BIOZONE

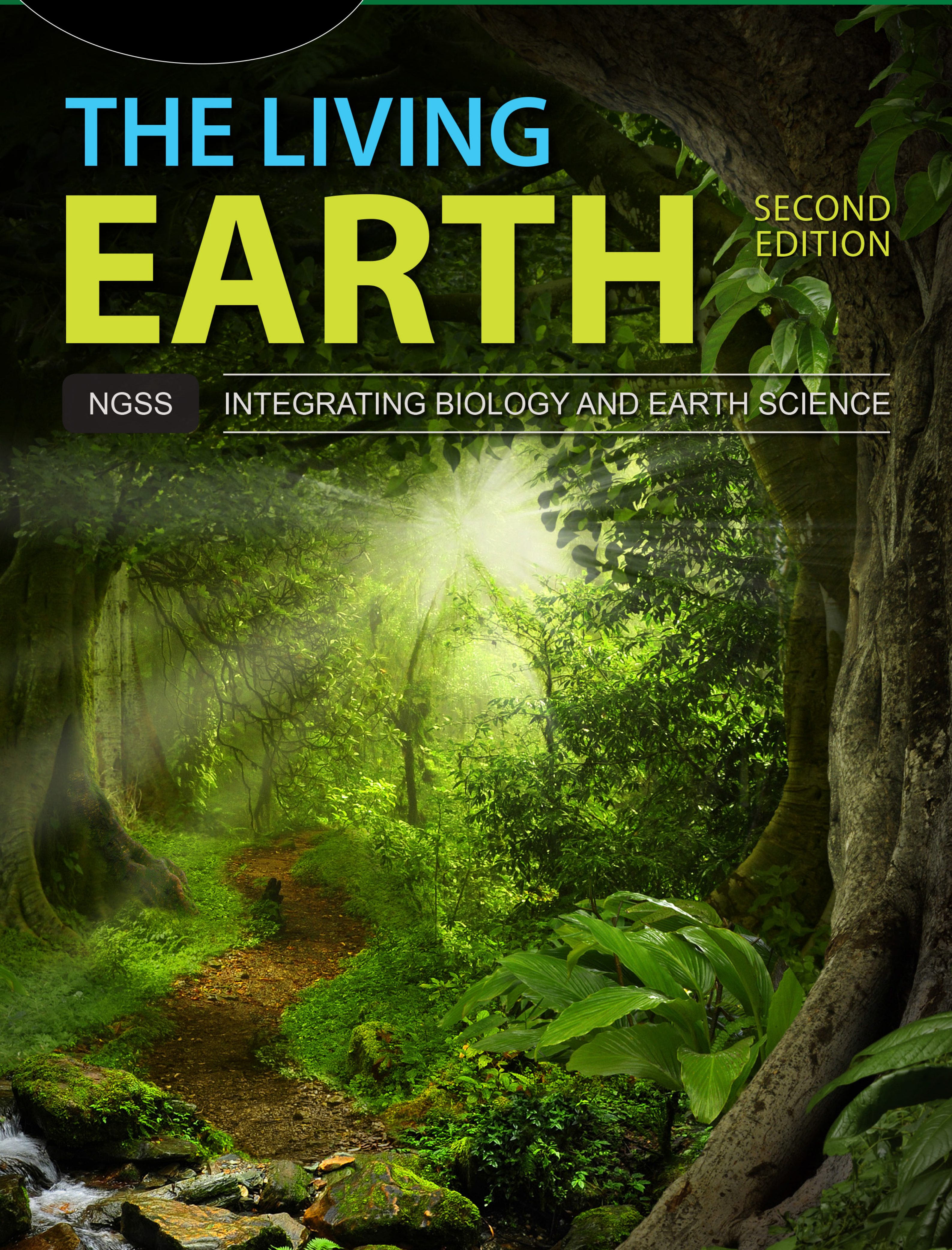
CLASSROOM GUIDE

THE LIVING EARTH

SECOND EDITION

NGSS

INTEGRATING BIOLOGY AND EARTH SCIENCE



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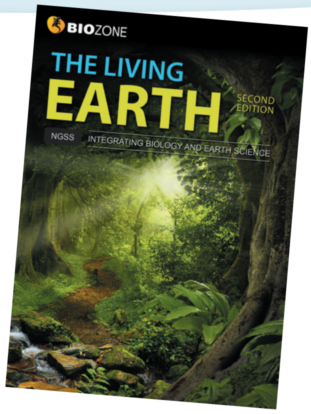
FAQs ABOUT THE LIVING EARTH



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Instructional Segment 3: Evidence of Common Ancestry and Diversity

Instructional Segment 6: Ecosystem Stability and the Response to Climate Change

SEP Support: Basic Skills for Students in Life Science

Suggested strategies for pacing

- Following the framework's progression, move sequentially through the book (IS1 to IS6). This might seem obvious, but teachers all have their own reasons for beginning with specific topics first.
- Don't forget to build in time to complete activities in the SEP/skills chapter as required.
- Use the first 6 activities as a guide to time taken vs total time allocated for the program. Next block out time using this extended contents based on the performance of your own students.
- Green dots indicate investigations. These can usually be completed within one hour or less.
- Red flags show where teacher guidance may be needed or where gifted students can work ahead.

List of Practical Investigations In *The Living Earth*

IS 1: Ecosystem Interactions and Energy

INVESTIGATION 1.1
Creating a model of logistic growth

INVESTIGATIONS 1.2–1.4
Population growth models

INVESTIGATION 1.5
Exploring biomass pyramids

INVESTIGATION 1.6
Pathways for toxins in food webs

IS 2: History of the Earth's Atmosphere: Photosynthesis and Respiration

INVESTIGATION 2.1
Carbon dioxide use by *Cabomba*

INVESTIGATION 2.2
Measuring bubble production in *Cabomba*

INVESTIGATION 2.3
The iodine test for starch

INVESTIGATION 2.4
Testing leaves for starch

INVESTIGATION 2.5
Measuring respiration in germinating seeds

INVESTIGATION 2.6
Modeling photosynthesis and respiration

INVESTIGATION 2.7
Designing a wastewater treatment plant

INVESTIGATION 2.8
Use of glucose by *Saccharomyces* yeast

INVESTIGATION 2.9
Using M&Ms® to model half lives

INVESTIGATION 2.10
Model of the carbon cycle

INVESTIGATION 2.11
Measuring the pH of substances

INVESTIGATION 2.12
How does dry ice affect pH?

IS 3: Evidence of Common Ancestry and Diversity

INVESTIGATION 3.1
Using stream trays to model erosion

INVESTIGATION 3.2
Surface area and limestone dissolution

INVESTIGATION 3.3
Investigation coastal erosion

INVESTIGATION 3.4
Investigation coastal defenses

INVESTIGATION 3.5
Phenotypic variation in your class

INVESTIGATION 3.6
Modeling selection with M&Ms®

INVESTIGATION 3.7
Modeling antibiotic resistance

INVESTIGATION 3.8
Making square world

INVESTIGATION 3.9
Modeling continental drift

IS 4: Inheritance of traits

INVESTIGATION 4.1
Making a DNA model

INVESTIGATION 4.2
Modeling meiosis using popsicle sticks

INVESTIGATION 4.3
Achoo syndrome

IS 5: Structure, Function, and Growth

INVESTIGATION 5.1
Forearm movements

INVESTIGATION 5.2a–5.2b
Gas exchange system model

INVESTIGATION 5.3
Protein denaturation

INVESTIGATION 5.4
Modeling protein structure

INVESTIGATION 5.5
Effect of temperature on enzyme activity

INVESTIGATION 5.6
Modeling meiosis

INVESTIGATION 5.7a
Changes in heart and breathing rates

INVESTIGATION 5.7b
Evaluating the effect of exercise on heart rate

INVESTIGATION 5.8
Modeling the effect of insulation

INVESTIGATION 5.9
Body shape and temperature gain/ loss

IS 6: Ecosystem Stability and the Response to Climate Change

INVESTIGATION 6.1
Factors influencing atmospheric temperature

INVESTIGATION 6.2
Albedo and ice sheet melting

INVESTIGATION 6.3
Effect of temperature on *Vibrio* doubling time

Summary of BIOZONE's 3D Approach By Chapter

Science and Engineering Practices (SEPs), Crosscutting Concepts (CCCs), Disciplinary Core ideas (DCIs), and Performance Expectations (PEs) for Instructional Segments 1-6 of the CA NGSS (Three Course Model) are summarized below. A concluding basic skills chapter, which covers some of the background for Science and Engineering Practices, is also included. Performance Expectations (PEs) are met within activities and/or the summing up activities concluding each Instructional Segment.

Page		Activity	Hub	SEP	DCI	CCC	PE
1		**IS1: Ecosystem Interactions and Energy**					
2	1	An Endless Swarm	✓				
3	2	The Earth's Systems	✓	2	LS2.A	4	
5	3	Abiotic Factors Influence Distribution	✓	4, 5	LS2.A	2	
10	4	The Ecological Niche	✓	4, 6	LS2.A	2	
13	5	Populations Have Varied Distributions	✓	2	LS2.A		
15	6	Population Growth	✓	3, 4, 5, 6	LS2.A	4, 7	HS-LS2-1, HS-LS2-2
21	7	Modeling Population Growth	✓	2,3	LS2.A	2, 7	HS-LS2-2
23	8	The Carrying Capacity of an Ecosystem	✓	2, 4, 5	LS2.A	2, 3, 5, 7	HS-LS2-1
27	9	Species Interactions Can Regulate Populations	✓	4	LS2.A	2	HS-LS2-2
29	10	Predation Can Control Some Populations	✓	4	LS2.A	2, 3, 5	HS-LS2-2, HS-LS2-4
32	11	Organisms Compete for Limited Resources	✓	2, 3, 4	LS2.A	2, 3, 5	HS-LS2-2
37	12	Human Activity Alters Populations	✓	6	LS2.C	2, 5	
40	13	Producers, Consumers, and Food Webs	✓	2	LS2.B	5	
46	14	Energy in Ecosystems	✓	2, 3, 4, 5	LS2.B	5	HS-LS2-4
53	15	Nutrient Cycles	✓	5	LS2.B	5	HS-LS2-4
52	16	Humans Intervene in Nutrient Cycles	✓	3, 5, 8	LS2.C	3, 5	HS-LS2-2
63	17	Group Behavior Improves Survival	✓	7	LS2.D	4, 5	HS-LS2-8
66	18	Individuals in Groups Often Cooperate	✓	7	LS2.D	4, 5	HS-LS2-8
73	19	An Endless Swarm Revisited					
74	20	Summing Up	✓	5, 7	*LS2.A, LS2.B, LS2.D*	2, 3, 5	HS-LS2-2, HS-LS2-4, HS-LS2-8

Page		Activity	Hub	SEP	DCI	CCC	PE
79		**IS2: History of the Earth's Atmosphere: Photosynthesis and Respiration**					
81	21	One of These Worlds is Not Like the Others	✓			3, 4	
79	22	Energy in the Cell	✓	2	LS1.C	5	
85	23	Photosynthesis	✓	2, 3, 6	LS1.C	5	HS-LS1-5, HS-LS1-6
93	24	Cellular Respiration	✓	3, 6	LS1.C LS2.B	5	HS-LS1-7, HS-LS2-3
101	25	Modeling Photosynthesis and Cellular Respiration	✓	2	LS1.C, LS2.B	5	HS-LS1-5, HS-LS1-6, HS-LS1-7
105	26	Putting Biological Processes To Work	✓	2, 3, 6, 8	LS2.B ETS1.B	5	HS-LS2-3
109	27	How Old is the Earth?	✓	2, 3, 6	ESS1.C	5, 7	HS-ESS1-6
113	28	The Coevolution of Earth's Systems	✓	7	ESS2.E	4, 7	HS-ESS2-7
120	29	Carbon Cycling	✓	2, 6	LS2.B, ESS2.D	2, 4, 5	HS-ESS2-6
123	30	Modeling the Carbon Cycle	✓	2, 3, 6	LS2.B ESS2.D	2, 4, 5	HS-ESS2-6
126	31	How Carbon Dioxide Affects the Oceans	✓	3, 6	LS2.A, LS2.B	2	Assessed in IS6
129	32	Fossil Fuels and the Environment	✓	2, 6	LS1.C	5, 7	HS-LS1-6
133	33	Revisiting Model Worlds	✓	2	LS2.B	3, 4	
134	34	Summing Up		2, 6, 7	LS1.C, LS2.B, ESS1.C, ESS2.D, ESS2.E	4, 5, 7	HS-LS1-5, HS-LS1-6, HS-LS1-7, HS-LS2-3, HS-ESS1-6, HS-ESS2-6, HS-ESS2-7

Page		Activity	Hub	SEP	DCI	CCC	PE
139		**IS3: Evidence of Common Ancestry and Diversity**					
141	35	The Rise of the Tyrants	✓				
142	36	What are Fossils and How Do They Form?	✓	4	LS4.A	2, 6, 7	
144	37	Erosion Shapes the Landscape	✓	1, 2, 3, 4, 6	ESS2.C ETS1.B	2,3,7	HS-ESS2-5, HS-ETS1-3
158	38	Evidence for Evolution	✓	7, 8	LS4.A	1, 2, 6	HS-LS4-1
166	39	All Life is Related	✓	7, 8	LS4.A	1, 6	
168	40	Natural Selection	✓	2, 3, 4, 6	LS4.B, LS4.C	1, 2, 7	HS-LS4-2, HS-LS4-3, HS-LS4-4
178	41	Speciation	✓	6, 7	LS4.C	1, 2, 7	HS-LS4-5
185	42	The Extinction of Species	✓	7	LS4.C	2	HS-LS4-5
188	43	SNAPSHOT: Antibiotic Resistance	✓	2, 6, 7	LS4.C	1, 7	HS-LS4-5
192	44	SNAPSHOT: Human Evolution	✓	1, 2	LS4.C	2	
		EXPLORE: Climate change	✓	1, 4, 7, 8	ESS2.E, ESS3.D	7	
		EXPLORE: Physical changes in human evolution	✓	1, 4, 7, 8	LS1.A, LS4.A, ESS1.C	6	
		EXPLORE: Molecular evidence of human evolution	✓	1, 4, 7, 8	LS4.A	1	
		EXPLORE: Human cultural evolution	✓	1, 4, 7, 8	LS2.D	2	
		EXPLAIN: Where did we come from?					HS-LS4-5
202	45	Continental Drift	✓	2, 7	ESS2.B	2	
209	46	The Rise of the Tyrants Revisited					
203	47	Summing Up	✓	6, 7, 8	LS4.A, LS4.C, ESS1.C, ESS3.A, ESS3.B	1, 2	HS-LS4-1, HS-LS4-4, HS-LS4-5, HS-ESS3-1,

Page		Activity	Hub	SEP	DCI	CCC	PE
217		**IS4: Inheritance of Traits**					
218	48	Pale and Interesting	✓				
219	49	Experiments Showed DNA Carries the Code	✓	1, 8	LS1.A, LS3.A	2	HS-LS3-1
222	50	Modeling the Structure of DNA	✓	2, 3	LS1.A, LS3.A	2	
227	51	Genome Studies	✓	1, 7	LS3.A, LS3.B	2	
230	52	Modern Genetics	✓	1, 8	LS3.A. ETS1.B	2	HS-LS3-1
235	53	Variation	✓	6, 7	LS3.B	2	
238	54	Sexual Reproduction Produces Genetic Variation	✓	2, 3, 6, 7	LS3.B	2	
245	55	Mutation Produces Variation	✓	7	LS3.B	2	
250	56	Mendelian Genetics	✓	2, 3, 4, 5	LS3.B	3	HS-LS3-3
265	57	Pedigree Analysis	✓	2, 7	LS3.B	1	HS-LS3-1
259	58	Environment Influences Phenotype	✓	5, 7	LS3.B	2	
270	59	Natural Selection Acts on Phenotype	✓	4, 6	LS4.B, LS4.C	1, 2	HS-LS4-2, HS-LS4-3
272	60	Pale and Interesting Revisited	✓				
268	61	Summing Up	✓	4, 7	LS3.B, LS4.B, LS4.C	1, 2	HS-LS3-2, HS-LS4-3,

