PhD Science® K–5 Curriculum Correlation to Arizona Science Standards

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PhD Science® Correlation to Arizona Science Standards: Level K

The *PhD Science* K–2 curriculum aligns with the Kindergarten Arizona Science Standards. A detailed analysis of alignment appears in the table below.

Key: Module (M), Lesson (L)

Kindergarten Standards

Physical Science		**Aligned *PhD Science* Lessons**
K.P2U1.1	Investigate how senses can detect light, sound, and vibrations even when they come from far away; use the collected evidence to develop and support an explanation.	Level 1 M2 L1–9, 21–23 Level 1 M3 L1–17, 26–29 Level 1 M4 L14–16
K.P2U2.2	Design and evaluate a tool that helps people extend their senses.	Level 1 M3 L18–29

Earth and Space Science		**Aligned *PhD Science* Lessons**
K.E1U1.3	Observe, record, and ask questions about temperature, precipitation, and other weather data to identify patterns or changes in local weather.	Level K M1 L1–11, 17–24, 28–30 Level K M4 L25
K.E1U1.4	Observe, describe, ask questions, and predict seasonal weather patterns; and how those patterns impact plants and animals (including humans).	Level K M1 L1–11, 17–24, 28–30 Level K M4 L25
K.E2U1.5	Observe and ask questions about patterns of the motion of the sun, moon, and stars in the sky.	Level 1 M4 L1–8, 14–25

Life Science		**Aligned *PhD Science* Lessons**
K.L1U1.6	Obtain, evaluate, and communicate information about how organisms use different body parts for survival.	Level 1 M1 L1–15, 27–29
K.L1U1.7	Observe, ask questions, and explain how specialized structures found on a variety of plants and animals (including humans) help them sense and respond to their environment.	Level 1 M1 L16–21, 27–29
K.L2U1.8	Observe, ask questions, and explain the differences between the characteristics of living and nonliving things.	Level 2 M4 L1–10

Core Ideas for Knowing Science

Physical Science

P2	Objects can affect other objects at a distance.	Aligned PhD Science Lessons
K.P2U1.1	People use their senses to learn about the world around them. Their eyes detect light, their ears detect sound, and they can feel vibrations by touch.	Level 1 M2 L1–9, 21–23 Level 1 M3 L1–17, 26–29 Level 1 M4 L14–16
K.P2U2.2	People use their senses to learn about the world around them. Their eyes detect light, their ears detect sound, and they can feel vibrations by touch.	Level 1 M2 L1–9, 21–23 Level 1 M3 L1–17, 26–29 Level 1 M4 L14–16
	People also use a variety of devices to communicate (send and receive information) over long distances.	Level 1 M3 L18–29

Earth and Space Science

E1	The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.	Aligned PhD Science Lessons
K.E1U1.3	Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.	Level K M1 L1–11, 17–24, 28–30 Level K M4 L25
	Weather is determined by the conditions and movement of the air.	Level K M1 L1–11, 17–24, 28–30
K.E1U1.4	Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.	Level K M1 L1–11, 17–24, 28–30 Level K M4 L25

E2	The Earth and our solar system are a very small part of one of many galaxies within the Universe.	Aligned PhD Science Lessons
K.E2U1.5	Patterns of the motion of the Sun, Moon, and stars can be observed, described, and predicted.	Level 1 M4 L1–8, 14–25

Life Science

L1	Organisms are organized on a cellular basis and have a finite life span.	Aligned PhD Science Lessons
K.L1U1.6	All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive, grow, and produce more plants.	Level 1 M1 L1–15, 27–29
K.L1U1.7	All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water, and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive, grow, and produce more plants.	Level 1 M1 L1–15, 27–29
	Animals have body parts that capture and convey different kinds of information needed for growth and survival—for example, eyes for light, ears for sounds, and skin for temperature or touch. Animals respond to these inputs with behaviors that help them survive.	Level 1 M1 L16–21, 27–29

L2	Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.	Aligned PhD Science Lessons
K.L2U1.8	There is a wide variety of living things, including plants and animals. They are distinguished from nonliving things by their ability to move, reproduce, and react to certain stimuli.	Level 2 M4 L1–10

Core Ideas for Using Science

U1	Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.	Aligned *PhD Science* Lessons
	Science investigations begin with a question.	Level K M1 L8–9 Level K M4 L20–24
	Science uses different ways to study the world.	Level K M2 L16
	Scientists look for patterns and order when making observations about the world.	Level K M3 L4–8, 14–16
	Science knowledge can change when new information is found.	Level 1 M3 L15–16 Level 2 M4 L4–6
	Science uses drawings, sketches, and models as a way to communicate ideas.	Level K M4 L1–2
	Science searches for cause and effect relationships to explain natural events.	Level 1 M2 L10–12 Level 2 M2 L10–12
	Science knowledge helps us know about the world.	Level K M2 L4–6, 9 Level K M4 L25
	Science assumes natural events happen today as they happened in the past.	Level K M1 L21
	Many events are repeated.	Level K M1 L17–20
	Scientists study the natural and material world.	Level K M1 L1–2, 12–16, 28–30 Level K M2 L21–23 Level K M3 L27–29 Level K M4 L26–28

U2	**The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.**	**Aligned *PhD Science* Lessons**
	A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions.	Level K M1 L4–7, 12–16 Level K M2 L17–20
	Asking questions, making observations, and gathering information are helpful in thinking about problems.	Level K M1 L12–16
	Before beginning to design a solution, it is important to clearly understand the problem.	Level K M1 L12–16
	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.	Level K M2 L17–20 Level K M4 L20–24
	To design something complicated, one may need to break the problem into parts and attend to each part separately but must then bring the parts together to test the overall plan.	Level K M1 L12–16 Level K M2 L17–20 Level K M4 L18–25
	Because there is always more than one possible solution to a problem, it is useful to compare designs, test them, and discuss their strengths and weaknesses.	Level K M4 L20–24
	Technologies have been created by people to provide the things they need or can use.	Level K M4 L18–19

U3	**Applications of science often have both positive and negative ethical, social, economic, and/or political implications.**	**Aligned *PhD Science* Lessons**
	Every human-made product is designed by applying some knowledge of the natural world and is built by using natural materials.	Level 1 M1 L10–15 Level 2 M2 L14–17 Level 2 M3 L14–18
	Taking natural materials to make things impacts the environment.	Level 2 M2 L8–9
	There are generally both positive and negative consequences of the applications of science.	Level K M4 L11–17
	People depend on various technologies in their lives; human life would be very different without technology.	Level K M4 L18–19

Science and Engineering Practices

Asking Questions and Defining Problems	**Aligned *PhD Science* Lessons**
Ask questions based on observations of the natural and/or designed world.	Level K M1 L1–3, 22–26 Level K M2 L1–3, 9 Level K M3 L1–3, 14–16, 27–29
Define a simple problem that can be solved through the development of a new or improved object or tool.	Level K M1 L4–7, 12–16

Developing and Using Models	**Aligned *PhD Science* Lessons**
Distinguish between a model and the actual object, process, and/or events the model represents.	Level K M1 L1–2, 12–16 Level K M2 L1–3, 10–12
Compare models to identify common features and differences.	Level 1 M1 L11–15 Level 1 M2 L1–3 Level 2 M4 L1–6, 20–21, 23–25
Develop and/or use models (i.e., diagrams, drawings, physical replicas, dioramas, dramatizations, or storyboards) that represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed worlds.	Level K M3 L1–3, 9–12, 19–20 Level K M4 L1–9, 11–16
Develop a simple model that represents a proposed object or tool.	Level K M1 L12–16

Planning and Carrying Out Investigations	Aligned *PhD Science* Lessons
With guidance, design and conduct investigations in collaboration with peers.	Level K M2 L7–8, 10–15 Level K M3 L4–8
Design and conduct investigations collaboratively.	Level 1 M1 L19–20 Level 1 M2 L15–18 Level 2 M2 L8–12 Level 2 M3 L3–7 Level 2 M4 L17–19
Evaluate different ways of observing and/or measuring an attribute of interest.	Level K M4 L3–5
Make direct or indirect observations and/or measurements to collect data, which can be used to make comparisons.	Level K M1 L4–7, 10–11, 17–24, 27–30 Level K M2 L7–8, 16–23 Level K M3 L21
Identify questions and make predictions based on prior experiences.	Level K M2 L13–15 Level K M3 L4–8
Make direct or indirect observations and/or measurements of a proposed object or tool or solution to determine if it solves a problem or meets a goal.	Level K M1 L4–7, 12–20 Level K M2 L17–20

Analyzing and Interpreting Data	Aligned *PhD Science* Lessons
Use and share pictures, drawings, and/or writings of observations.	Level K M2 L7–8 Level K M4 L1–2, 6–7, 10, 14–17, 20–24, 26–28
Use observations to describe patterns and/or relationships in the natural and designed worlds in order to answer scientific questions and solve problems.	Level K M3 L4–8, 14–20, 22–26 Level K M4 L25
Make measurements of length to quantify data	Level 2 M3 L3–6, 14–18, 25–29
Analyze data from tests of an object or tool to determine if a proposed object or tool functions as intended.	Level K M4 L20–24

