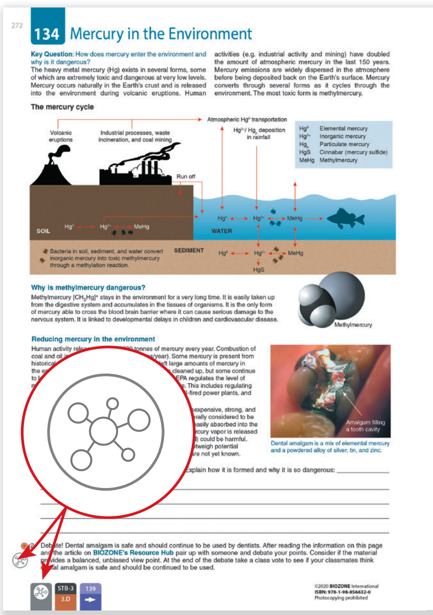
- The **Teacher's Digital Edition** provides a digital rights managed (DRM) version of the student book as PDF files. It features useful HIDE/SHOW answers, which can be used to review activities in class using a data projector or interactive whiteboard (left).
- Students benefit from the feedback in class, where questions can be addressed, and teachers benefit by having students self-mark their work and receive helpful feedback on their responses.
- This approach is particularly suited to activities with questions requiring a discussion, as students will be able to clarify some aspects of their responses. Stronger students can benefit by contributing to the explanatory feedback and class discussion.

Differentiated Learning

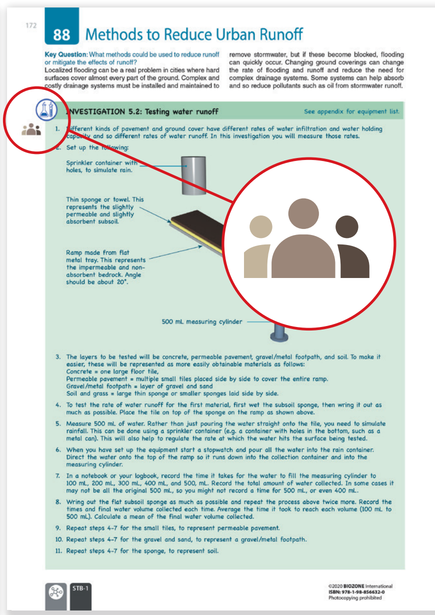
Tools for differentiated instruction within *AP Environmental Science* help teachers to cater for students of all abilities. BIOZONE's collaborative approach to science inquiry encourages students to share their ideas and knowledge with their peers while at the same time broadening their own understanding. There are several ways you can use *AP Environmental Science* in a differentiated classroom:



A red figure with a NEED HELP? icon helps students identify where they can go to get help with a specific skill. Relevant skills are provided in the *Science Practices for Environmental Science* chapter at the end of the book. Students can visit this chapter regularly, or you can assign activities as homework before they attempt a specific task in class.