Page		Activity	Hub	SEP	DCI	CCC	PE
278		**IS5: Structure, Function, and Growth**					
280	62	A Cancerous Creep	✓				
281	63	Cells and Life	✓	2, 6	LS1.A,	6	
287	64	Cells, Tissues, and Organs	✓	2, 6	LS1.A, LS2.B	6	HS-LS1-2, HS-LS1-4
294	65	Interacting Systems	✓	2, 3	LS1.A	6	
299	66	How Cells Make Proteins	✓	2, 3, 6	LS1.A	6	
305	67	The Functions of Proteins	✓	2, 6	LS1.A	6	
310	68	Proteins Do Work in Cells	✓	2, 3, 6	LS1.A, ETS1.B	5, 6	
315	69	How Do We Know What Proteins Do?	✓	4, 6	LS1.A	2, 6	
321	70	DNA Replication	✓	2, 4	LS1.B	6	
326	71	Growth and Repair of Cells	✓	2, 4	LS1.B	6, 7	HS-LS1-4
328	72	The Cell Cycle	✓	2, 4	LS1.B	7	
334	73	Keeping in Balance	✓	1, 2, 3, 6	LS1.A	4, 7	HS-LS1-3
347	74	Disease Affects Interactions	✓	2, 8	LS1.A	2, 7	
350	75	A Cancerous Creep Revisited	✓				
351	76	Summing Up	✓	2, 6	LS1.A, LS1.B	4, 6	HS-LS1-1, HS-LS1-2, HS-LS1-4

Page		Activity	Hub	SEP	DCI	CCC	PE
355		**IS6: Ecosystem Stability and Response to Climate Change**					
356	77	Weather Whiplash	✓				
357	78	Ecosystem Dynamics	✓	2, 7	LS2.C, LS4.C	7	HS-ESS4-5
363	79	Climate Change	✓	2, 3, 4, 5	ESS3.C, ESS3.D	3, 7	
370	80	Feedback Systems	✓	2, 3	ESS3.D	2, 4, 7	
374	81	Models of Climate Change	✓	4, 7	LS4.C, ESS3.D, ETS1.B	2, 4, 7	
382	82	Solutions for Climate Change	✓	6	LS2.C, LS4.D, ESS3.C, ETS1.B	4, 7	HS-LS2-7, HS-ESS3-4
385	83	Human Impact on Ecosystems	✓	3, 5, 6	LS2.C, LS4.D, ESS3.D, ETS1.B	2, 4, 7	HS-ESS3-6, HS-ETS1-3
381	84	Weather Whiplash Revisited					
382	85	Summing Up	✓	4, 7	ESS3.D	7	HS-LS2-6, HS-ESS3-5

Page		Activity	Hub	SEP	DCI	CCC	PE
399		**SEPs: Basic Skills for Students in Life Science**					
400	86	How Do We Do Science?	✓	1, 6, 7, 8		4	NA
401	87	Systems and System Models	✓	2		4	NA
402	88	Observations, Hypotheses, and Assumptions	✓	1			NA
403	89	Accuracy and Precision		3			NA
404	90	Working With Numbers		5			NA
405	91	Tallies, Percentages, and Rates		5			NA
406	92	Fractions and Ratios		5			NA
407	93	Dealing with Large Numbers	✓	5			NA
408	94	Apparatus and Measurement		3			NA
409	95	Describing Data	✓				NA
411	96	Variables and Controls		3			NA
412	97	Drawing Graphs	✓	4, 5			NA
414	98	Interpreting Line Graphs		4, 5			NA
415	99	Mean, Median, and Mode	✓	4, 5			NA
416	100	Can You Trust Your Data?	✓	4, 5			NA
418	101	Detecting Bias in Samples	✓	4, 5			NA

Identifying CA CCSS Connections

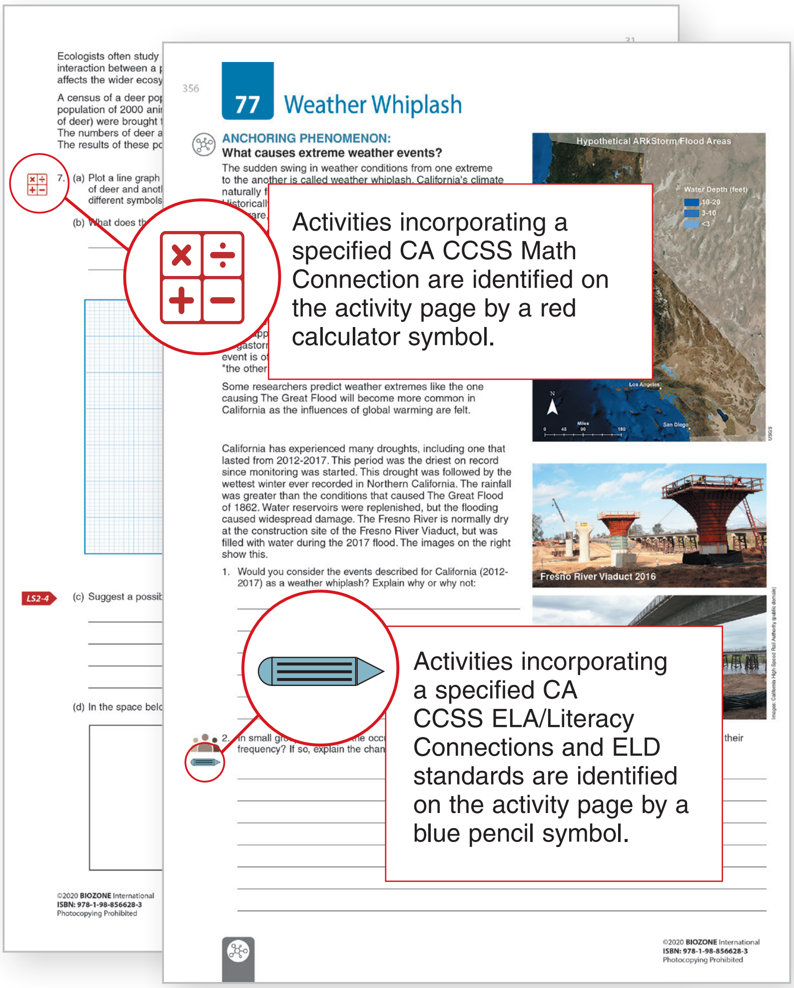
The activities in *The Living Earth* provide many opportunities to address the California Common Core State Standards (CA CCSS) for numeracy, literacy, and English language development (ELD). The incorporation of these standards allows students to practice and develop these key skills while exploring science.

Activities incorporating the CA CCSS Math Connections, ELA/ literacy, and ELD Connections specified in the California Science Framework are identified by codes (right) in the **Teacher's Edition** and **Teacher's Digital Edition**. Note that this coding is a tool for the teacher and is not present in the Student Edition.

- A red calculator indicates a math connection.
- A blue pencil indicates an ELA/literacy or ELD connection.

A list of the specific Math Connections, ELA/ Literacy Connections and ELD Standards addressed in the CA NGSS framework can be found in the tables at the bottom of this page and on the following page.

BIOZONE recognizes that CA ELD Standards are not to be used in isolation, and are intended to be implemented in conjunction with ELA/Literacy and other academic content standards. You will see them appearing along with the relevant ELA/ literacy connection in the following tables.



IS1: Ecosystem Interactions and Energy

Activity number	Activity	CA CCSS Math connection	CA CCSS ELA/Literacy & ELD connection
3	Abiotic Factors Influence Distribution	N-Q.1, S-IC.6, MP.4	RST.11-12.1, 8, WHST.9-12.2 ELD.P1.11-12.1, 5, 6, 9, 10, 11
6	Population Growth	N-Q.1, MP.4	
8	The Carrying Capacity of an Ecosystem	N-Q.1, MP.4	
9	Species Interactions Can Regulate Populations		RST.11-12.7, WHST.9-12.2 ELD.P1.11-12.1, 5, 9, 10
10	Predation Can Control Some Populations	N-Q.1, S-IC.6, MP.4	
11	Organisms Compete for Limited Resources	S-IC.6	
16	Humans Intervene in Nutrient Cycles	S-IC.6	
17	Group Behavior Improves Survival	S-IC.6	
18	Individuals in Groups Often Cooperate	N-Q.1, S-IC.6, MP.4	
20	Summing Up	S-IC.6	

IS2: History of the Earth's Atmosphere: Photosynthesis and Respiration

Activity number	Activity	CA CCSS Math connection	CA CCSS ELA/Literacy & ELD connection
23	Photosynthesis	N-Q.1, MP.4	
24	Cellular Respiration	N-Q.1, MP.4	
27	How Old is the Earth?	N-Q.1, MP.4	
28	The Coevolution of Earth's Systems		WHST.11-12.2, 9, ELD.P1.11-12.1, 5, 11
30	Modeling the Carbon Cycle	N-Q.1, MP.4	
32	Fossil Fuels and the Environment		ELD.P1.11-12.1, 5
34	Summing Up	N-Q.1, MP.4	

IS3: Evidence of Common Ancestry and Diversity

Activity number	Activity	CA CCSS Math connection	CA CCSS ELA/Literacy & ELD connection
36	What Are Fossils and How Do They Form?		SL.11-12.4, ELD.P1.11-12.1, 5
37	Erosion Shapes the Landscape	MP.4	RST.11-12.1, WHST.9-12.7, 9 ELD.P1.11-12.1, 6
38	Evidence for Evolution		SL.11-12.4, RST.11-12.1, WHST.9-12.7, 9, ELD.P1.11-12.1, 5, 11
40	Natural Selection	MP.4	ELD.P1.11-12.1, 5
44	SNAPSHOT: Human Evolution		SL.11-12.4, WHST.9-12.7, 9 ELD.P1.11-12.1, 5, 11
47	Summing Up	MP.4	

IS4: Inheritance of Traits

Activity number	Activity	CA CCSS Math connection	CA CCSS ELA/Literacy & ELD connection
49	Experiments Showed DNA Carries the Code		RST.11-12.9, WHST.9-12.2, 7, 9 ELD.P1.11-12.1, 5, 6, 11
52	Modern Genetics		RST.11-12.9, WHST.9-12.7 ELD.P1.11-12.1, 5, 9
53	Variation	MP.4	
58	Environment Influences Phenotype	MP.4	ELD.P1.11-12.1, 5
59	Natural Selection Acts on Phenotype	MP.4	

IS5: Structure, Function, and Growth

Activity number	Activity	CA CCSS Math connection	CA CCSS ELA/Literacy & ELD connection
62	A Cancerous Creep		WHST.9-12.7, ELD.P1.11-12.1, 5
67	The Functions of Proteins		WHST.9-12.7, 9
70	DNA Replication		ELD.P1.11-12.1, 5
71	Growth and Repair of Cells	MP.4	
73	Keeping in Balance	S-ID.2, MP.4	ELD.P1.11-12.10
74	Disease Affects Interactions		WHST.9-12.7, ELD.P1.11-12.1, 5
75	A Cancerous Creep Revisited		ELD.P1.11-12.10

IS6: Ecosystem Stability and Response to Climate Change

Activity number	Activity	CA CCSS Math connection	CA CCSS ELA/Literacy & ELD connection
77	Weather Whiplash		WHST.9-12.7, ELD.P1.11-12.10
78	Ecosystem Dynamics		WHST.9-12.7, ELD.P1.11-12.10
79	Climate Change	S-IC.6	
80	Feedback Systems	N-Q.1, S-IC.6, MP.4	
81	Models of Climate Change	S-IC.6	
82	Solutions to Climate Change		WHST.9-12.7, ELD.P1.11-12.1, 5, 10, 11
83	Human Impact on Ecosystems	N-Q.1, S-IC.6, MP.4	ELD.P1.11-12.1, 5, 10
85	Summing Up	S-IC.6	

SEPs: Basic Skills for Students in Life Science

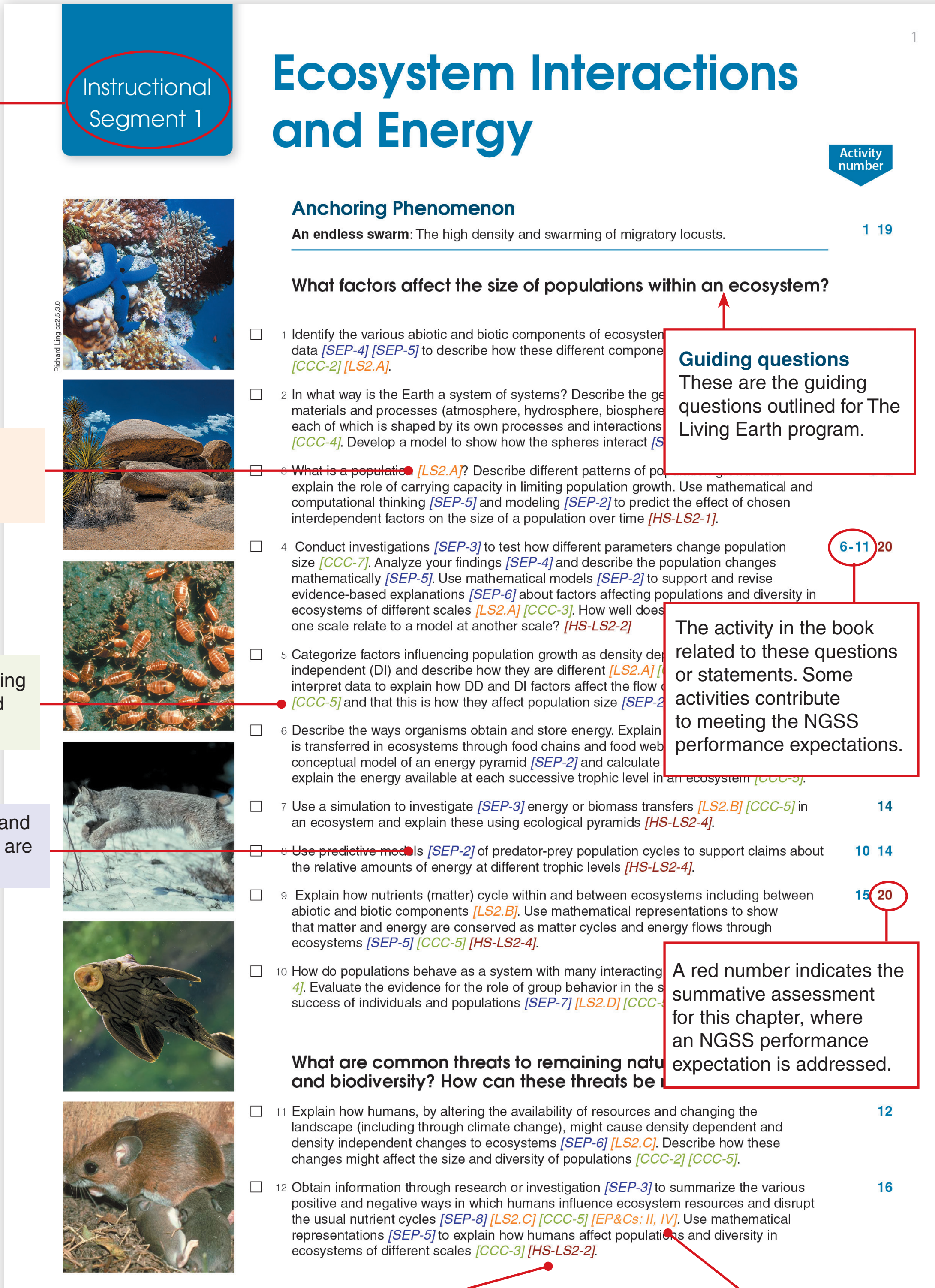
Activity number	Activity	CA CCSS Math connection	CA CCSS ELA/Literacy & ELD connection
86	How Do We Do Science?		SL.911-12.1, ELD.P1.11-12.1, 5,
93	Dealing with Large Numbers	N-Q.1, MP.4	
95	Describing Data	S-ID.2	
97	Drawing Graphs	N-Q.1, MP.4	
98	Interpreting Line Graphs	S-ID.7	
99	Mean, Median, and Mode	S-ID.2	
100	Can You Trust Your Data?	MP.4	
101	Detecting Bias in Samples	S-ID.3	

Identifying Learning Intentions and Goals

In developing *The Living Earth*, we have embraced the three dimensions of the CA NGSS framework, emphasizing the application of concepts and skills to the understanding of phenomena. The activities in *The Living Earth* have been specifically designed to address the **disciplinary core ideas, science and engineering practices**, and **crosscutting concepts** in a way that helps students to meet specific performance expectations.