Using Mathematics and Computational Thinking	Aligned *PhD Science* Lessons
Decide when to use qualitative vs. quantitative data.	Level K M2 L17–20
Use counting and numbers to identify and describe patterns in the natural and designed worlds.	Level K M1 L17–21, 25–30 Level K M2 L17–20
Describe, measure, and compare quantitative attributes of different objects and display the data using simple graphs.	Level 2 M1 L20–22 Level 2 M3 L8–11, 23–29 Level 2 M4 L17–19
Use quantitative data to compare two alternative solutions to a problem.	Level 1 M3 L21–25

Constructing Explanations and Designing Solutions	Aligned *PhD Science* Lessons
Use information from direct or indirect observations to construct explanations.	Level K M3 L4–16, 23–29
Use tools and materials provided to design a device or solution to a specific problem.	Level K M2 L17–20
Distinguish between opinions and evidence in one's own explanations.	Level K M3 L17–18
Generate and compare multiple solutions to a problem.	Level 1 M3 L21–25 Level 2 M2 L8–12, 14–17

Engaging in Argument from Evidence	Aligned *PhD Science* Lessons
Identify arguments that are supported by evidence.	Level K M3 L17–18
Listen actively to others' explanations and arguments and ask questions for clarification.	Level K M3 L17–20 Level K M4 L3–5, 11–13
Make a claim about the effectiveness of an object, tool, or solution that is based on relevant evidence.	Level 1 M3 L8–9, 18–20 Level 2 M3 L14–18, 21–22

Obtaining, Evaluating, and Communicating Information	Aligned *PhD Science* Lessons
Read and comprehend grade-appropriate texts and media to acquire scientific and/or technical information.	Level K M4 L1–2, 6–10, 14–16, 18–19
Critique and/or communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers.	Level K M1 L12–16, 28–30 Level K M2 L21–23 Level K M3 L27–29 Level K M4 L20–24, 26–28
Record observations, thoughts, and ideas.	Level K M1 L4–7, 22–24 Level K M2 L4–6, 21–23 Level K M3 L1–3, 9–16 Level K M4 L14–16
Explain how specific images (e.g., a diagram showing how a machine works) contribute to and clarify a text.	Level 1 M4 L14–18, 23–25 Level 2 M3 L14–18
Obtain information by using various text features (e.g., headings, tables of contents, glossaries, electronic menus, icons).	Level K M3 L23–26

Crosscutting Concepts

1	Patterns	Aligned *PhD Science* Lessons
	Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.	Level K M1 L17–30 Level K M2 L1–6, 17–20 Level K M3 L4–8, 14–20, 22, 26–29 Level K M4 L3–5

2	Cause and Effect	Aligned *PhD Science* Lessons
	Events have causes that generate observable patterns.	Level K M2 L4–16, 21–23 Level K M4 L3–5, 10, 14–19, 26–28
	Simple tests can be designed to gather evidence to support or refute student ideas about causes.	Level K M2 L10–12, 17–20

3	Scale, Proportion, and Quantity	Aligned *PhD Science* Lessons
	Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower).	Level K M1 L1–7, 10–24, 28–30 Level K M2 L7–9, 13–15, 21–23 Level K M3 L1–3 Level K M4 L25
	Standard units are used to measure length.	Level 2 M3 L3–6, 14–18, 25–29

4	Systems and System Models	Aligned *PhD Science* Lessons
	Objects and organisms can be described in terms of their parts.	Level 1 M1 L1–6, 16–17 Level 1 M3 L1–3, 8–10, 14, 21–29 Level 2 M1 L1–7, 12–13, 20–23, 29–31 Level 2 M2 L3–4, 7 Level 2 M3 L8–13, 19–24
	Systems in the natural and designed world have parts that work together.	Level K M3 L1–3, 9–13, 19–21, 23–25, 27–29 Level K M4 L1–9, 11–16

5	Energy and Matter	Aligned *PhD Science* Lessons
	Objects may break into smaller pieces, be put together into larger pieces, or change shapes.	Level 2 M1 L10–11, 29–31 Level 2 M2 L3–4, 8–13, 22–24

6	Structure and Function	Aligned *PhD Science* Lessons
	The shape and stability of structures of natural and designed objects are related to their function(s).	Level K M1 L10–16 Level K M4 L20–24

7	Stability and Change	Aligned *PhD Science* Lessons
	Some things stay the same while other things change.	Level K M1 L8–9, 17–21
	Things may change slowly or rapidly.	Level K M4 L14–16

PhD Science® Correlation to Arizona Science Standards: Level 1

The *PhD Science* K–2 curriculum aligns with the Grade 1 Arizona Science Standards. A detailed analysis of alignment appears in the table below.

Key: Module (M), Lesson (L)

Grade 1 Standards

Physical Science		**Aligned *PhD Science* Lessons**
1.P2U1.1	Plan and carry out investigations demonstrating the effect of placing objects made with different materials in the path of a beam of light and predict how objects with similar properties will affect the beam of light.	Level 1 M2 L1–3, 10–23
1.P2U1.2	Use models to provide evidence that vibrating matter creates sound and sound can make matter vibrate.	Level 1 M3 L1–17, 26–29
1.P3U1.3	Plan and carry out investigations which demonstrate how equal forces can balance objects and how unequal forces can push, pull, or twist objects, making them change their speed, direction, or shape.	Level K M2 L1–23 Level 3 M1 L1–9
1.P4U2.4	Design and evaluate ways to increase or reduce heat from friction between two objects.	Level 3 M4 L15–18

Earth and Space Science		
1.E1U1.5	Obtain, evaluate, and communicate information about the properties of Earth materials and investigate how humans use natural resources in everyday life.	Level 1 M1 L10–15

Life Science		Aligned *PhD Science* Lessons
1.L1U1.6	Observe, describe, and predict life cycles of animals and plants.	Level 2 M3 L1–7 Level 3 M3 L7–8, 23–28
1.L2U2.7	Develop and use models about how living things use resources to grow and survive; design and evaluate habitats for organisms using earth materials.	Level 2 M4 L1–10, 16, 23–25
1.L2U1.8	Construct an explanation describing how organisms obtain resources from the environment including materials that are used again by other organisms.	Level 2 M4 L1–10, 16, 23–25
1.L3U1.9	Obtain, evaluate, and communicate information to support an evidence-based explanation that plants and animals produce offspring of the same kind, but offspring are generally not identical to each other or their parents.	Level 1 M1 L22–23, 26–29
1.L4U1.10	Develop a model to describe how animals and plants are classified into groups and subgroups according to their similarities.	Level 1 M1 L22–23, 27–29
1.L4U3.11	Ask questions and explain how factors can cause species to go extinct.	Level K M3 L1–3, 9–29 Level K M4 L1–5, 8–9, 11–16 Level 3 M2 L1–8

Core Ideas for Knowing Science

Physical Science

P2	Objects can affect other objects at a distance.	Aligned *PhD Science* Lessons
1.P2U1.1	Some materials allow light to pass through them, others allow only some light through, and others block all the light and create a dark shadow on any surface beyond them where the light cannot reach. Mirrors can be used to redirect a light beam.	Level 1 M2 L1–3, 10–23
1.P2U1.2	Sound can make matter vibrate, and vibrating matter can make sound.	Level 1 M3 L1–17, 26–29
	Sound comes from things that vibrate and can be detected at a distance from the source because the air or other material around is made to vibrate. Sounds are heard when the vibrations in the air enter our ears.	Level 1 M3 L1–17, 26–29

P3	Changing the movement of an object requires a net force to be acting on it.	Aligned *PhD Science* Lessons
1.P3U1.3	Forces can push, pull, or twist objects, making them change their motion or shape.	Level K M2 L13–23
	Pushes and pulls can have different strengths and directions.	Level K M2 L7–23
	Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.	Level K M2 L1–23
	The movement of objects is changed if the forces acting on them are not in balance.	Level 3 M4 L10–18, 28–30

P4	The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.	Aligned *PhD Science* Lessons
1.P4U2.4	When two objects rub against each other, this interaction is called friction	Level 3 M4 L15–18
	Friction between two surfaces can warm both of them (e.g., rubbing hands together).	Level 3 M4 L15–18
	There are ways to reduce the friction between two objects.	Level 3 M4 L15–18

Earth and Space Science

E1	The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.	Aligned *PhD Science* Lessons
1.E1U1.5	Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do.	Level K M3 L1–3, 9–29 Level K M4 L1–5, 8–9, 11–16

Life Science

L1	Organisms are organized on a cellular basis and have a finite life span.	Aligned *PhD Science* Lessons
1.L1U1.6	Adult plants and animals can have young.	Level 1 M1 L24–29
	Plants and animals grow and change. Plants and animals have predictable characteristics at different stages of development.	Level 3 M3 L7–8, 23–28 Level 2 M3 L1–7