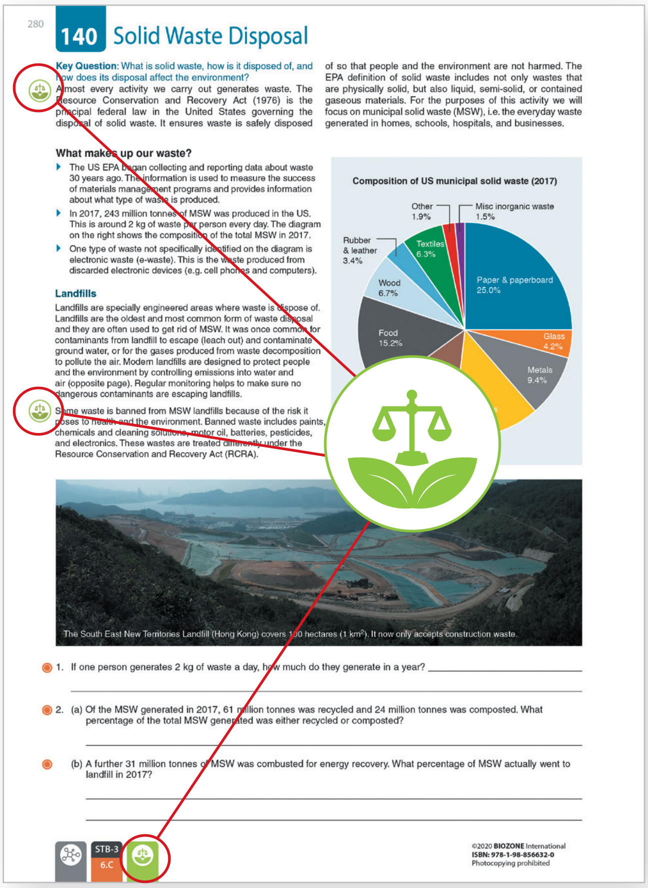


Animations and videos: Use the videos and animations on **BIOZONE's Resource Hub** to help student understanding of content. The Resource Hub also provides data sources, fact sheets, and material tagged for gifted and talented students. A gray hub icon at the bottom of the page indicates the activity has online support. Some hub resources are specific to a certain part of an activity. This is indicated by a hub icon in the page margin.



A group symbol indicates where students can work together. Group work provides opportunities for student collaboration and peer-to-peer support to explore phenomena. Working in groups, students can experiences the benefits of collaboration in the scientific process of discovery. By speaking and listening to each other, communication skills and scientific vocabulary are extended.

Environmental Legislation



280

140 Solid Waste Disposal

Key Question: What is solid waste, how is it disposed of, and how does its disposal affect the environment?

Almost every activity we carry out generates waste. The Resource Conservation and Recovery Act (1976) is the principal federal law in the United States governing the disposal of solid waste. It ensures waste is safely disposed of so that people and the environment are not harmed. The EPA definition of solid waste includes not only wastes that are physically solid, but also liquid, semi-solid, or contained gaseous materials. For the purposes of this activity we will focus on municipal solid waste (MSW), i.e. the everyday waste generated in homes, schools, hospitals, and businesses.

What makes up our waste?

- The US EPA began collecting and reporting data about waste 30 years ago. The information is used to measure the success of materials management programs and provides information about what type of waste is produced.
- In 2017, 243 million tonnes of MSW was produced in the US. This is around 2 kg of waste per person every day. The diagram on the right shows the composition of the total MSW in 2017.
- One type of waste not specifically identified on the diagram is electronic waste (e-waste). This is the waste produced from discarded electronic devices (e.g. cell phones and computers).

Landfills

Landfills are specially engineered areas where waste is dispose of. Landfills are the oldest and most common form of waste disposal and they are often used to get rid of MSW. It was once common for contaminants from landfill to escape (leach out) and contaminate ground water, or for the gases produced from waste decomposition to pollute the air. Modern landfills are designed to protect people and the environment by controlling emissions into water and air (opposite page). Regular monitoring helps to make sure no dangerous contaminants are escaping landfills.

Some waste is banned from MSW landfills because of the risk it poses to health and the environment. Banned waste includes paints, chemicals and cleaning solutions, motor oil, batteries, pesticides, and electronics. These wastes are treated differently under the Resource Conservation and Recovery Act (RCRA).

The South East New Territories Landfill (Hong Kong) covers 100 hectares (1 km^2). It now only accepts construction waste.

1. If one person generates 2 kg of waste a day, how much do they generate in a year? ____________

2. (a) Of the MSW generated in 2017, 61 million tonnes was recycled and 24 million tonnes was composted. What percentage of the total MSW generated was either recycled or composted?

   (b) A further 31 million tonnes of MSW was combusted for energy recovery. What percentage of MSW actually went to landfill in 2017?

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Environmental legislation refers to a collection of laws and regulations designed to help protect the environment and reduce or mitigate the negative effects of human activity.

The AP Environmental Science CED lists a number of required pieces of environmental legislation that teachers are encouraged to incorporate into their classes. Where possible, we have incorporated these into the activities in *AP Environmental Science*. These are identified in the green cells in the table below.

Activities containing environmental policy or legislation are identified by way of a green environmental icon at the bottom of the first page of the activity (left). An environmental icon in the page margin identifies specifically where in the activity that piece of environmental legislation is covered.