All three dimensions of the standards are identified and color coded in the chapter introduction text in both the Teacher's Edition and Teacher's Digital Edition (below). The performance expectations and California Environmental Principles and Concepts are also identified. Note that this coding is a tool for the teacher and is not present in the Student Edition.

This identifies the Instructional Segment to which this chapter applies.


Instructional Segment 1

1

Ecosystem Interactions and Energy

Activity number

Anchoring Phenomenon

An endless swarm: The high density and swarming of migratory locusts. 1 19

What factors affect the size of populations within an ecosystem?

☐ 1 Identify the various abiotic and biotic components of ecosystem… data *[SEP-4] [SEP-5]* to describe how these different compone… *[CCC-2] [LS2.A]*.

☐ 2 In what way is the Earth a system of systems? Describe the ge… materials and processes (atmosphere, hydrosphere, biosphere… each of which is shaped by its own processes and interactions… *[CCC-4]*. Develop a model to show how the spheres interact *[S…*

☐ 3 What is a population *[LS2.A]*? Describe different patterns of po… explain the role of carrying capacity in limiting population growth. Use mathematical and computational thinking *[SEP-5]* and modeling *[SEP-2]* to predict the effect of chosen interdependent factors on the size of a population over time *[HS-LS2-1]*.

☐ 4 Conduct investigations *[SEP-3]* to test how different parameters change population size *[CCC-7]*. Analyze your findings *[SEP-4]* and describe the population changes mathematically *[SEP-5]*. Use mathematical models *[SEP-2]* to support and revise evidence-based explanations *[SEP-6]* about factors affecting populations and diversity in ecosystems of different scales *[LS2.A] [CCC-3]*. How well does… one scale relate to a model at another scale? *[HS-LS2-2]* 6-11 20

☐ 5 Categorize factors influencing population growth as density de… independent (DI) and describe how they are different *[LS2.A] [*… interpret data to explain how DD and DI factors affect the flow o… *[CCC-5]* and that this is how they affect population size *[SEP-2…*

☐ 6 Describe the ways organisms obtain and store energy. Explain… is transferred in ecosystems through food chains and food web… conceptual model of an energy pyramid *[SEP-2]* and calculate… explain the energy available at each successive trophic level in an ecosystem *[CCC-5]*.

☐ 7 Use a simulation to investigate *[SEP-3]* energy or biomass transfers *[LS2.B] [CCC-5]* in an ecosystem and explain these using ecological pyramids *[HS-LS2-4]*. 14

☐ 8 Use predictive models *[SEP-2]* of predator-prey population cycles to support claims about the relative amounts of energy at different trophic levels *[HS-LS2-4]*. 10 14

☐ 9 Explain how nutrients (matter) cycle within and between ecosystems including between abiotic and biotic components *[LS2.B]*. Use mathematical representations to show that matter and energy are conserved as matter cycles and energy flows through ecosystems *[SEP-5] [CCC-5] [HS-LS2-4]*. 15 20

☐ 10 How do populations behave as a system with many interacting… 4]. Evaluate the evidence for the role of group behavior in the s… success of individuals and populations *[SEP-7] [LS2.D] [CCC-…*

What are common threats to remaining natu… and biodiversity? How can these threats be…

☐ 11 Explain how humans, by altering the availability of resources and changing the landscape (including through climate change), might cause density dependent and density independent changes to ecosystems *[SEP-6] [LS2.C]*. Describe how these changes might affect the size and diversity of populations *[CCC-2] [CCC-5]*. 12

☐ 12 Obtain information through research or investigation *[SEP-3]* to summarize the various positive and negative ways in which humans influence ecosystem resources and disrupt the usual nutrient cycles *[SEP-8] [LS2.C] [CCC-5] [EP&Cs: II, IV]*. Use mathematical representations *[SEP-5]* to explain how humans affect populations and diversity in ecosystems of different scales *[CCC-3] [HS-LS2-2]*. 16

Richard Ling cc2.5.3.0

Guiding questions
These are the guiding questions outlined for The Living Earth program.

The relevant disciplinary core are indicated in orange.

The activity in the book related to these questions or statements. Some activities contribute to meeting the NGSS performance expectations.

The relevant crosscutting concepts are indicated in green.

The relevant science and engineering practices are indicated in blue.

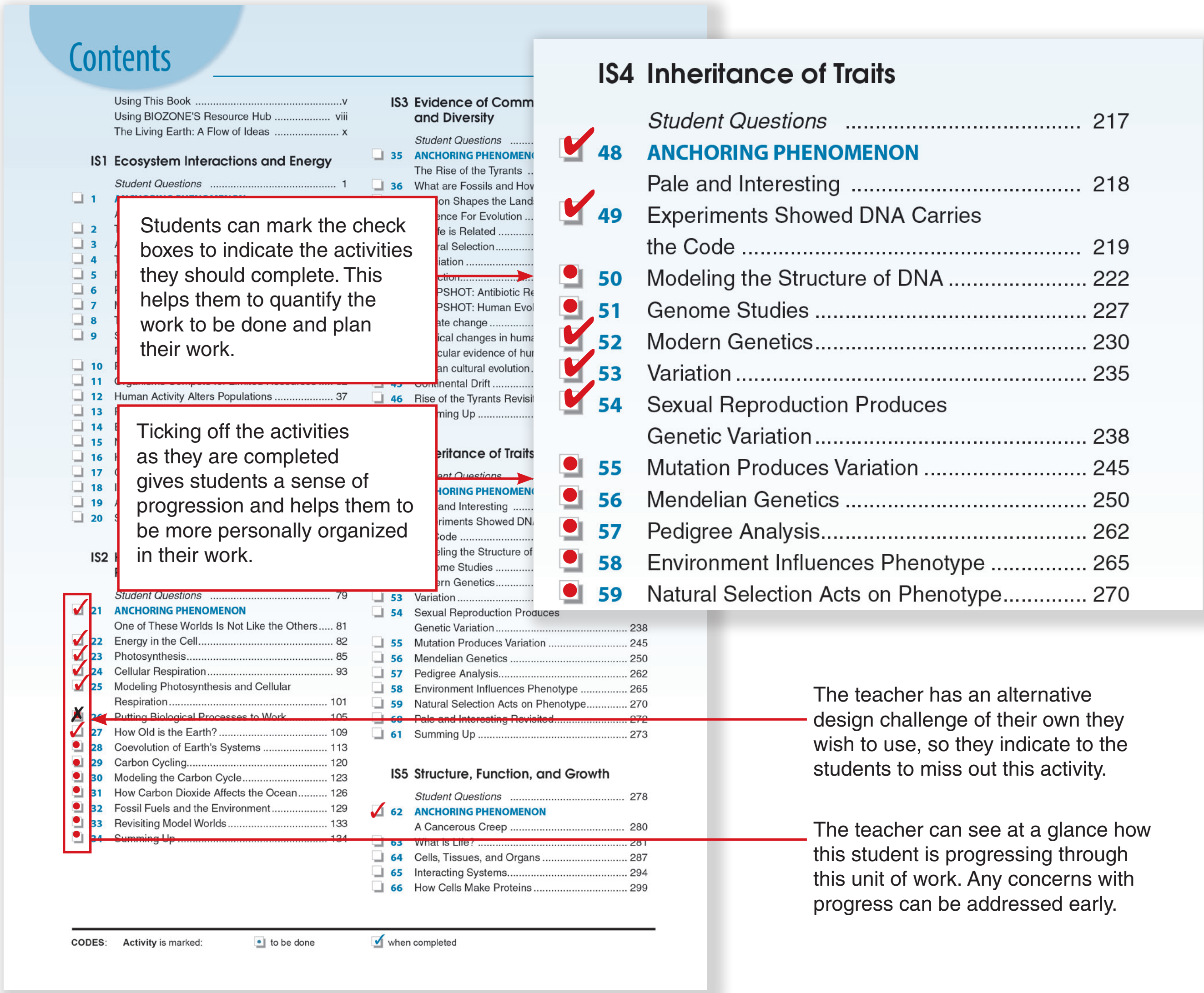
A red number indicates the summative assessment for this chapter, where an NGSS performance expectation is addressed.

The relevant performance expectation is indicated in red

California Environmental Principles and Concepts are indicated in orange.

Using the Contents: Planning and Pacing

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. The teacher can also see at a glance how quickly the student is progressing through the assigned material. Teacher's can use the extended version of the content to create a pacing guide.



What about a pacing guide?

The 9-12 Ca-NGSS framework is fluid in terms of the grade in which each program is offered, so in many respects defies a rigid pacing guide. Many schools/districts adopt an integrated life science-chemistry-physics but a physics-chemistry-life science approach is gaining popularity. These different grade levels accord with vastly different student competencies and prior experience. Within grade, other variables contribute to changes in pacing:

- There are opportunities for students to spend longer on some activities (e.g. in improving or refining their design solutions or in exploring simulations beyond the minimum). These elaborations will demand more time.
- For computer modeling activities, completed models are available on **BIOZONE's Resource Hub** and the Teacher's Digital Edition, so students can save time by exploring the model, but not building it themselves.
- The time allocated for investigations will depend on (1) how you choose to organize the class (which may be determined by available resources) and (2) how far students take the investigation. Adjust your lesson plan to incorporate more or less material as needed. You may have investigations you already like to use, so you could choose to leave out equivalent investigations in the book.
- The pace may quicken as students complete more of the book. Later chapters draw on knowledge and understanding of previous chapters, as well as exploring new concepts. Students gain increasing levels of competence and learn valuable skills that enable them to arrive at solutions more quickly. This isn't the rule, but an observation based on the structure of the framework. For help, see "Suggested strategies for pacing" (page CG6).

Scaffolded Learning with the 5Es

In developing *The Living Earth* we have utilized the 5Es instructional model as a basis for developing materials to address all three dimensions of the CA NGSS framework: **disciplinary core ideas**, **science and engineering practices**, and **crosscutting concepts**. By successfully completing the activities, students can demonstrate competence in all three dimensions. This is central to meeting the performance expectations for *The Living Earth* with confidence.

BIOZONE encourages the development of the NGSS learner profile using the 5 Es model

The Five Es

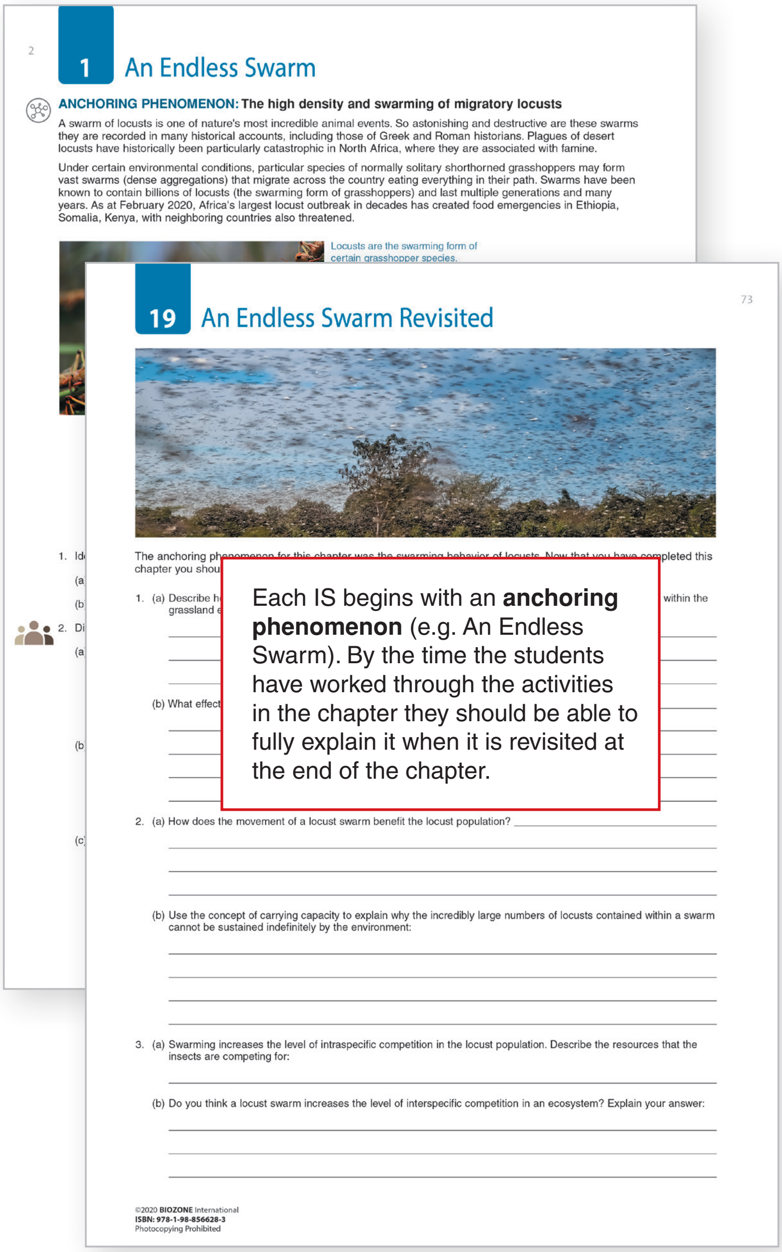
Engage:	make connections between past and present learning experiences.
Explore:	become actively involved in the activity.
Explain:	communicate the learning experience.
Elaborate:	expand on the concepts learned.
Evaluate:	assess understanding of the concepts.

BIOZONE's series for CA-NGSS is **phenomenon-based**. Students engage with phenomena through their own investigations and observations, through modeling and data analysis, and through collaborative work and discussion.

Using phenomena to drive inquiry promotes discussion and the sharing of ideas. The iterative approach presents opportunities to look at phenomena from several different perspectives. This allows students of all abilities to widen their thinking and understanding, increasing understanding each time the phenomenon is revisited.

Each IS begins with an **anchoring phenomenon** (right). In each instance, we have chosen a phenomenon that the student is probably familiar with, but which they cannot explain (or cannot explain fully). Teachers can use this activity to find out what the students already know (or think they know) before delving into the content more fully.

The subsequent activities in a chapter take the students, step by step, through phenomena that explore the ideas inherent in the anchoring phenomenon. By the time students revisit the anchoring phenomenon, they should be able to fully explain it.


2

1 An Endless Swarm

ANCHORING PHENOMENON: The high density and swarming of migratory locusts

A swarm of locusts is one of nature's most incredible animal events. So astonishing and destructive are these swarms they are recorded in many historical accounts, including those of Greek and Roman historians. Plagues of desert locusts have historically been particularly catastrophic in North Africa, where they are associated with famine.