L2	Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.	Aligned *PhD Science* Lessons
1.L2U2.7	All animals need food in order to live and grow. They obtain their food from plants or from other animals.	Level K M3 L4–16, 19–20, L22, L27–29
	Plants depend on air, water, minerals (in the soil), and light to grow.	Level 2 M3 L1–7, 25–29
	Animals can move around, but plants cannot, and they often depend on animals for pollination or to move their seeds around.	Level 2 M3 L8–29
	Animals depend on their surroundings to get what they need, including food, water, shelter, and a favorable temperature.	Level K M3 L4–16, 19–20, L22, L27–29
	Organisms obtain the materials they need to grow and survive from the environment. Many of these materials come from organisms and are used again by other organisms.	Level 2 M4 L1–10, 16, 23–25
1.L2U1.8	All animals need food in order to live and grow. They obtain their food from plants or from other animals.	Level K M3 L4–16, 19–20, L22, L27–29
	Plants depend on air, water, minerals (in the soil), and light to grow.	Level 2 M3 L1–7, 25–29
	Animals can move around, but plants cannot, and they often depend on animals for pollination or to move their seeds around.	Level 2 M3 L8–29
	Different plants survive better in different settings because they have varied needs for water, minerals, and sunlight.	Level 2 M3 L1–7, 25–29
	Organisms obtain the materials they need to grow and survive from the environment. Many of these materials come from organisms and are used again by other organisms.	Level 2 M4 L1–10, 16, 23–25

L3	Genetic information is passed down from one generation of organisms to another.	Aligned *PhD Science* Lessons
1.L3U1.9	Living things produce offspring of the same kind, but offspring are not identical with each other or with their parents.	Level 1 M1 L22–23, 26–29
	Plants and animals, including humans, resemble their parents in many features because information is passed from one generation to the next.	Level 1 M1 L22–23, 26–29
	Organisms have characteristics that can be similar or different.	Level 1 M1 L22–23, 27–29

L4	The unity and diversity of organisms, living and extinct, is the result of evolution.	Aligned *PhD Science* Lessons
1.L4U1.10	Animals and plants are classified into groups and subgroups according to their similarities.	Level 1 M1 L22–23, 27–29
1.L4U3.11	There are many different kinds of plants and animals in the world today and many kinds that once lived but are now extinct.	Level 3 M2 L1–8
	Living things can survive only where their needs are met. If some places are too hot or too cold or have too little water or food, plants and animals may not be able to live there.	Level K M3 L1–3, 9–29 Level K M4 L1–5, 8–9, 11–16

Core Ideas for Using Science

U1	Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.	Aligned *PhD Science* Lessons
	Science investigations begin with a question.	Level 1 M2 L15–18
	Science uses different ways to study the world.	Level 1 M4 L4–6
	Scientists look for patterns and order when making observations about the world.	Level 1 M1 L24–25 Level 1 M2 L10–12
	Science knowledge can change when new information is found.	Level 1 M3 L15–16
	Science uses drawings, sketches, and models as a way to communicate ideas.	Level 1 M4 L7–8
	Science searches for cause and effect relationships to explain natural events.	Level 1 M2 L10–12
	Science knowledge helps us know about the world.	Level K M2 L4–6, 9 Level K M4 L25
	Science assumes natural events happen today as they happened in the past.	Level 1 M4 L9–13
	Many events are repeated.	Level 1 M4 L9–13
	Scientists study the natural and material world.	Level 1 M1 L27–29 Level 1 M2 L21–23 Level 1 M3 L26–29 Level 1 M4 L23–25

U2	**The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.**	**Aligned *PhD Science* Lessons**
	A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions.	Level 1 M1 L11–15
	Asking questions, making observations, and gathering information are helpful in thinking about problems.	Level 1 M1 L11–15
	Before beginning to design a solution, it is important to clearly understand the problem.	Level 1 M1 L11–15
	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.	Level 1 M3 L21–25
	To design something complicated, one may need to break the problem into parts and attend to each part separately but must then bring the parts together to test the overall plan.	Level 1 M1 L10–15 Level 1 M3 L18–25
	Because there is always more than one possible solution to a problem, it is useful to compare designs, test them, and discuss their strengths and weaknesses.	Level 1 M3 L21–25
	Technologies have been created by people to provide the things they need or can use.	Level 1 M3 L20

U3	**Applications of science often have both positive and negative ethical, social, economic, and/or political implications.**	**Aligned *PhD Science* Lessons**
	Every human-made product is designed by applying some knowledge of the natural world and is built by using natural materials.	Level 1 M1 L10–15
	Taking natural materials to make things impacts the environment.	Level 2 M2 L8–9
	There are generally both positive and negative consequences of the applications of science.	Level 1 M3 L20
	People depend on various technologies in their lives; human life would be very different without technology.	Level 1 M3 L20

Science and Engineering Practices

Asking Questions and Defining Problems	**Aligned *PhD Science* Lessons**
Ask questions based on observations of the natural and/or designed world.	Level 1 M1 L1–3 Level 1 M2 L1–3 Level 1 M3 L1–3 Level 1 M4 L1–3, 14–16
Define a simple problem that can be solved through the development of a new or improved object or tool.	Level 1 M1 L11–15

Developing and Using Models	**Aligned *PhD Science* Lessons**
Distinguish between a model and the actual object, process, and/or events the model represents.	Level 1 M1 L4–9, 18 Level 1 M3 L14
Compare models to identify common features and differences.	Level 1 M1 L11–15 Level 1 M2 L1–3
Develop and/or use models (i.e., diagrams, drawings, physical replicas, dioramas, dramatizations, or storyboards) that represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed worlds.	Level 1 M1 L1–8 Level 1 M2 L1–7, 10–23 Level 1 M3 L7, 11–13 Level 1 M4 L1–3, 7–8
Develop a simple model that represents a proposed object or tool.	Level 1 M1 L11–15

Planning and Carrying Out Investigations	Aligned *PhD Science* Lessons
With guidance, design and conduct investigations in collaboration with peers.	Level K M2 L7–8, 10–15 Level K M3 L4–8
Design and conduct investigations collaboratively.	Level 1 M1 L19–20 Level 1 M2 L15–18
Evaluate different ways of observing and/or measuring an attribute of interest.	Level K M4 L3–5
Make direct or indirect observations and/or measurements to collect data, which can be used to make comparisons.	Level 1 M2 L4–12, 15–18, 20–23 Level 1 M3 L1–7, 11–13, 18–19 Level 1 M4 L4–6, 14–16, 19–21
Identify questions and make predictions based on prior experiences.	Level 1 M3 L11–13, L15–17, L26–29 Level 1 M4 L1–3
Make direct or indirect observations and/or measurements of a proposed object or tool or solution to determine if it solves a problem or meets a goal.	Level 1 M3 L8–9, 20–25

Analyzing and Interpreting Data	Aligned *PhD Science* Lessons
Use and share pictures, drawings, and/or writings of observations.	Level K M2 L7–8 Level K M4 L1–2, 6–7, 10, 14–17, 20–24, 26–28
Use observations to describe patterns and/or relationships in the natural and designed worlds in order to answer scientific questions and solve problems.	Level 1 M1 L16–21, 27–29 Level 1 M2 L1–9 Level 1 M3 L10 Level 1 M4 L4–6, L9–13
Make measurements of length to quantify data.	Level 2 M3 L3–6, 14–18, 25–29
Analyze data from tests of an object or tool to determine if a proposed object or tool functions as intended.	Level 1 M3 L8–9

Using Mathematics and Computational Thinking	Aligned *PhD Science* Lessons
Decide when to use qualitative vs. quantitative data.	Level 1 M2 L15–18
Use counting and numbers to identify and describe patterns in the natural and designed worlds.	Level K M1 L17–21, 25–30 Level K M2 L17–20 Level 2 M4 L7–8, 20–22
Describe, measure, and compare quantitative attributes of different objects and display the data using simple graphs.	Level 2 M1 L20–22 Level 2 M3 L8–11, 23–29 Level 2 M4 L17–19
Use quantitative data to compare two alternative solutions to a problem.	Level 1 M3 L21–25

Constructing Explanations and Designing Solutions	Aligned *PhD Science* Lessons
Use information from direct or indirect observations to construct explanations.	Level 1 M1 L7–8, 16–17, 22–23, 26–29 Level 1 M2 L4–7, 21–23 Level 1 M3 L4–6, 14, 26–29
Use tools and materials provided to design a device or solution to a specific problem.	Level 1 M1 L11–15
Distinguish between opinions and evidence in one's own explanations.	Level 1 M4 L9–13
Generate and compare multiple solutions to a problem.	Level 1 M3 L21–25

Engaging in Argument from Evidence	Aligned *PhD Science* Lessons
Identify arguments that are supported by evidence.	Level 1 M4 L4–8, 23–25
Listen actively to others' explanations and arguments and ask questions for clarification.	Level K M3 L17–20 Level K M4 L3–5, 11–13 Level 2 M2 L20 Level 2 M4 L4–6, 9–13, 23–25
Make a claim about the effectiveness of an object, tool, or solution that is based on relevant evidence.	Level 1 M3 L8–9, 18–20