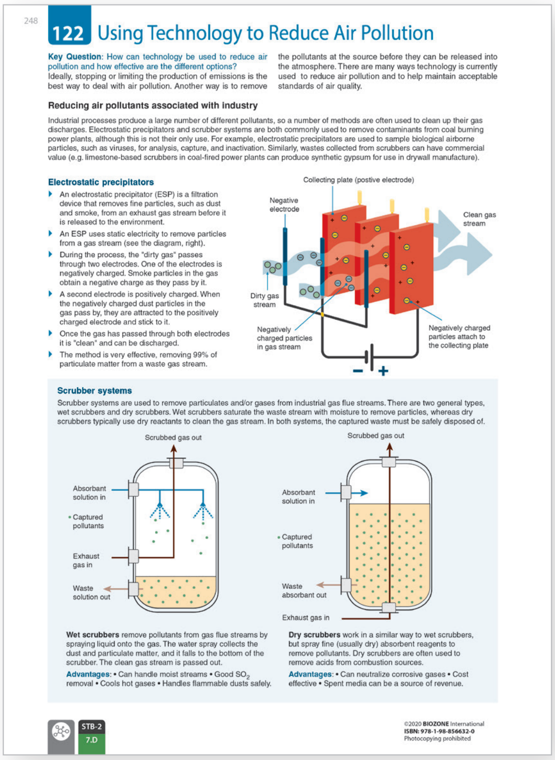
Additional, highly relevant, environmental legislation not mentioned in the CED is also covered in some activities. These are also identified in the table below (brown cells).

Environmental legislation/policy	US domestic (D) or International (I) policy	Activity number
Required legislation		
Clean Air Act	D	116, 121
Clean Water Act	D	127,130
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	I	165
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	D	143
Montreal Protocol	I	153
Kyoto Protocol	I	150, 154
Endangered Species Act	D	165
Safe Drinking Water Act (SDWA)	D	131
Delaney Clause of Food, Drug, and Cosmetic Act	D	79
Resource Conservation and Recovery Act (RCRA)	D	140

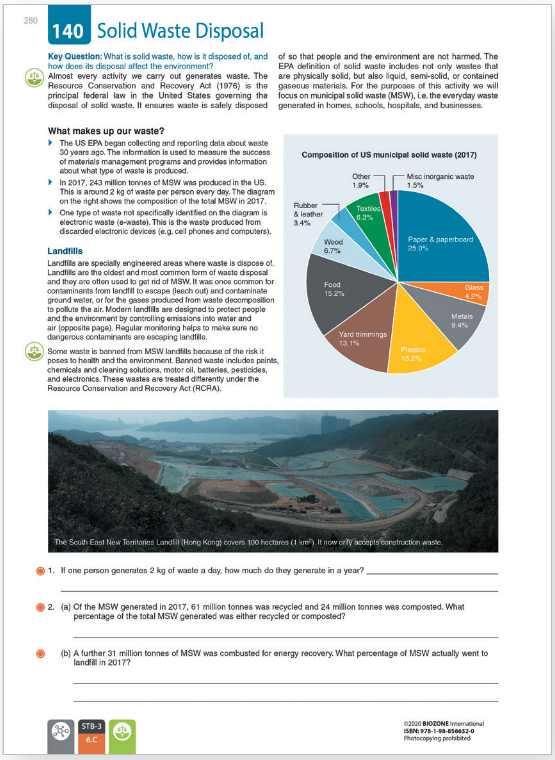
Additional legislation		
Taylor Grazing Act	D	74
The Corporate Average Fuel Economy (CAFE) standards	D	114
RAMSAR Convention on Wetlands of International Importance	I	136

Environmental Solutions

Environmental science often only makes the headlines for negative reasons, leaving students feeling overwhelmed with what may seem like constant bad news. It is important for students to realize that environmental science is also about designing solutions to combat the effects of human activity on the environment. Within *AP Environmental Science,* students are given opportunities to propose solutions to environmental problems. Students draw on their understanding of environmental legislation, technology, and scientific knowledge to propose and justify their solutions. Some examples are provided below.