Under certain environmental conditions, particular species of normally solitary shorthorned grasshoppers may form vast swarms (dense aggregations) that migrate across the country eating everything in their path. Swarms have been known to contain billions of locusts (the swarming form of grasshoppers) and last multiple generations and many years. As at February 2020, Africa's largest locust outbreak in decades has created food emergencies in Ethiopia, Somalia, Kenya, with neighboring countries also threatened.

Locusts are the swarming form of certain grasshopper species.

73

19 An Endless Swarm Revisited

The anchoring phenomenon for this chapter was the swarming behavior of locusts. Now that you have completed this chapter you shou...

1. (a) Describe h... within the grassland e...

(b) What effect...

2. (a) How does the movement of a locust swarm benefit the locust population?

(b) Use the concept of carrying capacity to explain why the incredibly large numbers of locusts contained within a swarm cannot be sustained indefinitely by the environment:

3. (a) Swarming increases the level of intraspecific competition in the locust population. Describe the resources that the insects are competing for:

(b) Do you think a locust swarm increases the level of interspecific competition in an ecosystem? Explain your answer:

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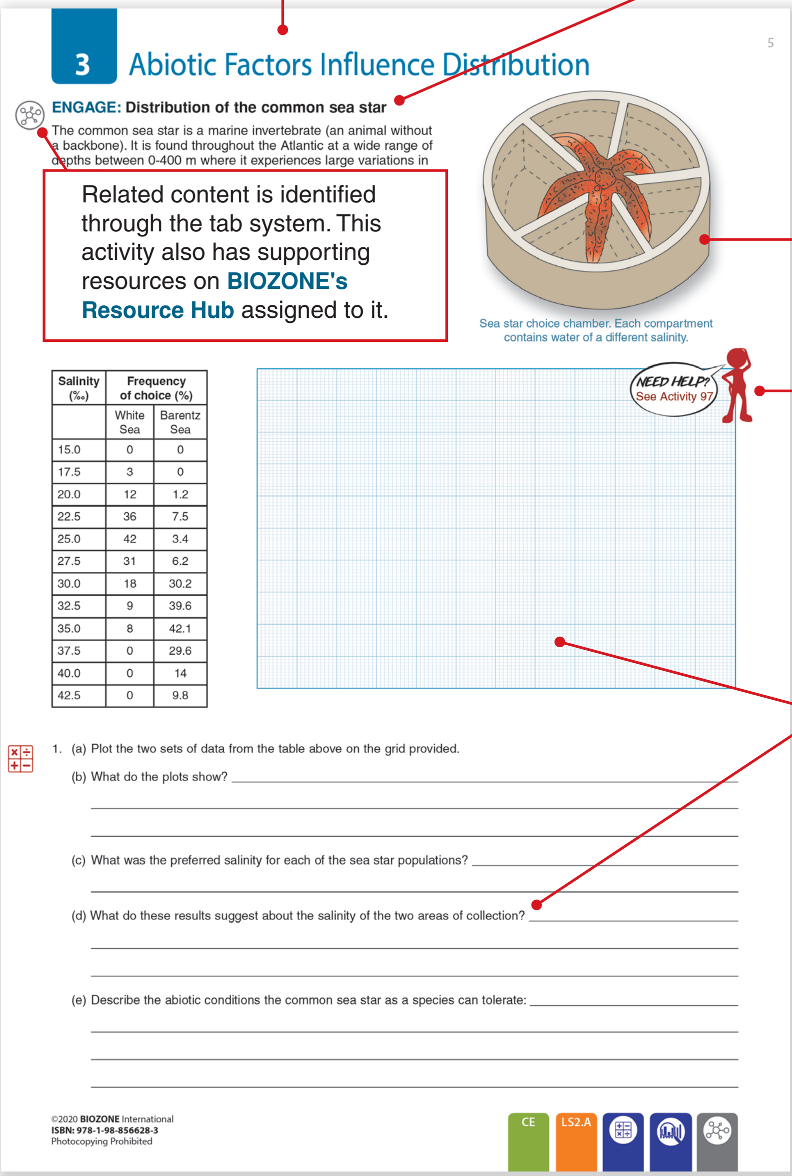
Each IS begins with an **anchoring phenomenon** (e.g. An Endless Swarm). By the time the students have worked through the activities in the chapter they should be able to fully explain it when it is revisited at the end of the chapter.

The content of the *The Living Earth* is organized into 7 chapters, corresponding to the six Instructional Segments (IS) and one chapter addressing basic skills for students studying life sciences. Each Instructional Segment begins with an introduction outlining key questions and is immediately followed by the Anchoring Phenomenon. Engaging activities make up the bulk of each chapter, with each activity focusing on the student investigating and developing understanding of phenomena, applying that understanding to new scenarios, and/or developing a skill or essential science practice, such as graphing, data analysis, modeling, or evidence-based explanation.

Annotated diagrams and photographs are a major part of most activities and the student's understanding of the information is evaluated through questions and/or tasks involving investigation, and data handling and analysis. Tabs at the bottom of the page identify crosscutting concepts, science and engineering practices, and disciplinary core ideas as appropriate. Hub tabs at the bottom of the page indicate if the activity is supported via **BIOZONE's Resource Hub**, which provides online teacher and student support for specific aspects of the activity. A hub icon in the margin indicates the specific part(s) of the activity supported with a hub resource.

Each activity is a sequence of related ideas, which build on each other to develop a student's understanding of the phenomenon being studied.

ENGAGE with phenomena
Each activity begins with a task to engage student thinking, asking them to review their current understanding of a phenomenon, or providing an interesting (if not yet fully explained) piece of information and setting the scene for the content to follow. Prior knowledge can also be assessed using the ENGAGE material.



3 Abiotic Factors Influence Distribution

5

ENGAGE: Distribution of the common sea star

The common sea star is a marine invertebrate (an animal without a backbone). It is found throughout the Atlantic at a wide range of depths between 0-400 m where it experiences large variations in

Sea star choice chamber. Each compartment contains water of a different salinity.

NEED HELP? See Activity 97

Salinity (‰)	Frequency of choice (%)	
	White Sea	Barentz Sea
15.0	0	0
17.5	3	0
20.0	12	1.2
22.5	36	7.5
25.0	42	3.4
27.5	31	6.2
30.0	18	30.2
32.5	9	39.6
35.0	8	42.1
37.5	0	29.6
40.0	0	14
42.5	0	9.8

1. (a) Plot the two sets of data from the table above on the grid provided.
(b) What do the plots show?
(c) What was the preferred salinity for each of the sea star populations?
(d) What do these results suggest about the salinity of the two areas of collection?
(e) Describe the abiotic conditions the common sea star as a species can tolerate:

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CE LS2.A

Related content is identified through the tab system. This activity also has supporting resources on **BIOZONE's Resource Hub** assigned to it.

Annotated diagrams, photographs, and graphs explain the content of the page, providing the information necessary to complete the activity.

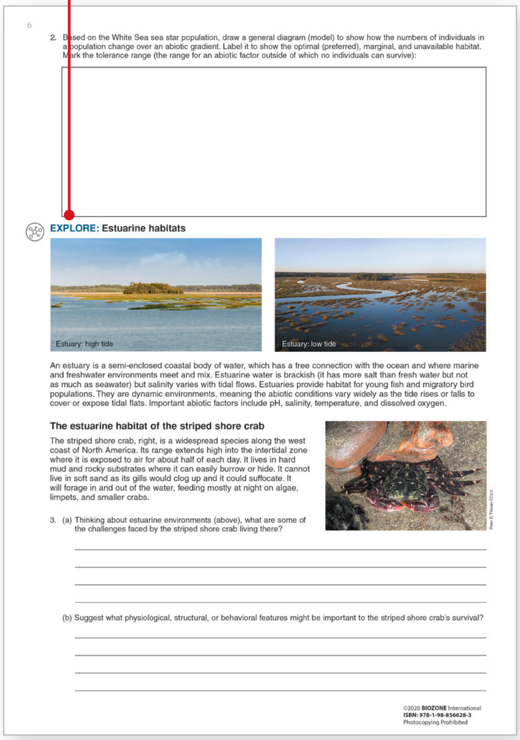
Students can refer to the help activity identified if they need assistance with a task (in this case, plotting the data).

Students are given enough information to complete the activity's tasks. To progress through the activity they will often need to apply knowledge and skills gained earlier.

Answers to questions are not always directly available on the page so students should not expect to search the text for direct answers. In most cases, they must formulate their responses from the information/data provided or their own investigations.

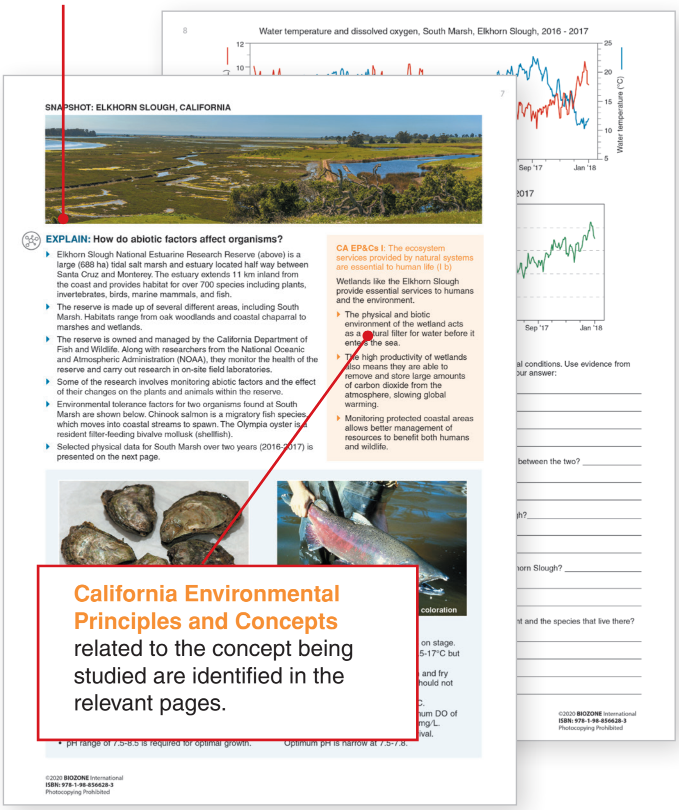
EXPLORE

After engaging with the opening information, students explore some aspect of the phenomenon more widely. In this case, students explore the abiotic factors of an estuary and are asked to suggest how these factors affect the inhabitants. Exploration often involves making a model or performing a simple experiment.



EXPLAIN

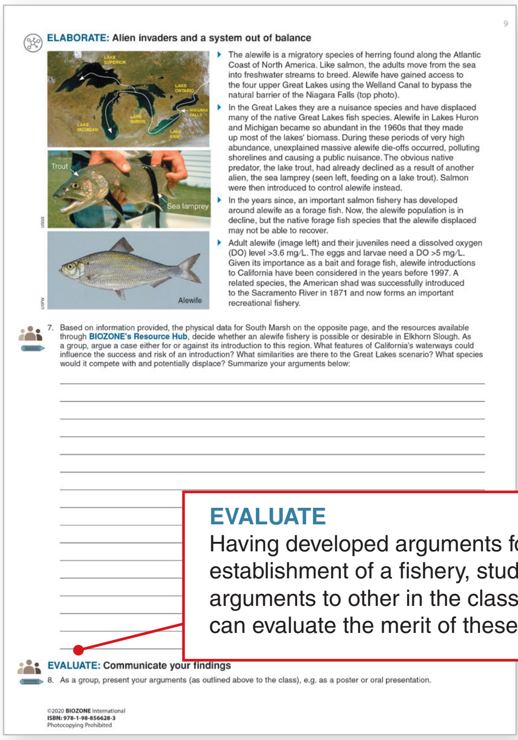
Once they have explored some basic concepts, students are given new information or data to analyze. They must explain any patterns they see in the data. Here students must analyze physical data over the course of a year and use it to predict how well estuarine inhabitants might tolerate the changes in the environment based on biological information.



California Environmental Principles and Concepts related to the concept being studied are identified in the relevant pages.

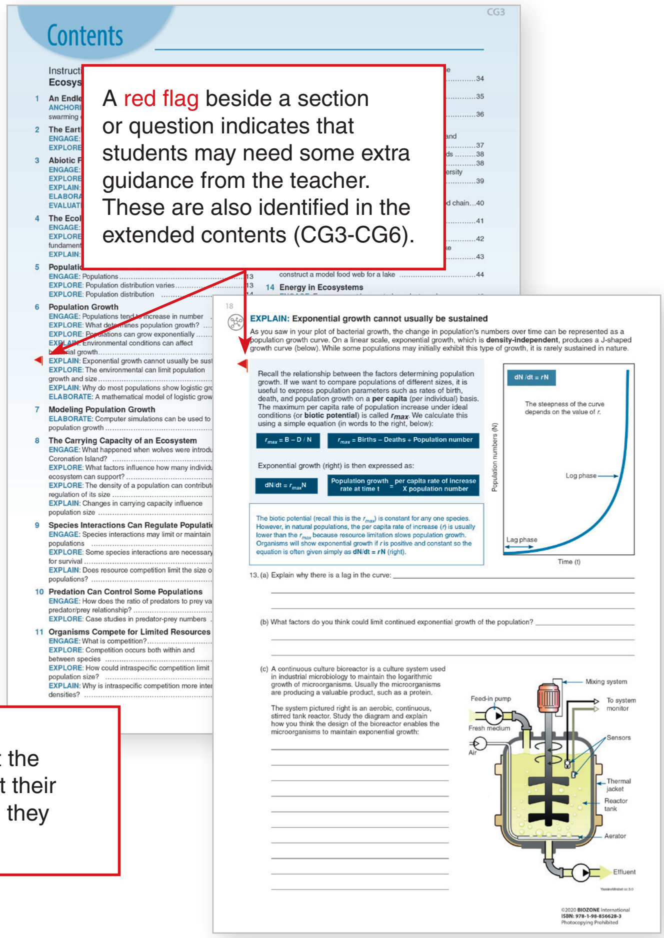
ELABORATE

Students apply their understanding to a new situation. Given the physical environment of Elkhorn Slough, could (and should) a new fishery be developed there by introducing a new species? Students will need to come up with reasoned arguments.



EVALUATE

Having developed arguments for or against the establishment of a fishery, students present their arguments to other in the class. As a class, they can evaluate the merit of these arguments.



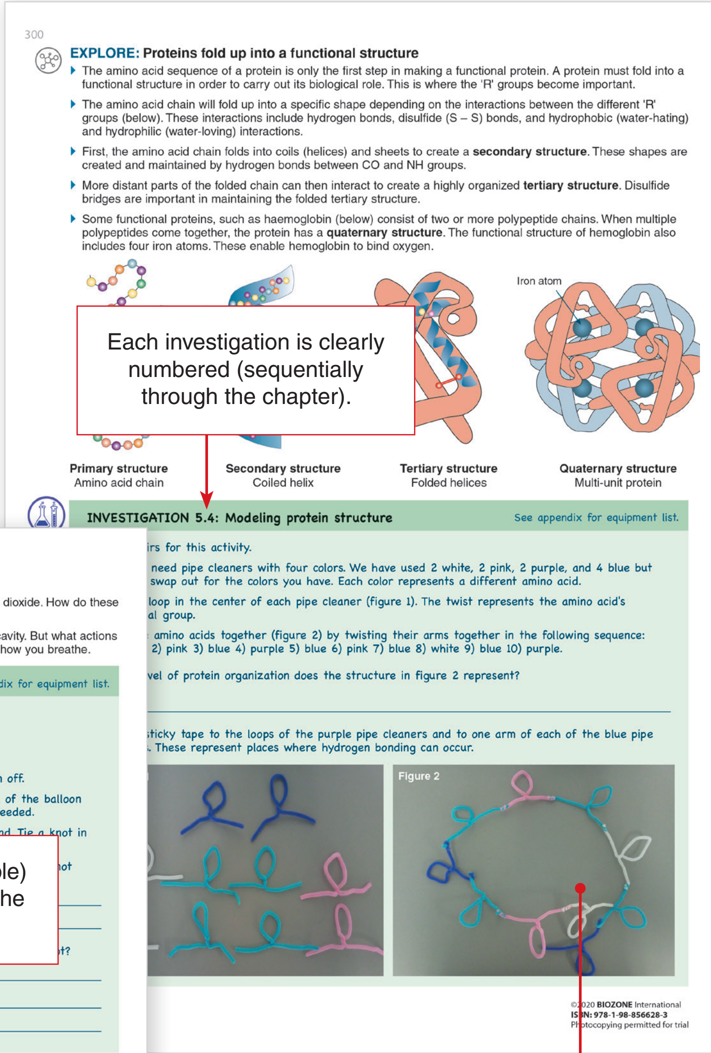
A red flag beside a section or question indicates that students may need some extra guidance from the teacher. These are also identified in the extended contents (CG3-CG6).