Obtaining, Evaluating, and Communicating Information	Aligned *PhD Science* Lessons
Read and comprehend grade-appropriate texts and media to acquire scientific and/or technical information.	Level 1 M1 L24–25 Level 1 M3 L18–19 Level 1 M4 L9–13
Critique and/or communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers.	Level 1 M1 L27–29 Level 1 M2 L21–23 Level 1 M3 L26–29 Level 1 M4 L23–25
Record observations, thoughts, and ideas.	Level 1 M1 L10
Explain how specific images (e.g., a diagram showing how a machine works) contribute to and clarify a text.	Level 1 M4 L14–18, 23–25
Obtain information by using various text features (e.g., headings, tables of contents, glossaries, electronic menus, icons).	Level K M3 L23–26 Level 2 M2 L5–6, 18–19 Level 2 M4 L4–9, 11–16, 23–25

Crosscutting Concepts

1	Patterns	Aligned *PhD Science* Lessons
	Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.	Level 1 M1 L1–6, 16–29 Level 1 M2 L1–9, 21–23 Level 1 M3 L1–7, 11–13, 17–20, 26–29 Level 1 M4 L1–25

2	Cause and Effect	Aligned *PhD Science* Lessons
	Events have causes that generate observable patterns.	Level 1 M2 L1–7, 10–12, 15–23 Level 1 M3 L4–6, 14, 17, 26–29 Level 1 M4 L4–6, 9–13, 17–21, 23–25
	Simple tests can be designed to gather evidence to support or refute student ideas about causes.	Level 1 M2 L13–14 Level 1 M3 L7, 15–16

3	Scale, Proportion, and Quantity	Aligned *PhD Science* Lessons
	Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower).	Level K M1 L1–7, 10–24, 28–30 Level K M2 L7–9, 13–15, 21–23 Level K M3 L1–3 Level K M4 L25 Level 2 M1 L8–9 Level 2 M2 L18–21 Level 2 M3 L25–29 Level 2 M4 L1–6, 17–19, 22–25
	Standard units are used to measure length.	Level 2 M3 L3–6, 14–18, 25–29

4	Systems and System Models	Aligned *PhD Science* Lessons
	Objects and organisms can be described in terms of their parts.	Level 1 M1 L1–6, 16–17 Level 1 M3 L1–3, 8–10, 14, 21–29
	Systems in the natural and designed world have parts that work together.	Level 1 M1 L7–8 Level 1 M2 L1–3, 10–23 Level 1 M3 L21–25

5	Energy and Matter	Aligned *PhD Science* Lessons
	Objects may break into smaller pieces, be put together into larger pieces, or change shapes.	Level 2 M1 L10–11, 29–31 Level 2 M2 L3–4, 8–13, 22–24

6	Structure and Function	Aligned *PhD Science* Lessons
	The shape and stability of structures of natural and designed objects are related to their function(s).	Level 1 M1 L4–15, 27–29 Level 1 M3 L8–9

7	Stability and Change	Aligned *PhD Science* Lessons
	Some things stay the same while other things change.	Level K M1 L8–9, 17–21 Level 2 M2 L1–2, 22–24 Level 2 M3 L1–2, 25–29
	Things may change slowly or rapidly.	Level K M4 L14–16 Level 2 M2 L18–24

PhD Science® Correlation to Arizona Science Standards: Level 2

The *PhD Science* K–2 curriculum aligns with the Grade 2 Arizona Science Standards. A detailed analysis of alignment appears in the table below.

Key: Module (M), Lesson (L)

Grade 2 Standards

Physical Science		**Aligned *PhD Science* Lessons**
2.P1U1.1	Plan and carry out an investigation to determine that matter has mass, takes up space, and is recognized by its observable properties; use the collected evidence to develop and support an explanation.	Level 2 M1 L1–16, 19, 23, 29–31 Level 2 M2 L3–4, 14–17
2.P1U1.2	Plan and carry out investigations to gather evidence to support an explanation on how heating or cooling can cause a phase change in matter.	Level 2 M1 L14–19, 29–31
2.P4U1.3	Obtain, evaluate and communicate information about ways heat energy can cause change in objects or materials.	Level 2 M1 L14–19, 29–31

Earth and Space Science		**Aligned *PhD Science* Lessons**
2.E1U1.4	Observe and investigate how wind and water change the shape of the land resulting in a variety of landforms.	Level 2 M2 L1–17, 20, 22–24
2.E1U1.5	Develop and use models to represent that water can exist in different states and is found in oceans, glaciers, lakes, rivers, ponds, and the atmosphere.	Level 2 M4 L1–6, 16, 22–25
2.E1U2.6	Analyze patterns in weather conditions of various regions of the world and design, test, and refine solutions to protect humans from severe weather conditions.	Level K M1 17–20, 22–30 Level 3 M1 L1–15, 19–20, 27–29
2.E1U3.7	Construct an argument from evidence regarding positive and negative changes in water and land systems that impact humans and the environment.	Level K M3 L1–10, 14–16, 26–28 Level K M4 L11–24, 26–28 Level 2 M2 L1–17, 20, 22–24
2.E2U1.8	Observe and explain the Sun's position at different times during a twenty-four-hour period and changes in the apparent shape of the Moon from one night to another.	Level 1 M4 L1–8, 14–25

Life Science		Aligned *PhD Science* Lessons
2.L2U1.9	Obtain, analyze, and communicate evidence that organisms need a source of energy, air, water, and certain temperature conditions to survive.	Level K M3 L14–16, 19–20, 22, 27–29 Level 2 M4 L1–3, 7–25
2.L2U1.10	Develop a model representing how life on Earth depends on energy from the Sun and energy from other organisms.	Level K M3 L4–16, 19–20, 22, 27–29 Level 2 M3 L1–7, 25–29 Level 5 M2 L1–2

Core Ideas for Knowing Science

Physical Science

P1	All matter in the Universe is made of very small particles.	Aligned *PhD Science* Lessons
2.P1U1.1	All the 'stuff' encountered in everyday life, including air, water, and different kinds of solid substances, is called matter because it has mass and takes up space.	Level 2 M1 L1–16, 19, 23, 29–31 Level 2 M2 L3–4, 14–17
	Different materials are recognizable by their properties, some of which are used to classify them as being solid or liquid, depending on temperature. Matter can be described by its observable properties.	Level 2 M1 L1–16, 19, 23, 29–31 Level 2 M2 L3–4, 14–17
2.P1U1.2	Different materials are recognizable by their properties, some of which are used to classify them as being solid or liquid, depending on temperature.	Level 2 M1 L1–16, 19, 23, 29–31 Level 2 M2 L3–4, 14–17
	Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.	Level 2 M1 L14–19, 29–31
	Heating can cause change, as in cooking, melting solids or changing water to vapor.	Level 2 M1 L14–16, 19

P4	The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.	Aligned *PhD Science* Lessons
2.P4U1.3	Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.	Level 2 M1 L14–19, 29–31

Earth and Space Science

E1	The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.	Aligned *PhD Science* Lessons
2.E1U1.4	Wind and water can change the shape of the land.	Level 2 M2 L1–17, 20, 22–24
2.E1U1.5	Water is found in the oceans, rivers, lakes, and ponds. Water exists as solid ice and in liquid form.	Level 2 M4 L1–6, 16, 22–25
2.E1U2.6	Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events.	Level K M1 L17–20, 22–30 Level 3 M1 L1–3, 16–29
	The temperature, pressure, direction, speed of movement and the amount of water vapor in the air combine to create the weather. Measuring these properties over time enables patterns to be found that can be used to predict the weather.	~~Level K M1 L1–11, 17–24, 28–30~~ ~~Level K M4 L25~~ Level 3 M1 L1–15, 19–20, 27–29
2.E1U3.7	Plants and animals can change their environment.	Level K M4 L1–10, 14–16, 26–28
	Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things.	Level K M4 L11–24, 26–28 Level 2 M2 L1–17, 20, 22–24

E2	The Earth and our solar system are a very small part of one of many galaxies within the Universe.	Aligned *PhD Science* Lessons
2.E2U1.8	There are patterns in the position of the Sun seen at different times of the day and in the shape of the Moon from one night to another.	Level 1 M4 L1–8, 14–25

Life Science

L2	Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.	Aligned *PhD Science* Lessons
2.L2U1.9	All living things need food as their source of energy as well as air, water, and certain temperature conditions. Plants can use sunlight to make the food they need and can store food that they do not immediately use.	Level 2 M4 L1–3, 7–25
	Animals need food that they can break down, which comes either directly by eating plants or by eating animals which have eaten plants or other animals. Animals are ultimately dependent on plants for their survival.	Level K M3 L4–16, 19–20, 22, 27–29
2.L2U1.10	All living things need food as their source of energy as well as air, water, and certain temperature conditions. Plants use sunlight to make the food they need and can store food that they do not immediately use.	Level 2 M4 L1–3, 7–25
	Animals need food that they can break down, which comes either directly by eating plants or by eating animals which have eaten plants or other animals. Animals are ultimately dependent on plants for their survival.	Level K M3 L4–16, 19–20, 22, 27–29
	The relationships among organisms can be represented as a food chain.	Level 5 M2 L1–2