122 Using Technology to Reduce Air Pollution

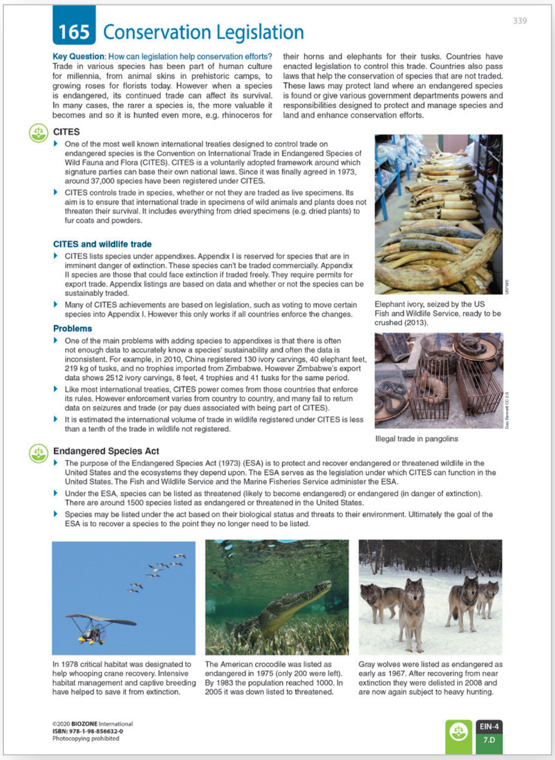
Students explore technological ways to remove particulate matter from industrial gas streams (and on the next page reducing transport related air pollutants) as a means of improving air quality.


140 Solid Waste Disposal

Historical landfills often leaked waste into the surrounding environment. Technological advances coupled with environmental legislation have resulted in the construction of safe landfills to prevent this occurring.


141 Reducing Waste

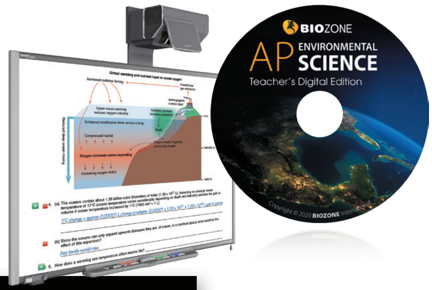
US landfills are reaching maximum capacity as the population grows and more waste is generated. Students look at ways to reduce the amount of waste entering landfills, in attempt to prolong the use of landfills.


165 Conservation Legislation

Species conservation is important for ecosystem health and function. Domestic and international conservation legislation have helped stabilize populations of some endangered species (above). Technology also plays an important role.

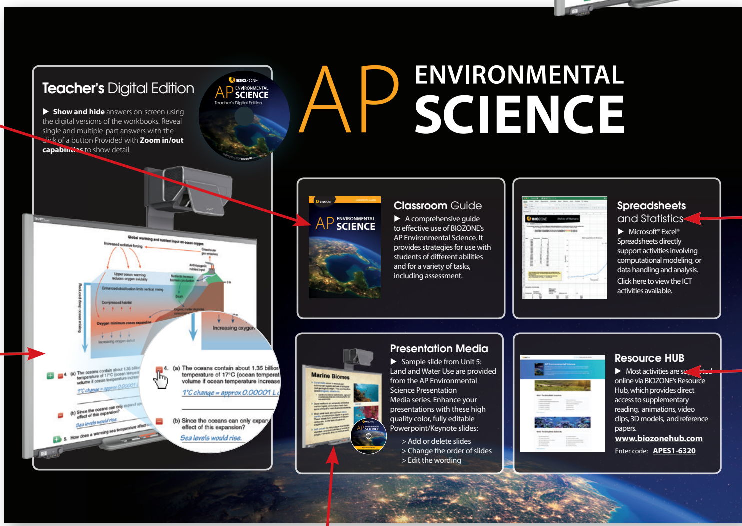
The Teacher's Digital Edition

The *Teacher's Digital Edition* is a DRM product, sold separately, and aimed primarily at extending the pedagogical tools at a teacher's disposal. Many of the features of this resource have been developed in response to requests from teachers themselves.



The **Classroom Guide** is provided as a printable PDF.