Practical Investigations

Throughout *The Living Earth*, students are given opportunities to explore phenomena through simple experiments. These **investigative phenomena** are opportunities for students to develop competency in laboratory procedures, to practice and refine skills in observation and analysis, and to manipulate data. Some investigations act as stimulus material while others require students to take what they have already learned and apply their knowledge to a more complex scenario.

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 English language learners to interact in meaningful ways to extend their English language and scientific vocabulary.

- 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.
- A list of the equipment and chemicals required for each investigation is provided in the appendix.
- Only standard equipment is used. No special kits are required.


300

EXPLORE: Proteins fold up into a functional structure

- The amino acid sequence of a protein is only the first step in making a functional protein. A protein must fold into a functional structure in order to carry out its biological role. This is where the 'R' groups become important.
- The amino acid chain will fold up into a specific shape depending on the interactions between the different 'R' groups (below). These interactions include hydrogen bonds, disulfide (S – S) bonds, and hydrophobic (water-hating) and hydrophilic (water-loving) interactions.
- First, the amino acid chain folds into coils (helices) and sheets to create a **secondary structure**. These shapes are created and maintained by hydrogen bonds between CO and NH groups.
- More distant parts of the folded chain can then interact to create a highly organized **tertiary structure**. Disulfide bridges are important in maintaining the folded tertiary structure.
- Some functional proteins, such as haemoglobin (below) consist of two or more polypeptide chains. When multiple polypeptides come together, the protein has a **quaternary structure**. The functional structure of hemoglobin also includes four iron atoms. These enable hemoglobin to bind oxygen.

INVESTIGATION 5.4: Modeling protein structure See appendix for equipment list.

...irs for this activity.

...need pipe cleaners with four colors. We have used 2 white, 2 pink, 2 purple, and 4 blue but swap out for the colors you have. Each color represents a different amino acid.

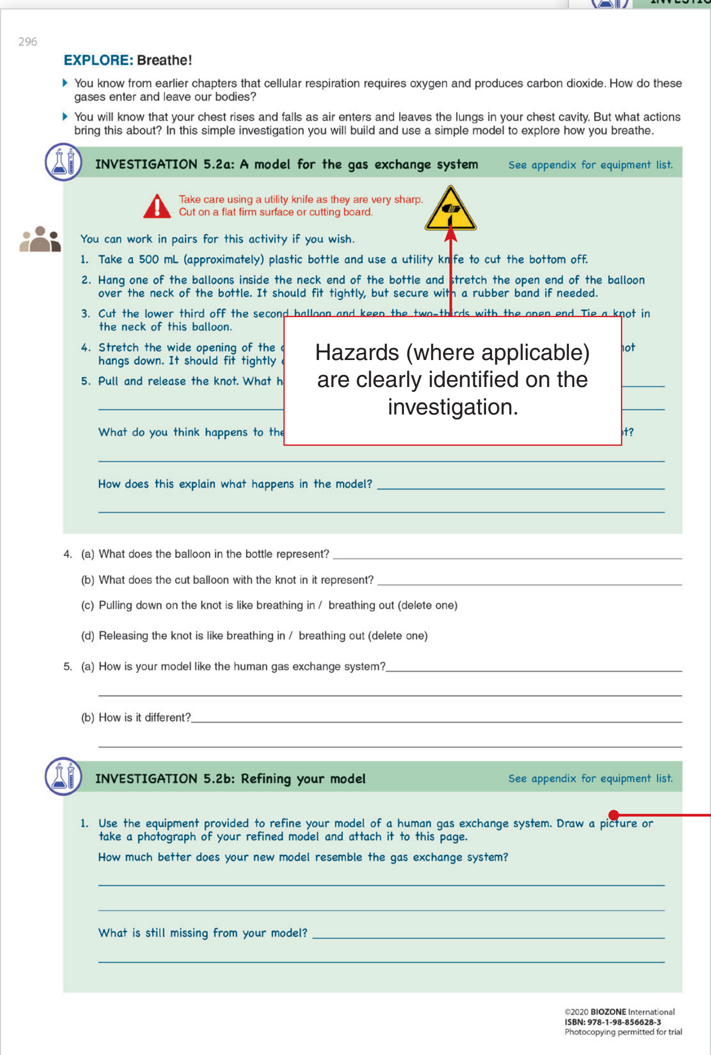
...loop in the center of each pipe cleaner (figure 1). The twist represents the amino acid's ...al group.

...amino acids together (figure 2) by twisting their arms together in the following sequence: ...2) pink 3) blue 4) purple 5) blue 6) pink 7) blue 8) white 9) blue 10) purple.

...vel of protein organization does the structure in figure 2 represent?

...sticky tape to the loops of the purple pipe cleaners and to one arm of each of the blue pipe... These represent places where hydrogen bonding can occur.

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


296

EXPLORE: Breathe!

- You know from earlier chapters that cellular respiration requires oxygen and produces carbon dioxide. How do these gases enter and leave our bodies?
- You will know that your chest rises and falls as air enters and leaves the lungs in your chest cavity. But what actions bring this about? In this simple investigation you will build and use a simple model to explore how you breathe.

INVESTIGATION 5.2a: A model for the gas exchange system See appendix for equipment list.

Take care using a utility knife as they are very sharp. Cut on a flat firm surface or cutting board.

You can work in pairs for this activity if you wish.

1. Take a 500 mL (approximately) plastic bottle and use a utility knife to cut the bottom off.
2. Hang one of the balloons inside the neck end of the bottle and stretch the open end of the balloon over the neck of the bottle. It should fit tightly, but secure with a rubber band if needed.
3. Cut the lower third off the second balloon and keep the two-thirds with the open end. Tie a knot in the neck of this balloon.
4. Stretch the wide opening of the ... hangs down. It should fit tightly ...
5. Pull and release the knot. What h...

What do you think happens to the ...

How does this explain what happens in the model? ___

4. (a) What does the balloon in the bottle represent? ___
   (b) What does the cut balloon with the knot in it represent? ___
   (c) Pulling down on the knot is like breathing in / breathing out (delete one)
   (d) Releasing the knot is like breathing in / breathing out (delete one)
5. (a) How is your model like the human gas exchange system? ___
   (b) How is it different? ___

INVESTIGATION 5.2b: Refining your model See appendix for equipment list.

1. Use the equipment provided to refine your model of a human gas exchange system. Draw a picture or take a photograph of your refined model and attach it to this page.

How much better does your new model resemble the gas exchange system?

What is still missing from your model? ___

Hazards (where applicable) are clearly identified on the investigation.

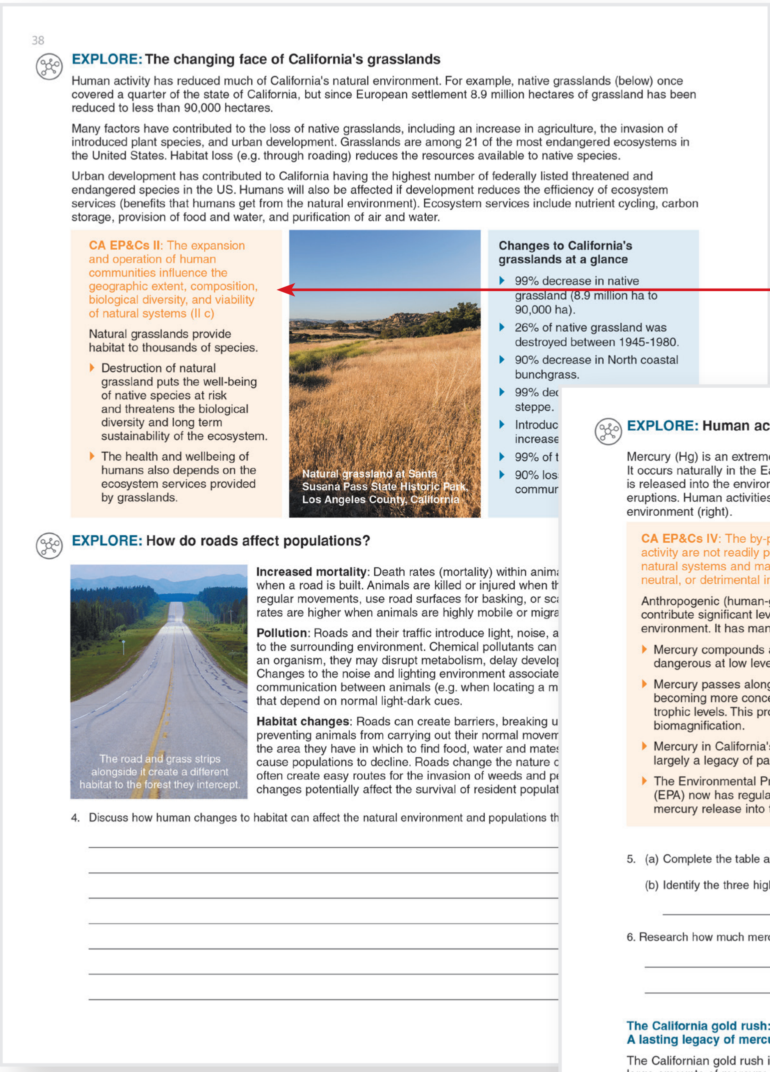
The investigations have been designed using everyday materials and equipment easily found in most high school laboratories. **No special kits are required.**

California Environmental Principles and Concepts

The California Environmental Principles and Concepts (EP&Cs) have been incorporated into *The Living Earth* to address environmental literacy. This is in accordance with the requirements of the California Education and the Environment Initiative (EEI). Within *The Living Earth*, the EP&Cs material provides examples and context for students to study the relationship between humans and the natural world.

Activities containing EP&Cs are easily identified in *The Living Earth*.

- In the Teacher's Edition (and Teacher's Digital Edition) the EP&Cs are identified in the chapter front in orange. In the first example below, students investigate how the by-products of human activity can affect the environment. The specific focus is the effect of mercury on the environment *[EP&Cs: IV]*. In the second example, students investigate the impact of an invasive species (Kudzu) on an ecosystem *[EP&Cs: V]* and look at how the introduction of new species is managed now to mitigate negative effects.
- **Orange** boxes within specific activities clearly identify where EP&Cs are covered (see below).
- The specific EP&C code (e.g. EP&C V) is identified on the page so you know exactly which principle is being covered.



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EXPLORE: The changing face of California's grasslands

Human activity has reduced much of California's natural environment. For example, native grasslands (below) once covered a quarter of the state of California, but since European settlement 8.9 million hectares of grassland has been reduced to less than 90,000 hectares.

Many factors have contributed to the loss of native grasslands, including an increase in agriculture, the invasion of introduced plant species, and urban development. Grasslands are among 21 of the most endangered ecosystems in the United States. Habitat loss (e.g. through roading) reduces the resources available to native species.

Urban development has contributed to California having the highest number of federally listed threatened and endangered species in the US. Humans will also be affected if development reduces the efficiency of ecosystem services (benefits that humans get from the natural environment). Ecosystem services include nutrient cycling, carbon storage, provision of food and water, and purification of air and water.

CA EP&Cs II: The expansion and operation of human communities influence the geographic extent, composition, biological diversity, and viability of natural systems (II c)

Natural grasslands provide habitat to thousands of species.

- Destruction of natural grassland puts the well-being of native species at risk and threatens the biological diversity and long term sustainability of the ecosystem.
- The health and wellbeing of humans also depends on the ecosystem services provided by grasslands.

Natural grassland at Santa Susana Pass State Historic Park, Los Angeles County, California

Changes to California's grasslands at a glance

- 99% decrease in native grassland (8.9 million ha to 90,000 ha).
- 26% of native grassland was destroyed between 1945-1980.
- 90% decrease in North coastal bunchgrass.
- 99% dec… steppe.
- Introduc… increase…
- 99% of t…
- 90% los… commun…

EXPLORE: How do roads affect populations?

The road and grass strips alongside it create a different habitat to the forest they intercept.

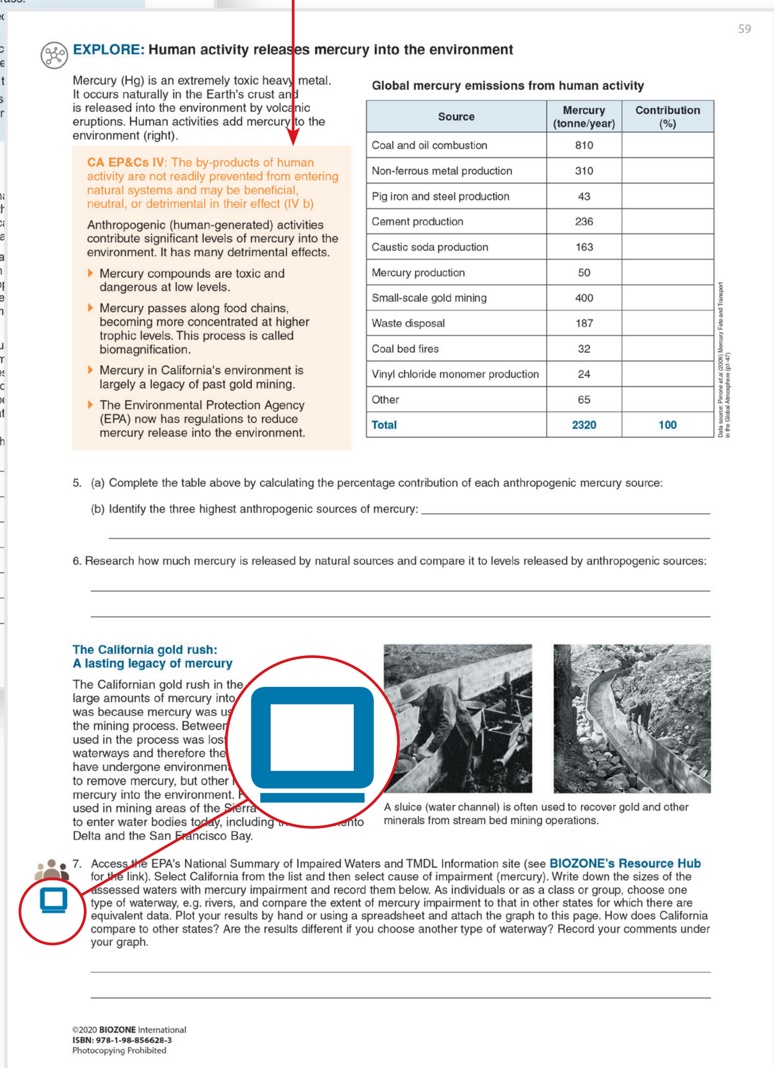
Increased mortality: Death rates (mortality) within anima… when a road is built. Animals are killed or injured when th… regular movements, use road surfaces for basking, or sca… rates are higher when animals are highly mobile or migra…

Pollution: Roads and their traffic introduce light, noise, a… to the surrounding environment. Chemical pollutants can… an organism, they may disrupt metabolism, delay develop… Changes to the noise and lighting environment associate… communication between animals (e.g. when locating a m… that depend on normal light-dark cues.