Core Ideas for Using Science

U1	**Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.**	**Aligned *PhD Science* Lessons**
	Science investigations begin with a question.	Level 1 M2 L15–18
	Science uses different ways to study the world.	Level 1 M4 L4–6
	Scientists look for patterns and order when making observations about the world.	Level 2 M4 L11–13, 17–21
	Science knowledge can change when new information is found.	Level 2 M4 L4–6
	Science uses drawings, sketches, and models as a way to communicate ideas.	Level 2 M4 L14–17
	Science searches for cause and effect relationships to explain natural events.	Level 2 M2 L10–12
	Science knowledge helps us know about the world.	Level K M2 L4–6, 9 Level K M4 L25
	Science assumes natural events happen today as they happened in the past.	Level 2 M2 L20–21
	Many events are repeated.	Level K M1 L17–20 Level 1 M4 L9–13
	Scientists study the natural and material world.	Level 2 M1 L20–22, 29–31 Level 2 M2 L1–4, 22–24 Level 2 M3 L25–29 Level 2 M4 L23–25

U2	**The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.**	**Aligned *PhD Science* Lessons**
	A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions.	Level 2 M1 L24–28 Level 2 M2 L8–12
	Asking questions, making observations, and gathering information are helpful in thinking about problems.	Level 2 M1 L24–28
	Before beginning to design a solution, it is important to clearly understand the problem.	Level 2 M1 L24–28
	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.	Level 2 M3 L14–18
	To design something complicated, one may need to break the problem into parts and attend to each part separately but must then bring the parts together to test the overall plan.	Level 2 M1 L24–28 Level 2 M2 L14–17 Level 2 M3 L14–18
	Because there is always more than one possible solution to a problem, it is useful to compare designs, test them, and discuss their strengths and weaknesses.	Level 2 M2 L8–12, 14–17
	Technologies have been created by people to provide the things they need or can use.	Level 2 M2 L10–12

U3	**Applications of science often have both positive and negative ethical, social, economic, and/or political implications.**	**Aligned *PhD Science* Lessons**
	Every human-made product is designed by applying some knowledge of the natural world and is built by using natural materials.	Level 2 M2 L14–17 Level 2 M3 L14–18
	Taking natural materials to make things impacts the environment.	Level 2 M2 L8–9
	There are generally both positive and negative consequences of the applications of science.	Level K M4 L11–17 Level 1 M3 L20
	People depend on various technologies in their lives; human life would be very different without technology.	Level 2 M2 L10–12

Science and Engineering Practices

Asking Questions and Defining Problems	**Aligned *PhD Science* Lessons**
Ask questions based on observations of the natural and/or designed world.	Level 2 M1 L1–3 Level 2 M2 L1–2 Level 2 M3 L1–2 Level 2 M4 L1–3
Define a simple problem that can be solved through the development of a new or improved object or tool.	Level 2 M3 L14–18

Developing and Using Models	**Aligned *PhD Science* Lessons**
Distinguish between a model and the actual object, process, and/or events the model represents.	Level 2 M4 L4–6
Compare models to identify common features and differences.	Level 2 M4 L1–6, 20–21, 23–25
Develop and/or use models (i.e., diagrams, drawings, physical replicas, dioramas, dramatizations, or storyboards) that represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed worlds.	Level 2 M1 L1–3, 14–16, 19, 29–31 Level 2 M2 L1–2, 14–17, 20–24 Level 2 M3 L1–6, 8–12, 19–20, 23–29 Level 2 M4 L1–3, 7–8
Develop a simple model that represents a proposed object or tool.	Level 2 M3 L14–18

Planning and Carrying Out Investigations	**Aligned *PhD Science* Lessons**
With guidance, design and conduct investigations in collaboration with peers.	Level K M2 L7–8, 10–15 Level K M3 L4–8
Evaluate different ways of observing and/or measuring an attribute of interest.	Level 2 M2 L3–4, 8–12, 22–24
Make direct or indirect observations and/or measurements to collect data, which can be used to make comparisons.	Level 2 M1 L1–3, 29–31 Level 2 M2 L1–6, 14–19 Level 2 M3 L3–6, 8–11, 13, 21–22, 25–29 Level 2 M4 L16–19
Identify questions and make predictions based on prior experiences.	Level 2 M1 L17–18
Make direct or indirect observations and/or measurements of a proposed object or tool or solution to determine if it solves a problem or meets a goal.	Level 2 M1 L20–22, 24–28 Level 2 M2 L14–17

Analyzing and Interpreting Data	Aligned *PhD Science* Lessons
Use and share pictures, drawings, and/or writings of observations.	Level K M2 L7–8 Level K M4 L1–2, 6–7, 10, 14–17, 20–24, 26–28
Use observations to describe patterns and/or relationships in the natural and designed worlds in order to answer scientific questions and solve problems.	Level 2 M1 L4–11 Level 2 M2 L5–6, 8–9 Level 2 M3 L19–20 Level 2 M4 L22–25
Make measurements of length to quantify data.	Level 2 M3 L3–6, 14–18, 25–29
Analyze data from tests of an object or tool to determine if a proposed object or tool functions as intended.	Level 2 M1 L20–22, 24–28 Level 2 M3 L14–18

Using Mathematics and Computational Thinking	Aligned *PhD Science* Lessons
Decide when to use qualitative vs. quantitative data.	Level K M2 L17–20 Level 1 M2 L15–18
Use counting and numbers to identify and describe patterns in the natural and designed worlds.	Level 2 M4 L7–8, 20–22
Describe, measure, and compare quantitative attributes of different objects and display the data using simple graphs.	Level 2 M1 L20–22 Level 2 M3 L8–11, 23–29 Level 2 M4 L17–19
Use quantitative data to compare two alternative solutions to a problem.	Level 2 M2 L14–17

Constructing Explanations and Designing Solutions	Aligned *PhD Science* Lessons
Use information from direct or indirect observations to construct explanations.	Level 2 M1 L8–9, 12–13, 17–19, 23, 29–31 Level 2 M2 L3–4, 7, 13, 22–24 Level 2 M4 L23–25
Use tools and materials provided to design a device or solution to a specific problem	Level 2 M1 L24–28
Distinguish between opinions and evidence in one's own explanations.	Level K M3 L17–18
Generate and compare multiple solutions to a problem.	Level 2 M2 L8–12, 14–17

Engaging in Argument from Evidence	Aligned *PhD Science* Lessons
Identify arguments that are supported by evidence.	Level K M3 L17–18 Level 1 M4 L4–8, 23–25
Listen actively to others' explanations and arguments and ask questions for clarification.	Level 2 M2 L20 Level 2 M4 L4–6, 9–13, 23–25
Make a claim about the effectiveness of an object, tool, or solution that is based on relevant evidence.	Level 2 M3 L14–18, 21–22

Obtaining, Evaluating, and Communicating Information	Aligned *PhD Science* Lessons
Read and comprehend grade-appropriate texts and media to acquire scientific and/or technical information.	Level 2 M2 L1–2, 14–17
Critique and/or communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers.	Level 2 M1 L29–31 Level 2 M2 L22–24 Level 2 M3 L8–12, 14–20, 25–29 Level 2 M4 L23–25
Record observations, thoughts, and ideas.	Level 2 M1 L4–7, 10–11, 14–18
Explain how specific images (e.g., a diagram showing how a machine works) contribute to and clarify a text.	Level 2 M3 L14–18
Obtain information by using various text features (e.g., headings, tables of contents, glossaries, electronic menus, icons).	Level 2 M2 L5–6, 18–19 Level 2 M4 L4–9, 11–16, 23–25

Crosscutting Concepts

1	**Patterns**	**Aligned *PhD Science* Lessons**
	Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.	Level 2 M1 L4–9 Level 2 M2 L1–2, 5–6 Level 2 M4 L1–8, 11–15, 20–21, 23–25

2	**Cause and Effect**	**Aligned *PhD Science* Lessons**
	Events have causes that generate observable patterns.	Level 2 M1 L14–19, 29–31 Level 2 M2 L20–21 Level 2 M3 L8–11
	Simple tests can be designed to gather evidence to support or refute student ideas about causes.	Level 2 M1 L14–18 Level 2 M2 L8–12 Level 2 M3 L3–7

3	**Scale, Proportion, and Quantity**	**Aligned *PhD Science* Lessons**
	Relative scales allow objects and events to be compared and described (e.g., bigger and smaller, hotter and colder, faster and slower).	Level 2 M1 L8–9 Level 2 M2 L18–21 Level 2 M3 L25–29 Level 2 M4 L1–6, 17–19, 22–25
	Standard units are used to measure length.	Level 2 M3 L3–6, 14–18, 25–29

4	**Systems and System Models**	**Aligned *PhD Science* Lessons**
	Objects and organisms can be described in terms of their parts.	Level 2 M1 L1–7, 12–13, 20–23, 29–31 Level 2 M2 L3–4, 7 Level 2 M3 L8–13, 19–24
	Systems in the natural and designed world have parts that work together.	Level 2 M2 L8–12, 14–17 Level 2 M4 L7–16, 23–25

5	**Energy and Matter**	**Aligned *PhD Science* Lessons**
	Objects may break into smaller pieces, be put together into larger pieces, or change shapes.	Level 2 M1 L10–11, 29–31 Level 2 M2 L3–4, 8–13, 22–24

6	**Structure and Function**	**Aligned *PhD Science* Lessons**
	The shape and stability of structures of natural and designed objects are related to their function(s).	Level 2 M1 L24–28 Level 2 M2 L14–17 Level 2 M3 L8–11, 14–22

7	**Stability and Change**	**Aligned *PhD Science* Lessons**
	Some things stay the same while other things change.	Level 2 M2 L1–2, 22–24 Level 2 M3 L1–2, 25–29
	Things may change slowly or rapidly.	Level 2 M2 L18–24

PhD Science® Correlation to Arizona Science Standards: Level 3

The *PhD Science* 3–5 curriculum aligns with the Grade 3 Arizona Science Standards. A detailed analysis of alignment appears in the table below.