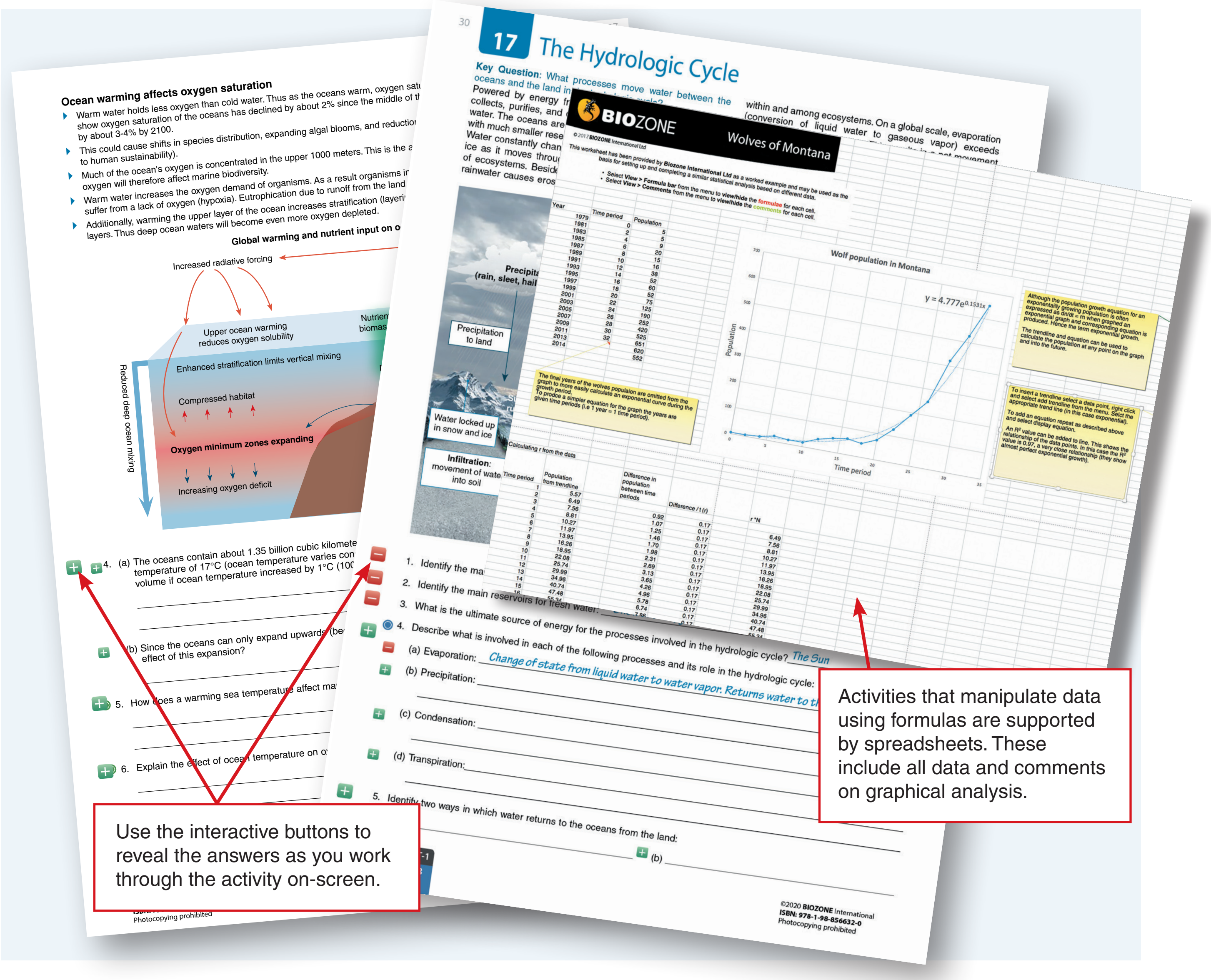
A digital (PDF) version of the Teacher's Edition (non-printable) is provided. Use the interactive buttons to HIDE or SHOW the answers.



Link to ***Excel***® **spreadsheets** for selected activities with a data analysis or computer modeling component.

Access **BIOZONE's Resource Hub** directly from this link for a range of resources to support the activities.

A **BONUS** sample from the upcoming Presentation Media for *The Living World: Ecosystems.* It is fully editable.



Activities that manipulate data using formulas are supported by spreadsheets. These include all data and comments on graphical analysis.

Use the interactive buttons to reveal the answers as you work through the activity on-screen.