Habitat changes: Roads can create barriers, breaking u… preventing animals from carrying out their normal moven… the area they have in which to find food, water and mates… cause populations to decline. Roads change the nature o… often create easy routes for the invasion of weeds and pe… changes potentially affect the survival of resident populat…

4. Discuss how human changes to habitat can affect the natural environment and populations th…

The specific EP&C is clearly identified on the page. Points relevant to the content are outlined beneath the EP&C statement.



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EXPLORE: Human activity releases mercury into the environment

Mercury (Hg) is an extremely toxic heavy metal. It occurs naturally in the Earth's crust and is released into the environment by volcanic eruptions. Human activities add mercury to the environment (right).

CA EP&Cs IV: The by-products of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect (IV b)

Anthropogenic (human-generated) activities contribute significant levels of mercury into the environment. It has many detrimental effects.

- Mercury compounds are toxic and dangerous at low levels.
- Mercury passes along food chains, becoming more concentrated at higher trophic levels. This process is called biomagnification.
- Mercury in California's environment is largely a legacy of past gold mining.
- The Environmental Protection Agency (EPA) now has regulations to reduce mercury release into the environment.

Global mercury emissions from human activity

Source	Mercury (tonne/year)	Contribution (%)
Coal and oil combustion	810	
Non-ferrous metal production	310	
Pig iron and steel production	43	
Cement production	236	
Caustic soda production	163	
Mercury production	50	
Small-scale gold mining	400	
Waste disposal	187	
Coal bed fires	32	
Vinyl chloride monomer production	24	
Other	65	
Total	**2320**	**100**

5. (a) Complete the table above by calculating the percentage contribution of each anthropogenic mercury source:
(b) Identify the three highest anthropogenic sources of mercury:

6. Research how much mercury is released by natural sources and compare it to levels released by anthropogenic sources:

The California gold rush: A lasting legacy of mercury

The Californian gold rush in the… large amounts of mercury into… was because mercury was us… the mining process. Between… used in the process was lost… waterways and therefore the… have undergone environmen… to remove mercury, but other… mercury into the environment. … used in mining areas of the Sierra… to enter water bodies today, including… Delta and the San Francisco Bay.

A sluice (water channel) is often used to recover gold and other minerals from stream bed mining operations.

7. Access the EPA's National Summary of Impaired Waters and TMDL Information site (see **BIOZONE's Resource Hub** for the link). Select California from the list and then select cause of impairment (mercury). Write down the sizes of the assessed waters with mercury impairment and record them below. As individuals or as a class or group, choose one type of waterway, e.g. rivers, and compare the extent of mercury impairment to that in other states for which there are equivalent data. Plot your results by hand or using a spreadsheet and attach the graph to this page. How does California compare to other states? Are the results different if you choose another type of waterway? Record your comments under your graph.

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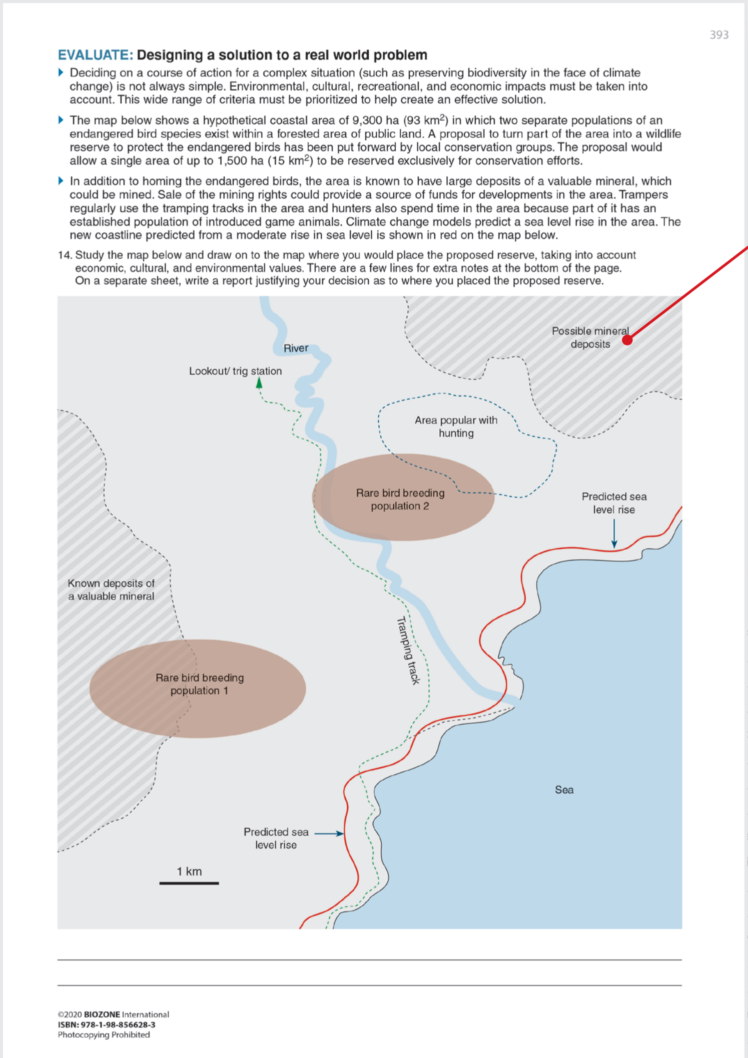
A computer monitor indicates an activity where a device will be needed to carry out part or all of an activity. The activity may require access to online simulations, the interactive spreadsheets on **BIOZONE's Resource Hub**, or specific external websites suggested by BIOZONE as part of a student investigation. Computer models can be used by students to explore, elaborate and evaluate content.

Engineering Design Solutions

ETS SEPs, CCCs, DCIs, and performance expectations as indicated in the CA-NGSS framework are met through appropriately integrated engineering and design challenges. Typically tasks include analyzing problems, developing solutions using engineering, evaluating a design solution based on costs and benefits, or modeling a design solution.

The three dimensions of the NGSS framework appropriate to each design challenge are indicated in the chapter introduction of the Teacher's Edition (and Teacher's Digital Edition) and indicated through the tab system on the activity itself. Such tasks are usually examples of 'ELABORATE' as they involve the students applying what they learned to solve a problem. As such, they also make good tasks for formative or summative assessment.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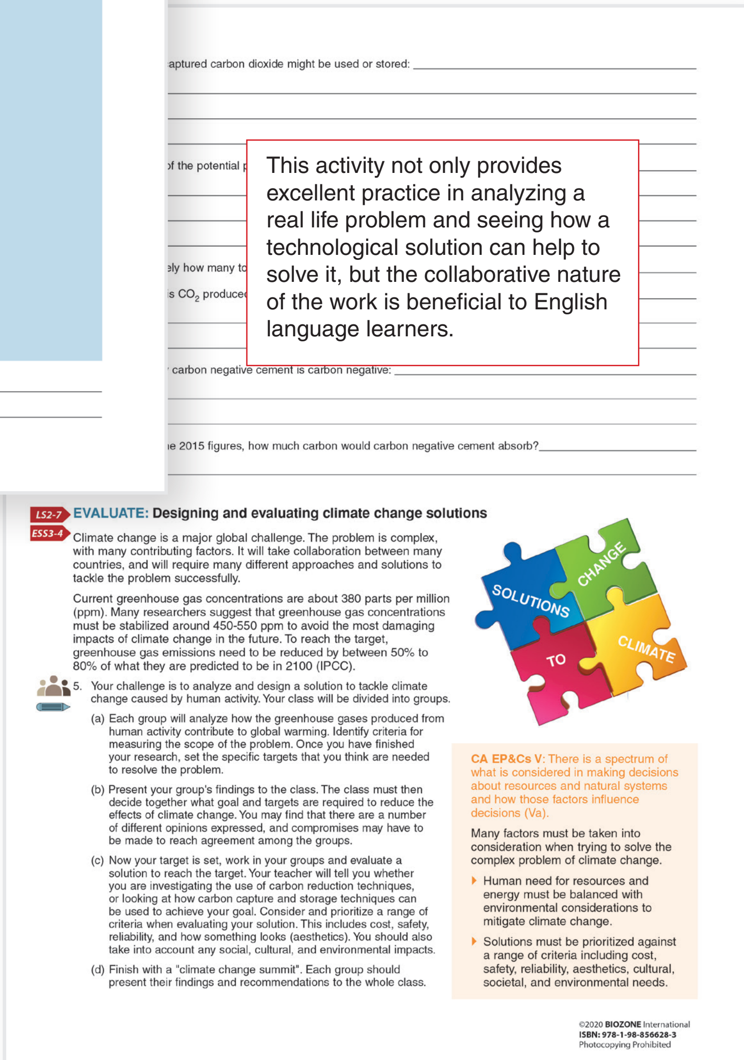
EVALUATE: Designing a solution to a real world problem

- Deciding on a course of action for a complex situation (such as preserving biodiversity in the face of climate change) is not always simple. Environmental, cultural, recreational, and economic impacts must be taken into account. This wide range of criteria must be prioritized to help create an effective solution.
- The map below shows a hypothetical coastal area of 9,300 ha (93 km^2) in which two separate populations of an endangered bird species exist within a forested area of public land. A proposal to turn part of the area into a wildlife reserve to protect the endangered birds has been put forward by local conservation groups. The proposal would allow a single area of up to 1,500 ha (15 km^2) to be reserved exclusively for conservation efforts.
- In addition to homing the endangered birds, the area is known to have large deposits of a valuable mineral, which could be mined. Sale of the mining rights could provide a source of funds for developments in the area. Trampers regularly use the tramping tracks in the area and hunters also spend time in the area because part of it has an established population of introduced game animals. Climate change models predict a sea level rise in the area. The new coastline predicted from a moderate rise in sea level is shown in red on the map below.

14. Study the map below and draw on to the map where you would place the proposed reserve, taking into account economic, cultural, and environmental values. There are a few lines for extra notes at the bottom of the page. On a separate sheet, write a report justifying your decision as to where you placed the proposed reserve.

In this ETS example, students decide where to locate a new reserve to protect an endangered bird species. However, the area is also rich in coal deposits. When making their decision students must take into consideration the needs of society (the benefits to be gained by mining a coal deposit), recreational value (tramping), and changing environmental conditions (sea level rise). Once they have decided, they must justify their decision to convince others the right choice has been made.


...aptured carbon dioxide might be used or stored:

...of the potential...

...ely how many to...

...s CO_2 produce...

...carbon negative cement is carbon negative:

...e 2015 figures, how much carbon would carbon negative cement absorb?

LS2-7 ESS3-4 **EVALUATE: Designing and evaluating climate change solutions**

Climate change is a major global challenge. The problem is complex, with many contributing factors. It will take collaboration between many countries, and will require many different approaches and solutions to tackle the problem successfully.

Current greenhouse gas concentrations are about 380 parts per million (ppm). Many researchers suggest that greenhouse gas concentrations must be stabilized around 450-550 ppm to avoid the most damaging impacts of climate change in the future. To reach the target, greenhouse gas emissions need to be reduced by between 50% to 80% of what they are predicted to be in 2100 (IPCC).

5. Your challenge is to analyze and design a solution to tackle climate change caused by human activity. Your class will be divided into groups.
   (a) Each group will analyze how the greenhouse gases produced from human activity contribute to global warming. Identify criteria for measuring the scope of the problem. Once you have finished your research, set the specific targets that you think are needed to resolve the problem.
   (b) Present your group's findings to the class. The class must then decide together what goal and targets are required to reduce the effects of climate change. You may find that there are a number of different opinions expressed, and compromises may have to be made to reach agreement among the groups.
   (c) Now your target is set, work in your groups and evaluate a solution to reach the target. Your teacher will tell you whether you are investigating the use of carbon reduction techniques, or looking at how carbon capture and storage techniques can be used to achieve your goal. Consider and prioritize a range of criteria when evaluating your solution. This includes cost, safety, reliability, and how something looks (aesthetics). You should also take into account any social, cultural, and environmental impacts.
   (d) Finish with a "climate change summit". Each group should present their findings and recommendations to the whole class.

CA EP&Cs V: There is a spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions (Va).

Many factors must be taken into consideration when trying to solve the complex problem of climate change.

- Human need for resources and energy must be balanced with environmental considerations to mitigate climate change.
- Solutions must be prioritized against a range of criteria including cost, safety, reliability, aesthetics, cultural, societal, and environmental needs.

This activity not only provides excellent practice in analyzing a real life problem and seeing how a technological solution can help to solve it, but the collaborative nature of the work is beneficial to English language learners.

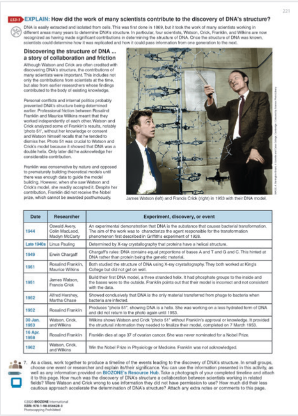
Students have previously investigated climate change and some solutions to reduce its effects. In this ETS example, they put this knowledge to use by designing solutions to mitigate the effects of human-induced climate change. The students hold a climate summit to set targets and goals, then work in groups to investigate a variety of solutions to see how the goals can be achieved. Factors they must consider include cost, safety, and reliability, plus social, cultural and environmental considerations.

The activity provides an excellent example of how ETS can be linked to achieve CA EP&Cs outcomes.

The Nature of Science

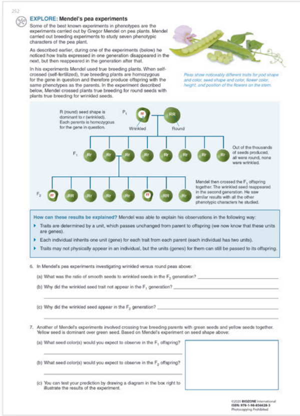
The Nature of Science combines established information with new knowledge to constantly refine what we know about the natural world. Eight Nature of Science understandings are presented in the NGSS document. Four are associated most closely with Science and Engineering Practices, and four with the Crosscutting Concepts. Because the Nature of Science understandings have been incorporated into most activities in the *The Living Earth*, we have not identified them specifically on the activity page. Some examples of activities relating to the eight Nature of Science understandings are illustrated below. The subheading to which they relate is also given.

Nature of science understandings most closely associated with science and engineering practices



Scientific investigations use a variety of methods.

- Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge



Scientific knowledge is based on empirical evidence.

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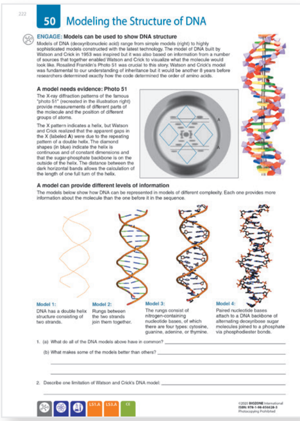
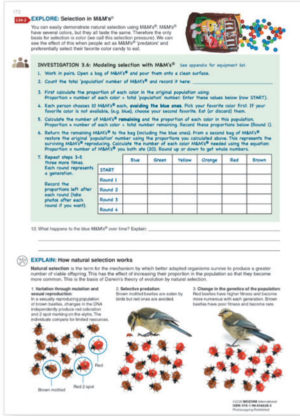


Scientific knowledge is open to revision in light of new evidence.