Key: Module (M), Lesson (L)

Grade 3 Standards

Physical Science		**Aligned *PhD Science* Lessons**
3.P2U1.1	Ask questions and investigate the relationship between light, objects, and the human eye.	Level 4 M4 L1–17, 21, 25–27
3.P2U1.2	Plan and carry out an investigation to explore how sound waves affect objects at varying distances.	Level 4 M3 L7–14, 29–31 Level 4 M4 L22–24
3.P4U1.3	Develop and use models to describe how light and sound waves transfer energy.	Level 4 M3 L7–14, 29–31 Level 4 M4 L14–19, 18–21, 25–27

Earth and Space Science		**Aligned *PhD Science* Lessons**
3.E1U1.4	Construct an explanation describing how the Sun is the primary source of energy impacting Earth systems.	Level 5 M2 L6–7, 15–19, 24–26

Life Science		**Aligned *PhD Science* Lessons**
3.L1U1.5	Develop and use models to explain that plants and animals (including humans) have internal and external structures that serve various functions that aid in growth, survival, behavior, and reproduction.	Level 4 M3 L1–6, 20, 26–31
3.L2U1.6	Plan and carry out investigations to demonstrate ways plants and animals react to stimuli.	Level 4 M3 L1–6, 15–25, 29–31
3.L2U1.7	Develop and use system models to describe the flow of energy from the Sun to and among living organisms.	Level 5 M2 L1–26
3.L2U1.8	Construct an argument from evidence that organisms are interdependent.	Level 5 M2 L1–26

Core Ideas for Knowing Science

Physical Science

P2	Objects can affect other objects at a distance.	Aligned *PhD Science* Lessons
3.P2U1.1	An object can be seen when light reflected from its surface enters the eyes; the color people see depends on the color of the available light sources as well as the properties of the surface.	Level 4 M4 L1–17, 25–27
3.P2U1.2	Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).	Level 4 M3 L7–14, 29–31
	Sound comes from things that vibrate and can be detected at a distance from the source because the air or other material around is made to vibrate. Sounds are heard when the vibrations in the air enter our ears.	Level 1 M3 L1–17, 26–29

P4	The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.	Aligned *PhD Science* Lessons
3.P4U1.3	Energy can be moved from place to place by moving objects or through sound or light.	Level 4 M2 L1–3, 10–26

Earth and Space Science

E1	The composition of the Earth and its atmosphere and the natural and human processes occurring withing them shape the Earth's surface and its climate.	Aligned *PhD Science* Lessons
3.E1U1.4	Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans).	Level 5 M3 L1–13, 24–27
	Radiation from the Sun heats the Earth's surface.	Level K M1 L8–16, 28–30
	Energy radiated from the Sun is transferred to earth by light. When this light is absorbed, it warms earth's land, air, and water and facilitates plant growth.	Level 5 M2 L6–7

Life Science

L1	Organisms are organized on a cellular basis and have a finite life span.	Aligned *PhD Science* Lessons
3.L1U1.5	Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.	Level 4 M3 L1–6, 20, 26–31
3.L1U1.6	Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions.	Level 4 M3 L1–6, 15–25, 29–31

L2	Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.	Aligned *PhD Science* Lessons
3.L2U1.7	The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants. Either way, they are "consumers."	Level 5 M2 L1–2, 8–14, 20, 24–26
	Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil for plants to use.	Level 5 M2 L1–2, 8–14, 20, 24–26
	Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life.	Level 5 M2 L1–2, 8–14, 20, 24–26
3.L2U1.8	Animals need food that they can break down, which comes either directly by eating plants (herbivores) or by eating animals (carnivores) [that] have eaten plants or other animals.	Level 5 M2 L1–2, 8–14, 20, 24–26 *PhD Science* K–5 curriculum does not directly address herbivores or carnivores.
	Animals are ultimately dependent on plants for their survival. The relationships among organisms can be represented as food chains and food webs. Some animals are dependent on plants in other ways as well as for food. Plants also depend on animals in various ways.	Level 5 M2 L1–2, 8–14, 20, 24–26
	Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil for plants to use.	Level 5 M2 L1–2, 8–14, 20, 24–26

Core Ideas for Using Science

U1	Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.	Aligned *PhD Science* Lessons
	Science investigations use a variety of methods, tools, and techniques.	Level 3 M4 L15–16
	Science findings are limited to questions that can be answered with empirical evidence.	Level 5 M3 L10–11 Level 5 M4 L5–8
	Science findings are based on recognizing patterns.	Level 3 M3 L7–8 Level 3 M4 L4–6
	Science explanations can change based on new evidence.	Level 5 M4 L14–15
	Science theories are based on a body of evidence and many tests.	Level 3 M4 L12–14
	Science explanations describe the mechanisms for natural events.	Level 5 M2 L14 Level 5 M4 L1–2, 7–8, 13
	Science is both a body of knowledge and processes that add new knowledge.	Level 5 M3 L6–8
	Science assumes consistent patterns in natural systems.	Level 3 M2 L4–5
	Basic laws of nature are the same everywhere in the universe.	Level 5 M4 L9–12, 16–17

U2	The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.	Aligned *PhD Science* Lessons
	Possible solutions to a problem are limited by available materials and resources (constraints).	Level 3 M1 L21–26
	The success of a designed solution is determined by considering the desired features of a solution(criteria.).	Level 3 M1 L21–26
	Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	Level 3 M1 L21–26
	Research on a problem should be carried out before beginning to design a solution.	Level 3 M1 L22–23
	Testing a solution involves investigating how well it performs under a range of likely conditions.	Level 3 M1 L22–23
	At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.	Level 3 M2 L22–25
	Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.	Level 3 M4 L23–27
	Technologies are developed using engineering, which involves identifying problems and using ideas of science and other ideas to design and develop possible solutions.	Level 3 M4 L23–27

U3	Applications of science often have both positive and negative ethical, social, economic, and/or political implications.	Aligned *PhD Science* Lessons
	People's needs and wants change over time, as do their demands for new and improved technologies.	Level 3 M1 L21–26
	Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.	Level 3 M2 L22–25
	When new technologies become available, they can bring about changes in the way people live and interact with one another.	Level 3 M4 L22–27
	There are generally both positive and negative consequences of the applications of science.	Level 3 M2 L20–21
	While technological solutions have improved the lives and health of many people in countries across the world, it has to be recognized that they may use materials from the natural world which may be in short supply or may be detrimental to the environment.	Level 4 M1 L21–27 Level 5 M3 L14–18, 24–27

Science and Engineering Practices

Asking Questions and Defining Problems	**Aligned *PhD Science* Lessons**
Identify scientific (testable) and non-scientific (non-testable) questions.	Level 3 M3 L12–13 Level 3 M4 L15–16, 19–21
Ask questions based on careful observations of phenomena and information.	Level 3 M1 L1–3, 10, 15–16, 20, 26–29 Level 3 M2 L1–2, 8, 12–15, 26–28 Level 3 M3 L1–3, 6, 11, 18, 21, 25–28 Level 3 M4 L1–3, 6, 9, 16–18, 21, 28–30
Ask questions to clarify ideas or request evidence.	Level 3 M1 L1–3, 21–29 Level 3 M2 L1–2, 26–28 Level 3 M3 L1–3, 12–13, 26–28 Level 3 M4 L1–3, 7–9, 15–16, 19–30
Ask questions that relate one variable to another variable.	Level 3 M3 L12–13, 19 Level 3 M4 L7–8, 15–16, 23–27
Ask questions to clarify the constraints of solutions to a problem.	Level 3 M1 L21–26 Level 3 M2 L22–25 Level 3 M4 L23–27
Use prior knowledge to describe problems that can be solved.	Level 3 M4 L22, 29–30
Define a simple design problem that can be solved through the development of an object, tool, or process, and includes several criteria for success and constraints on materials, time, or cost.	Level 3 M1 L21–26, 28–29 Level 3 M4 L23–27
Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.	Level 3 M1 L1–3 Level 3 M2 L1–2 Level 3 M3 L1–3 Level 3 M4 L1–3, 7–9, 28–30