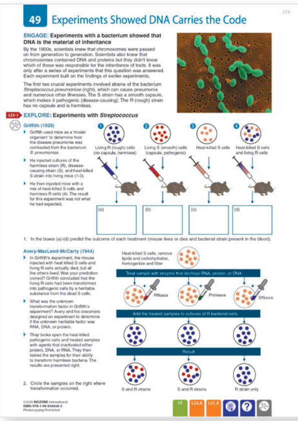
- Most scientific knowledge is quite durable but is subject to change based on new evidence and/or reinterpretations of existing evidence.



Science models, laws, mechanisms, and theories explain natural phenomena.

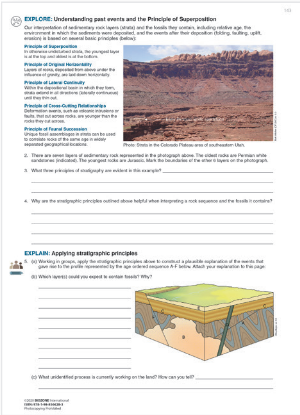
- Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory.

Nature of science understandings most closely associated with crosscutting concepts



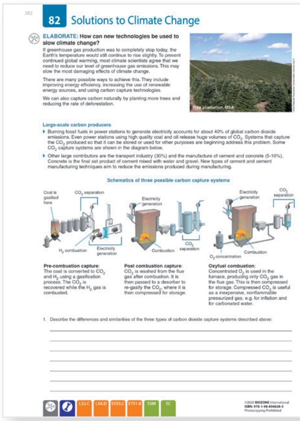
Science is a way of knowing.

- Scientific knowledge has a history that includes refinement of, and changes to, theories, ideas, and beliefs over time.



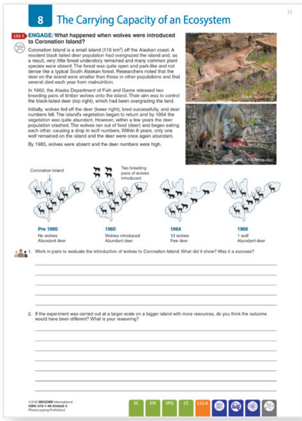
Scientific knowledge assumes an order and consistency in natural systems.

- Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and will continue to do so in the future.



Science is a human endeavor.

- Technological advances have influenced the progress of science and science has influenced advances in technology.



Science addresses questions about the natural and material world.

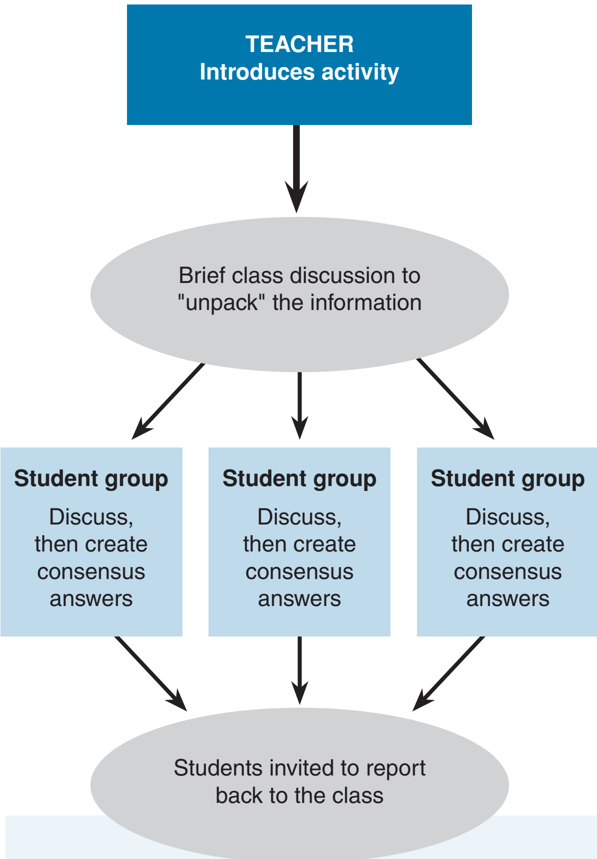
- Scientific knowledge indicates what can happen in natural systems - not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge.

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 *The Living Earth* 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.
- 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 paper 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.

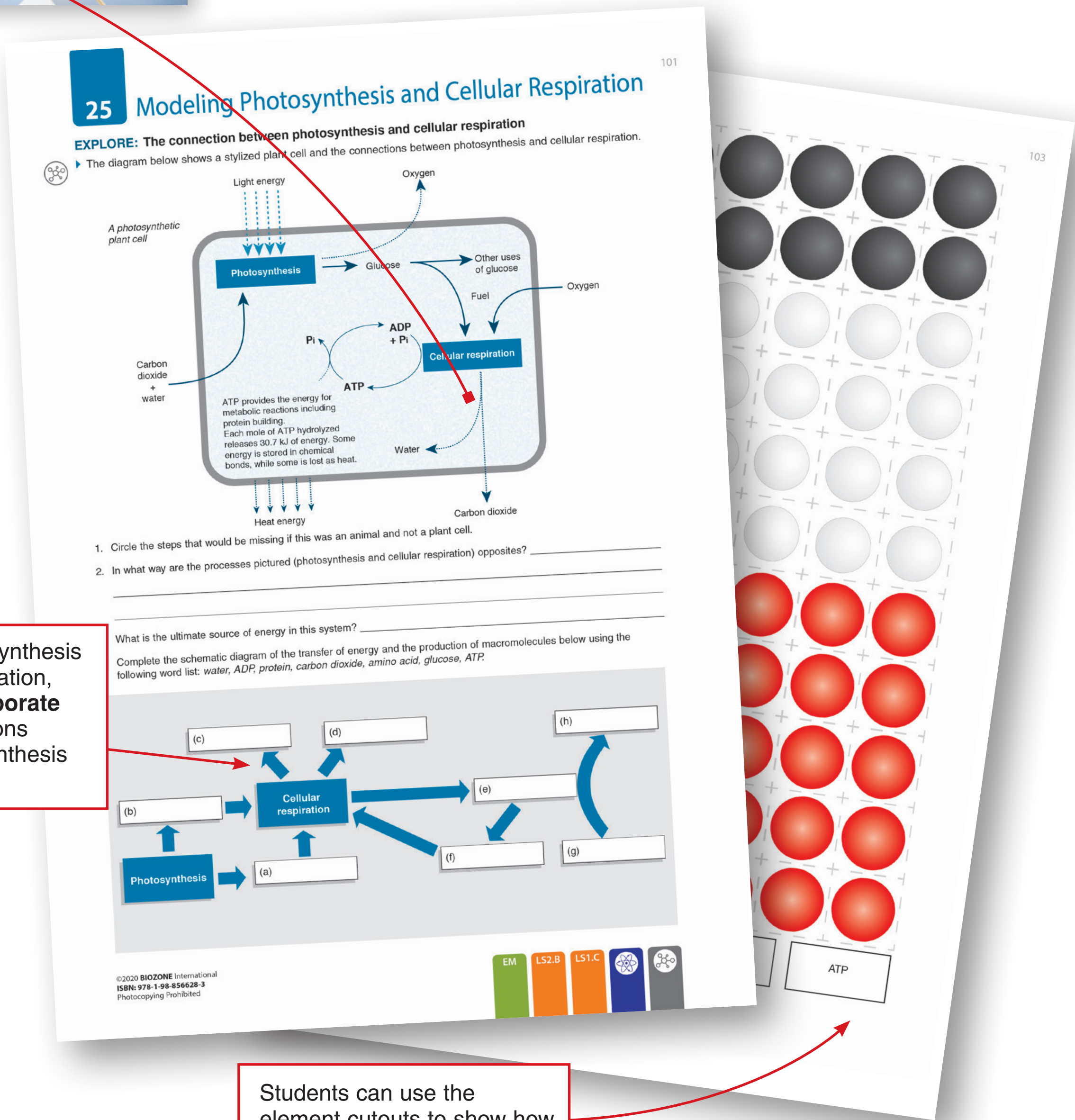
Students work in small groups so everyone's contribution is heard. They collaborate, share ideas, and engage in discourse. The emphasis is on discussing questions and formulating a consensus answer, not just sharing ideas.

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

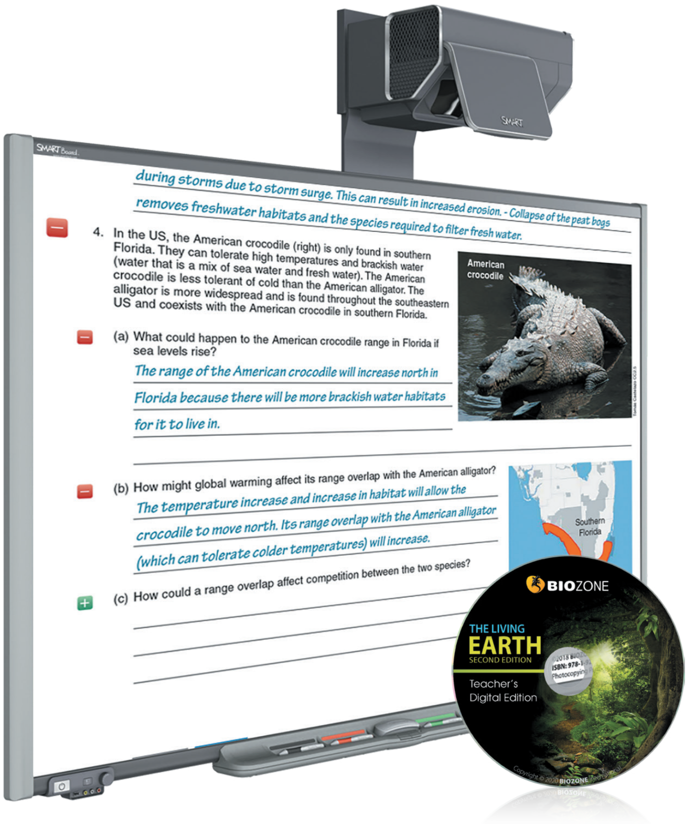
- **Peer-to-peer learning** can be used for any activities, but is particularly valuable for more challenging activities in which the content is more complex or the questions require students to draw on several areas of their knowledge to synthesize an answer. Examples of such activities include modeling activities, activities with a design component, or activities involving data analysis, graphing, and evaluation.
- Stronger peers can assist weaker students and both groups benefit from verbalizing their thoughts and presenting them to a group. Students for whom English is a second language can ask their peers to explain unfamiliar terms (both scientific and English) and this benefits both parties.

Paper practicals (Included in the activities *Modeling Photosynthesis and Respiration, Natural Selection*, *Continental Drift, Modeling the Structure of DNA, Sexual Reproduction Produces Genetic Variation*) are an ideal vehicle for this kind of peer-to-peer learning. They are not only enjoyable, but they prompt students to ask questions and think about how they could use the model to answer those questions. There are also opportunities to collaborate on online and paper simulations (e.g. **Populus**).



In Modeling Photosynthesis and Cellular Respiration, students can **collaborate** to model the reactions involved in photosynthesis and respiration.

Students can use the element cutouts to show how matter moves through the system, and how products and by-products form.



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 (see opposite).
- 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.

NGSS as collaboration and discovery

- BIOZONE's The Living Earth provides multiple chances for collaboration and discovery. By working together and sharing ideas, students are exposed to different perspectives and levels of knowledge about a particular phenomenon.
- NGSS requires deeper student engagement with less emphasis on facts and more on understanding. By exploring principles and concepts within a context students are more easily able to apply these principles to new phenomena.
- BIOZONE's The Living Earth uses the CA NGSS as a framework to develop student understanding by providing a range of activities. These begin by getting students to think about and share what they already know and then build on this knowledge by providing opportunities to explore and explain phenomena.
- Activities supporting the **ETS Performance Expectations** involve collaboration. In this way, students can discuss possible solutions to engineering problems, and evaluate and refine their own (or existing) solutions.

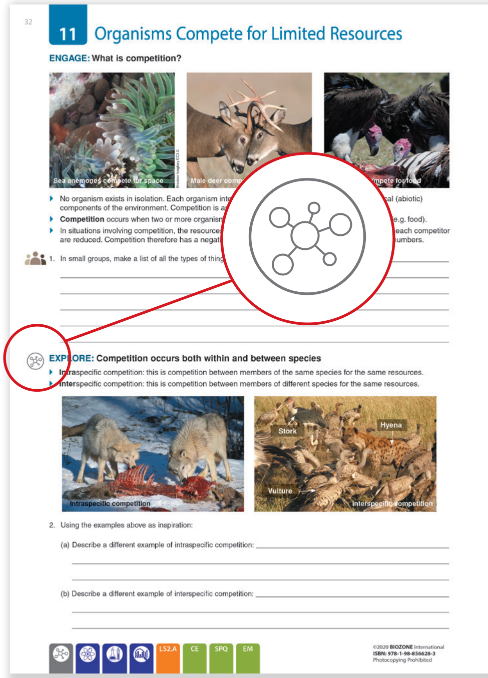
Student A is capable. He helps to lead the discussion and records the others ideas in a structured way.

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.

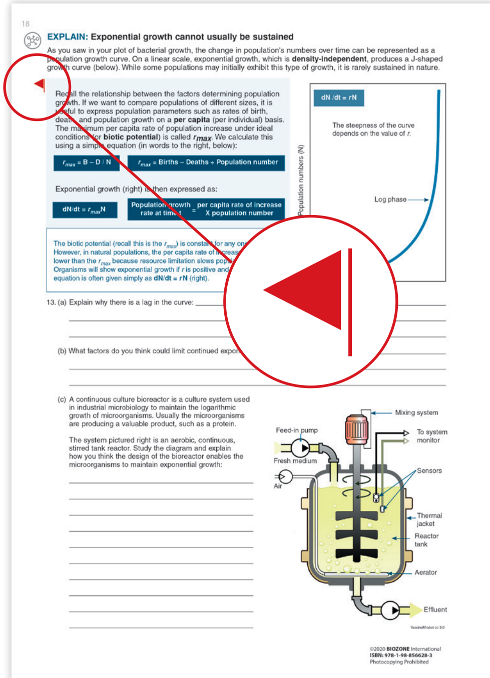
Student D is less able but gains ideas and understanding from the discussion of students A, B, and C. She may add to the discussion as she gains confidence in the material being studied.

Tools for Differentiated Instruction

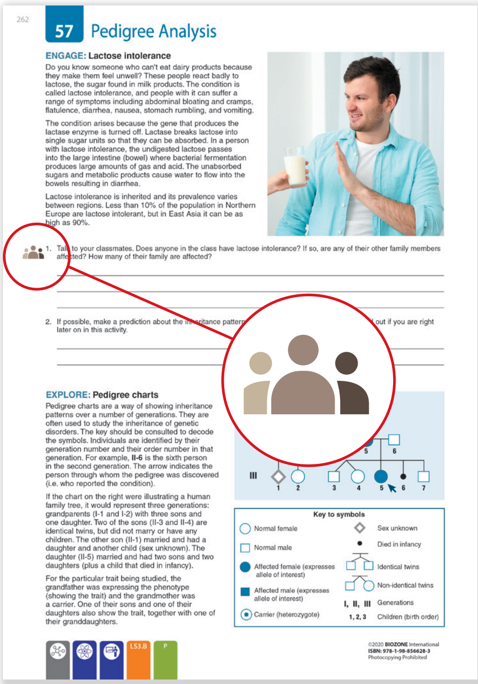
The structure of *The Living Earth* promotes differentiated instruction, and has been designed to cater for students of all abilities. BIOZONE's collaborative approach to science inquiry encourages students of all abilities to share their ideas and knowledge with their peers while at the same time broadening their own understanding of phenomena.
There are several ways you can use *The Living Earth* to implement differentiated instruction in your classroom:



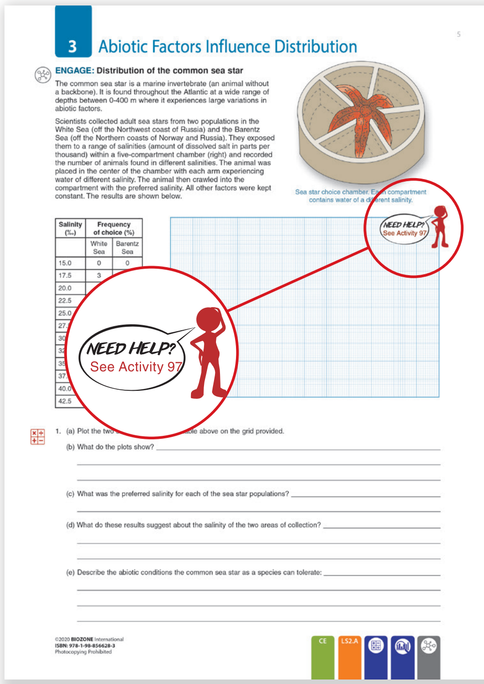
Animations and videos: Use the videos and animations on BIOZONE's Resource Hub to help striving learners with their English language skills and understanding of content. The Resource Hub also provides material tagged for gifted and talented students.



Red flag codes beside a section or question (on the Teacher's Edition or Teacher's Digital Edition) indicate that students may need extra guidance from the teacher to complete them. These questions are also suitable as challenges for more gifted students. Red flag questions are also identified in the extended contents of this guide.



A group symbol indicates where students can work together. Group work provides opportunities for student collaboration and peer-to-peer support to explore and explain phenomena. Working in groups, students can experience the benefits of collaboration in the scientific process of discovery. English language skills and scientific vocabulary are extended when students discuss and listen.



A red figure with a NEED HELP? icon helps students identify where they can go to get help with a specific skill. Skills and tips for computation, data analysis, plotting, statistical analysis, and aspects of experimental design are provided in the Basic Skills 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.

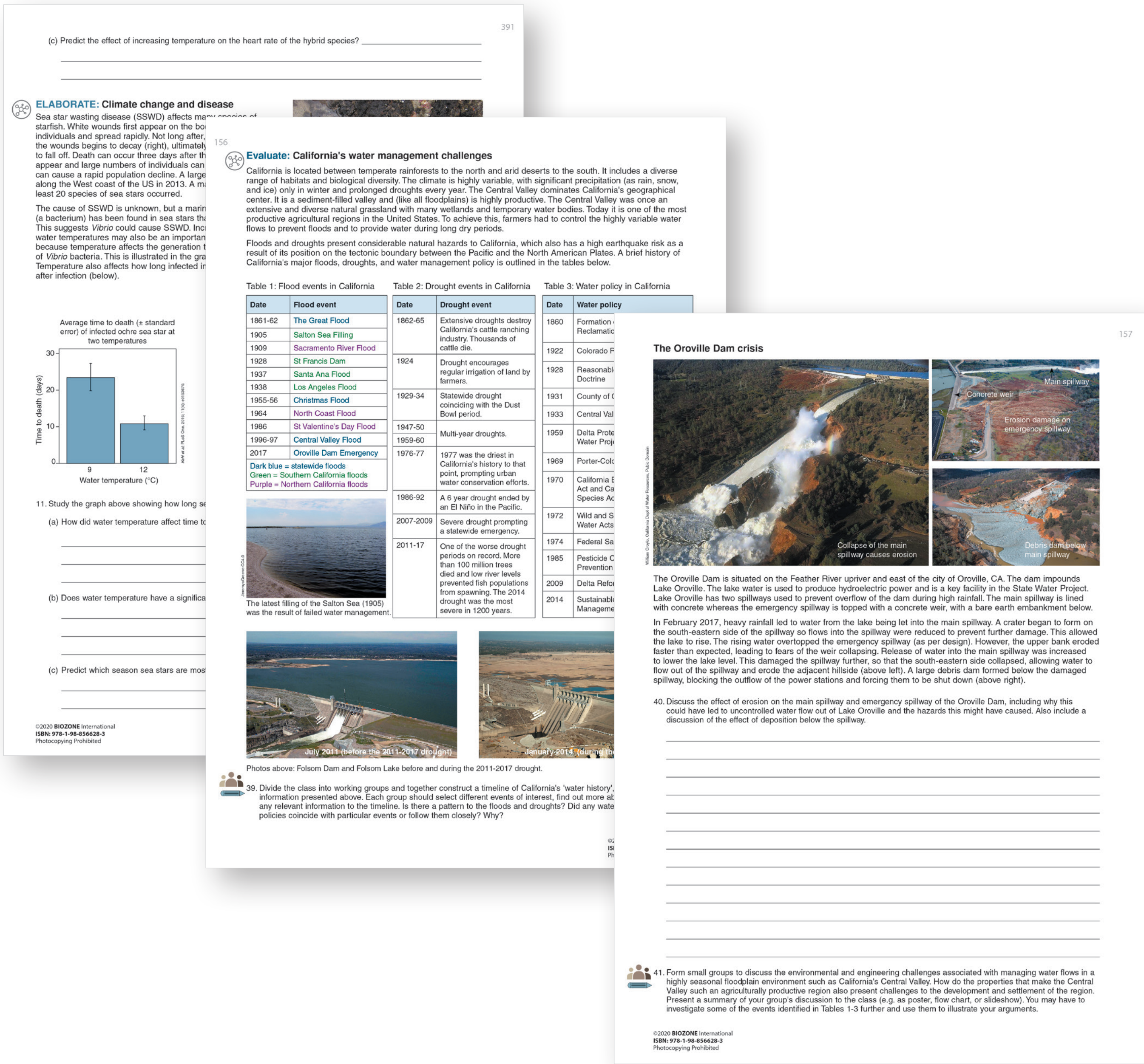
Formative and Summative Assessment

The Living Earth provides ample opportunity for students to demonstrate their understanding and proficiency in all three dimensions of the standards. Opportunities for both formative and summative and assessment are provided.

As this series has been written specifically for the CA-NGSS Three Course Model, all activities (including assessments) are three-dimensional in their approach, with the goal to enable achievement of specific performance expectations. Performance expectations (PE) are not always met through completion of one activity or assessment, but through completion of a connected suite of tasks (as intended by the framework).

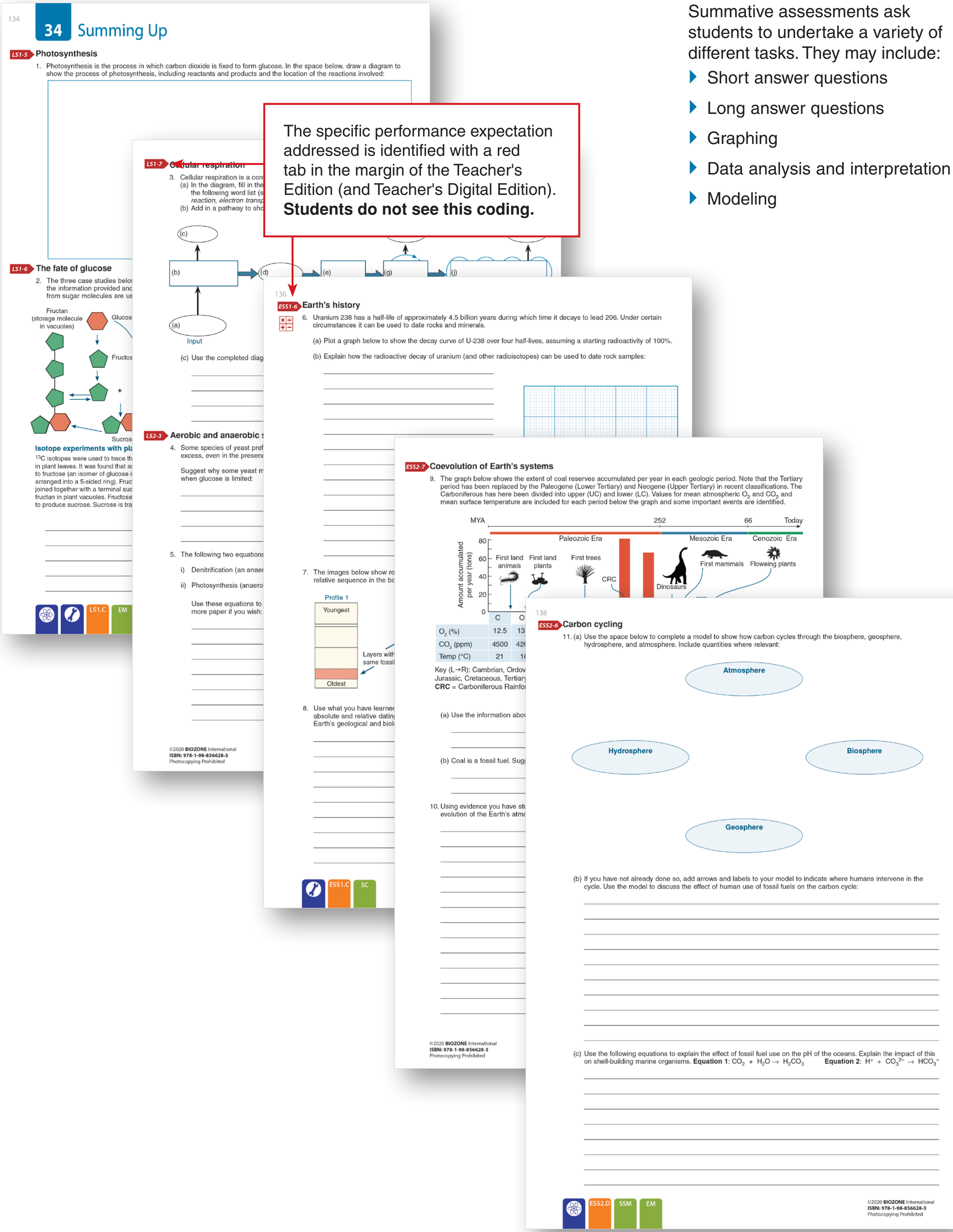
Assessments involve a variety of tasks as appropriate to a 3D approach, e.g., constructing models, analyzing and interpreting data, explaining, and communicating understanding through short and long answers, drawings, calculations, group work, design, and problem solving. The structure of the tasks is such that students use specific science and engineering practices and apply relevant crosscutting concepts to demonstrate their understanding of disciplinary core ideas.

Formative assessments can be chosen by the teacher to determine how a student's knowledge is progressing within a selected topic. We suggest that 'ELABORATE' and 'EVALUATE' sections of activities be used for formative assessment. These may incorporate some aspect of a performance expectation with the goal being to build confidence. Teachers can revise their instruction, revisit material, or set further tasks if a student is having difficulty with the material. Revisiting the Anchoring Phenomenon near the end of each instructional segment also provides a way to evaluate student understanding.



Summing up tasks at the close of each instructional segment can be used as a formal summative testing moment to evaluate student skills, understanding, and application of knowledge. These tasks are designed to meet part or all of one or more performance expectations. Material to address specific performance expectations is identified with a red tab in the margin throughout the Teacher's Edition. Performance expectations are also identified in the chapter introduction for the instructional segment, and in the tables summarizing BIOZONE's 3D approach by chapter earlier in this guide.

Note: All coding associated with assessment is hidden from the student and is available only in teacher's materials.

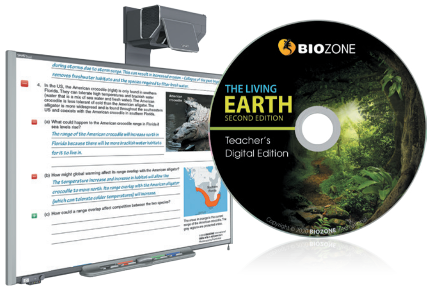


Summative assessments ask students to undertake a variety of different tasks. They may include:

- Short answer questions
- Long answer questions
- Graphing
- Data analysis and interpretation
- Modeling

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.



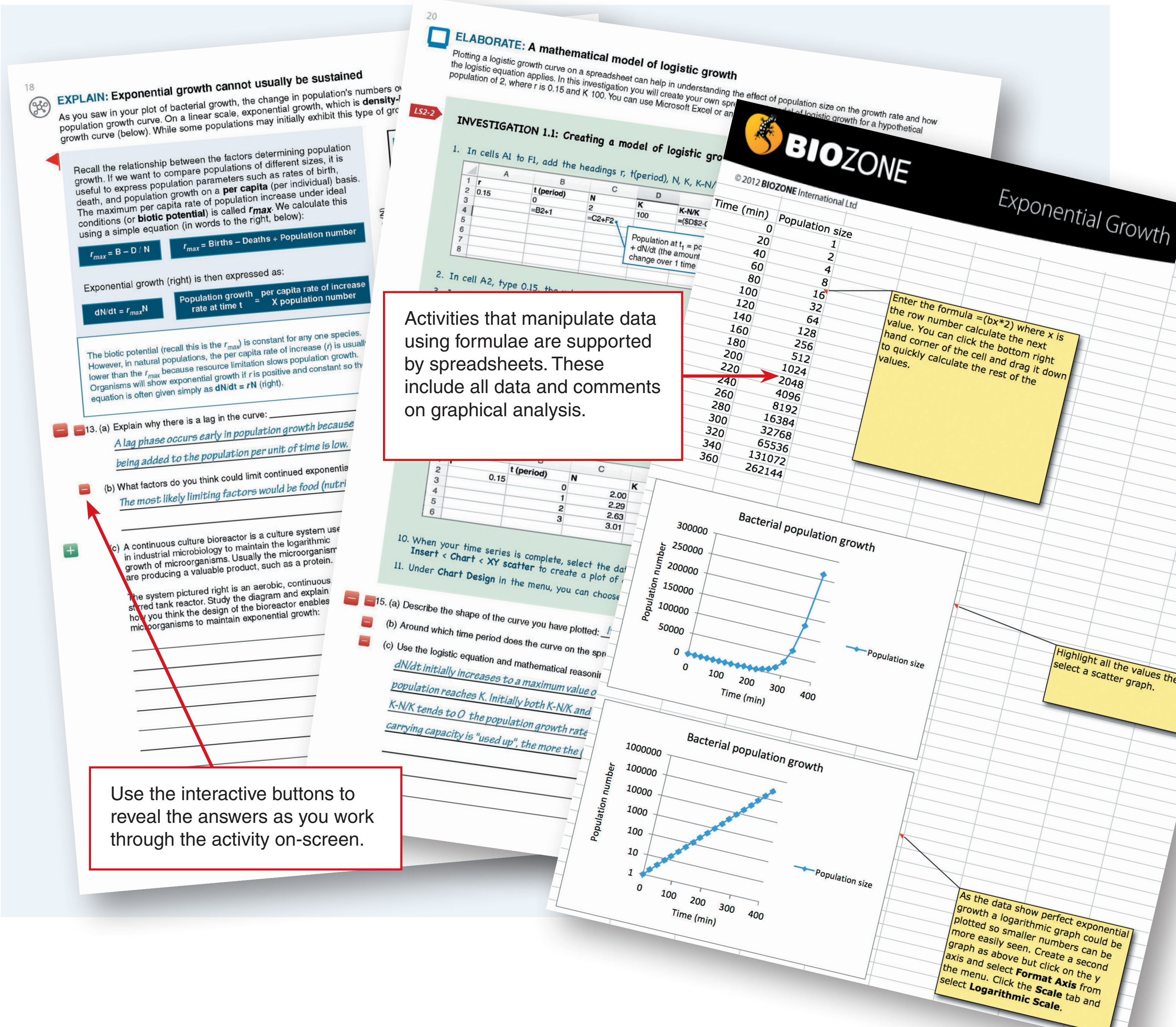
The **Classroom Guide** is provided as a printable PDF.

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 sample of Presentation Media from IS1: Ecosystem Interactions and Energy is included. It is fully editable.



Activities that manipulate data using formulae 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.