Developing and Using Models	Aligned *PhD Science* Lessons
Develop and revise models collaboratively to measure and explain frequent and regular events.	Level 4 M2 L15–16 Level 4 M4 L3–8, 10–13 Level 5 M1 L5–6 Level 5 M2 L1–2, 6–7 Level 5 M4 L1–2, 7–8, 14–17
Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.	Level 3 M1 L1–3 Level 3 M2 L1–3, 6–8, 27–28
Use simple models to describe or support explanations for phenomena and test cause and effect relationships or interactions concerning the functioning of a natural or designed system.	Level 4 M3 L7–11 Level 4 M4 L10–13, 18–24 Level 5 M3 L12–13 Level 5 M4 L9–12
Identify limitations of models.	Level 4 M4 L14–17, 26–27 Level 5 M1 L5–6 Level 5 M2 L14 Level 5 M3 L6–8, 25–27
Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.	Level 3 M2 L22–25 Level 3 M4 L23–27
Use a simple model to test cause and effect relationships concerning the functioning of a proposed object, tool, or process.	Level 4 M3 L7–11 Level 4 M4 L10–13, 18–24 Level 5 M3 L12–13 Level 5 M4 L9–12

Planning and Carrying Out Investigations	Aligned *PhD Science* Lessons
Design and conduct investigations collaboratively, using fair tests in which variables are controlled and the number of trials considered.	Level 3 M4 L7–9, 15–16, 23–27, 29–30
Evaluate appropriate methods and/or tools for collecting data.	Level 3 M3 L12–13
Make observations and/or measurements, collect appropriate data, and identify to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.	Level 3 M2 L4–5 Level 3 M4 L7–18, 29–30
Make measurements of two different models of the same proposed object, tool, or process to determine which better meets criteria for success.	Level 4 M4 L14–17

Analyzing and Interpreting Data	Aligned *PhD Science* Lessons
Display data in tables and graphs, using digital tools when feasible, to reveal patterns that indicate relationships.	Level 3 M1 L4–12 Level 3 M3 L7–8, 27–28 Level 3 M4 L4–9
Use data to evaluate claims about cause and effect.	Level 3 M1 L27–29 Level 3 M3 L19–20 Level 3 M4 L12–14
Compare data collected by different groups in order to discuss similarities and differences in their findings.	Level 3 M3 L14–15, 19–20 Level 3 M4 L7–9
Use data to evaluate and refine design solutions.	Level 4 M4 L14–17
Interpret data to make sense of and explain phenomena, using logical reasoning, mathematics, and/or computation.	Level 3 M1 L11–15, 19–20, 27–29 Level 3 M2 L3–8, 16–19, 27–28 Level 3 M3 L4–6, 14–18, 27–28
Analyze data to refine a problem statement or the design of a proposed object, tool, or process.	Level 4 M4 L14–17

Using Mathematics and Computational Thinking	Aligned *PhD Science* Lessons
Use mathematical thinking and/or computational outcomes to compare alternative solutions to an engineering problem.	Level 4 M4 L14–17
Organize simple data sets to reveal patterns that suggest relationships.	Level 3 M1 L4–12 Level 3 M2 L3, 16–19 Level 3 M3 L7–8
Describe, measure, estimate, and graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.	Level 3 M3 L7–8
Decide if qualitative or quantitative data is best to determine whether a proposed object or tool meets criteria for success.	Level 3 M4 L23–27

Constructing Explanations and Designing Solutions	Aligned *PhD Science* Lessons
Construct explanations of observed relationships (e.g., the distribution of plants in the back yard).	Level 3 M2 L6–8 Level 3 M3 26–28 Level 3 M4 L10–14
Use evidence (e.g., measurements, observations, patterns) to construct a scientific explanation or design a solution to a problem.	Level 3 M1 L13–15, 18 Level 3 M2 L6–8, 26–28 Level 3 M3 L9–11, 14–15, 21–28 Level 3 M4 L10–14, 19–21, 28–30
Identify the evidence that supports particular points in an explanation.	Level 3 M2 L26–28 Level 3 M3 L26–28 Level 3 M4 L28–30
Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.	Level 5 M4 L5–6
Apply scientific ideas to solve design problems.	Level 3 M2 L22–25 Level 3 M4 L28–30
Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.	Level 3 M1 L21–29 Level 3 M2 L22–25

Engaging in Argument from Evidence	Aligned *PhD Science* Lessons
Construct and/or support scientific arguments with evidence, data, and/or a model.	Level 3 M2 L9–15, 27–28 Level 3 M3 L16–18
Compare and refine arguments based on the strengths and weaknesses of the evidence presented.	Level 3 M3 L16–18
Respectfully provide and receive critiques on scientific arguments with peers by citing relevant evidence and posing specific questions.	Level 4 M3 L21–23 Level 5 M2 L3–5, 21–23, 25–26
Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	Level 3 M1 L21–26, 28–29 Level 3 M2 L20–21

Obtaining, Evaluating, and Communicating Information	Aligned *PhD Science* Lessons
Compare and/or combine ideas across complex texts and/or other reliable media to acquire appropriate scientific and/or technical information.	Level 3 M2 L13–15
Determine the main idea of a scientific text and explain how it is supported by key details; summarize the text.	Level 3 M1 L21–26 Level 3 M2 L1–2, 9–12, 16, 22–25 Level 3 M3 L1–3, 5, 11, 25 Level 3 M4 L22
Combine information in written text with that contained in corresponding tables, diagrams, and/or charts.	Level 5 M4 L18–19
Use multiple sources to generate and communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.	Level 3 M2 L20–21
Use models to share findings or solutions in oral and/or written presentations and/or extended discussions.	Level 3 M1 L25 Level 3 M4 L27
Obtain and combine information from books and/or other reliable media about potential solutions to a specific design problem.	Level 3 M1 L11–17, 28–29

Crosscutting Concepts

1	**Patterns**	**Aligned *PhD Science* Lessons**
	Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena and designed products.	Level 3 M3 L1–8, 14–15, 27–28 Level 3 M4 L29–30
	Patterns of change can be used to make predictions.	Level 3 M1 L11–15, 19–20, 27–29 Level 3 M3 L7–8 Level 3 M4 L1–9, 28–30
	Patterns can be used as evidence to support an explanation.	Level 3 M1 L11–15, 28–29 Level 3 M2 L3–8, 13–15, 27–28 Level 3 M3 L16–18, 26–28

2	**Cause and Effect**	**Aligned *PhD Science* Lessons**
	Cause and effect relationships are routinely identified, tested, and used to explain change.	Level 3 M1 L16–18, 21–26, 28–29 Level 3 M2 L9–12, 16–28 Level 3 M3 L9–13, 19–25, 27–28 Level 3 M4 L1–3, L10–30
	Events that occur together with regularity might or might not be a cause and effect relationship.	Level 3 M1 L1–3, 27–29 Level 3 M2 L9–12

3	**Scale, Proportion, and Quantity**	**Aligned *PhD Science* Lessons**
	Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.	Level 3 M2 L1–2, 27–28 Level 3 M3 L1–3
	Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.	Level 3 M1 L4–10 Level 3 M3 L1–3, 14–15

4	Systems and System Models	Aligned *PhD Science* Lessons
	A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.	Level 4 M1 L21–24 Level 4 M2 L15–23 Level 4 M4 L14–17, 26–27 Level 5 M2 L14, 18–19, 24–26 Level 5 M3 L6–8
	A system can be described in terms of its components and their interactions.	Level 3 M1 L1–3, 16–20 Level 3 M2 L6–15, 20–28 Level 3 M3 L9–11 Level 3 M4 L1–30

5	Energy and Matter	Aligned *PhD Science* Lessons
	Matter is made of particles.	Level 5 M1 L5–8, 23–26 Level 5 M2 L6–9, 14, 25–26 Level 5 M4 L3–4
	Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.	Level 5 M2 L10–11 Level 5 M2 L25–26
	Energy can be transferred in various ways and between objects.	Level 4 M2 L1–3, 8–26 Level 4 M3 L10–19, 30–31 Level 5 M1 L13–14 Level 5 M2 L15–19, 24–26 Level 5 M3 L10–11

6	**Structure and Function**	**Aligned *PhD Science* Lessons**
	Different materials have different substructures, which can sometimes be observed.	Level 3 M2 L1–3
	Substructures have shapes and parts that serve functions.	Level 3 M2 L9–12 Level 3 M3 L4–6, 21–28

7	**Stability and Change**	**Aligned *PhD Science* Lessons**
	Change is measured in terms of differences over time and may occur at different rates.	Level 3 M1 L4–15, 27–29 Level 3 M2 L16–19 Level 3 M3 L7–8, 12–13, 19–20, 26–28
	Some systems appear stable, but over long periods of time will eventually change.	Level 3 M1 L8–10

PhD Science® Correlation to Arizona Science Standards: Level 4

The *PhD Science* 3–5 curriculum aligns with the Grade 4 Arizona Science Standards. A detailed analysis of alignment appears in the table below.

Key: Module (M), Lesson (L)

Grade 4 Standards

Physical Science		**Aligned *PhD Science* Lessons**
4.P4U1.1	Develop and use a model to demonstrate how a system transfers energy from one object to another even when the objects are not touching.	Level 4 M2 L1–5, 8–11, 15–16, 24–26
4.P4U1.2	Develop and use a model that explains how energy is moved from place to place through electric currents.	Level 4 M2 L1–5, 8–26
4.P2U1.3	Develop and use a model to demonstrate magnetic forces.	Level 3 M4 L19–30
4.P4U3.4	Engage in argument from evidence on the use and impact of renewable and nonrenewable resources to generate electricity.	Level 4 M1 L21–27 Level 4 M2 L12–14, 24–26

Earth and Space Science		**Aligned *PhD Science* Lessons**
4.E1U1.5	Use models to explain seismic waves and their effect on the Earth.	Level 4 M1 L1–5, 18, 19–20, 25–27 Level 5 M2 L1–5, 15–19, 24–26
4.E1U1.6	Plan and carry out an investigation to explore and explain the interactions between Earth's major systems and the impact on Earth's surface materials and processes.	Level 4 M1 L1–11, 18–20, 25–27 Level 5 M3 L1–13, 24–27
4.E1U1.7	Develop and/or revise a model using various rock types, fossil location, and landforms to show evidence that Earth's surface has changed over time.	Level 4 M1 L1–11, 18–20, 25–27
4.E1U1.8	Collect, analyze, and interpret data to explain weather and climate patterns.	Level 3 M1 L1–15, 19–20, 27–29
4.E1U3.9	Construct and support an evidence-based argument about the availability of water and its impact on life.	Level 5 M3 L4–5, 24–27
4.E1U2.10	Define problem(s) and design solution(s) to minimize the effects of natural hazards.	Level 4 M1 L12–17, 25–27

Life Science		
4.L4U1.11	Analyze and interpret environmental data to demonstrate that species either adapt and survive or go extinct over time.	Level 3 M2 L1–12, 16–28

Core Ideas for Knowing Science

Physical Science

P2	Objects can affect other objects at a distance.	Aligned *PhD Science* Lessons
4.P2U1.3	Magnetic forces between a pair of objects do not require that the objects be in contact. The size of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other.	Level 3 M4 L19–30

P4	The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.	Aligned *PhD Science* Lessons
4.P4U1.1	Energy is transferred from one object, which is an energy source or resource, to another.	Level 4 M2 L1–5, 8–11, 15–16, 24–26
	Energy is present whenever there are moving objects, sound, light, or heat.	Level 4 M2 L1–5, 8–9, 24–26
4.P4U1.2	Energy is present whenever there are moving objects, sound, light, or heat.	Level 4 M2 L1–5, 8–9, 24–26
	Energy can be moved from place to place by moving objects or through sound or light or electric currents.	Level 4 M2 L1–3, 10–11, 15–16, 24–26
	Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.	Level 4 M2 L1–3, 10–26
	Light also transfers energy from place to place.	Level 4 M2 L10–11, 24–26
4.P4U3.4	The expression “produce energy” typically refers to the conversion of stored energy into a desired form for practical use.	Level 4 M2 L12–14, 24–26
	Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.	Level 4 M1 L21–27

Earth and Space Science

E1	The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.	Aligned *PhD Science* Lessons
4.E1U1.5	Earthquakes cause seismic waves, which are waves of motion in Earth's crust.	Level 4 M1 L1–5, 18, 19–20, 25–27
	Energy originates from the sun and from Earth's interior. Transfers of energy and the movements of matter can cause physical changes among Earth's materials and living organisms.	Level 5 M2 L1–5, 15–19, 24–26
	Local, regional, and global patterns of rock formations reveal changes overtime due to Earth forces, such as earthquakes.	Level 4 M1 L1–5, 18, 19–20, 25–27
4.E1U1.6	Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.	Level 5 M3 L1–13, 24–27
	The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans.	Level 4 M1 L18–20, 25–27
	Rainfall helps shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.	Level 4 M1 L6–11, 25–27
4.E1U1.7	Local, regional, and global patterns of rock formations reveal changes overtime due to Earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed.	Level 4 M1 L1–5, 18, 19–20, 25–27
	Rainfall helps shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.	Level 4 M1 L6–11, 25–27
	Earth has changed over time. Understanding how landforms develop, are weathered (broken down into smaller pieces), and erode (get transported elsewhere) can help infer the history of the current landscape.	Level 4 M1 L1–11, 19–20, 25–27

E1 (cont.)	The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.	Aligned *PhD Science* Lessons
4.E1U1.8	Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.	Level 3 M1 L1–15, 19–20, 27–29
	Climate describes the ranges of an area's typical weather conditions and the extent to which those conditions vary over years.	Level 3 M1 L11–15, 27–29
4.E1U3.9	Nearly all of Earth's available water is in the ocean. Most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.	Level 5 M3 L4–5, 24–27
	About two-thirds of the surface of the Earth is covered by liquid water, which is essential to life.	Level 5 M3 L4–5, 24–27
4.E1U2.10	A variety of hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts.	Level 4 M1 L12–17, 25–27

Life Science

L4	The unity and diversity of organisms, living and extinct, is the result of evolution.	Aligned *PhD Science* Lessons
4.L4U1.11	When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.	Level 3 M2 L16–28
	Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.	Level 3 M2 L1–8, 26–28
	For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	Level 3 M2 L1–2, 9–12, 16–19, 22–28

Core Ideas for Using Science

U1	**Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.**	**Aligned *PhD Science* Lessons**
	Science investigations use a variety of methods, tools, and techniques.	Level 3 M4 L15–16 Level 5 M2 L8–9
	Science findings are limited to questions that can be answered with empirical evidence.	Level 5 M3 L10–11 Level 5 M4 L5–8
	Science findings are based on recognizing patterns.	Level 3 M3 L7–8 Level 3 M4 L4–6
	Science explanations can change based on new evidence.	Level 5 M4 L14–15
	Science theories are based on a body of evidence and many tests.	Level 3 M4 L12–14
	Science explanations describe the mechanisms for natural events.	Level 5 M2 L14 Level 5 M4 L1–2, 7–8, 13
	Science is both a body of knowledge and processes that add new knowledge.	Level 5 M3 L6–8
	Science assumes consistent patterns in natural systems.	Level 4 M1 L6–7
	Basic laws of nature are the same everywhere in the universe.	Level 5 M4 L9–12, 16–17

U2	The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.	Aligned *PhD Science* Lessons
	Possible solutions to a problem are limited by available materials and resources (constraints).	Level 4 M2 L17–23
	The success of a designed solution is determined by considering the desired features of a solution(criteria.).	Level 4 M2 L17–23
	Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	Level 4 M2 L17–23
	Research on a problem should be carried out before beginning to design a solution.	Level 4 M1 L12–17 Level 4 M4 L14–17
	Testing a solution involves investigating how well it performs under a range of likely conditions.	Level 4 M1 L12–17 Level 4 M4 L14–17
	At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.	Level 4 M1 L12–17 Level 4 M4 L14–17
	Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.	Level 4 M1 L12–17 Level 4 M4 L14–17
	Technologies are developed using engineering, which involves identifying problems and using ideas of science and other ideas to design and develop possible solutions.	Level 3 M4 L23–27

U3	Applications of science often have both positive and negative ethical, social, economic, and/or political implications.	Aligned *PhD Science* Lessons
	People's needs and wants change over time, as do their demands for new and improved technologies.	Level 4 M1 L23–24 Level 4 M2 L17–23
	Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.	Level 4 M1 L12–17 Level 4 M2 L15–16 Level 4 M4 L14–17
	When new technologies become available, they can bring about changes in the way people live and interact with one another.	Level 3 M4 L22–27
	There are generally both positive and negative consequences of the applications of science.	Level 4 M1 L22–24
	While technological solutions have improved the lives and health of many people in countries across the world, it has to be recognized that they may use materials from the natural world which may be in short supply or may be detrimental to the environment.	Level 4 M1 L21–27

Science and Engineering Practices

Asking Questions and Defining Problems	**Aligned *PhD Science* Lessons**
Identify scientific (testable) and non-scientific (non-testable) questions.	Level 3 M3 L12–13 Level 3 M4 L15–16, 19–21
Ask questions based on careful observations of phenomena and information.	Level 4 M1 L1–5, 8–11, 20, 22–24, 26 Level 4 M2 L1–3, 8, 11, 16, 23–26 Level 4 M3 L1–3, 6, 19, 25, 29–31 Level 4 M4 L1–2, 4, 10–13, 24–27
Ask questions to clarify ideas or request evidence.	Level 4 M1 L1–2 Level 4 M2 L1–3, 8–9 Level 4 M3 L1–3, 6, 15–19 Level 4 M4 L1–2,
Ask questions that relate one variable to another variable.	Level 4 M2 L6–7, 15–16 Level 4 M3 L18–19 Level 4 M4 L3–8, 10–13, 18–21
Ask questions to clarify the constraints of solutions to a problem.	Level 4 M1 L12–17 Level 4 M2 L17–23 Level 4 M4 L18–21
Use prior knowledge to describe problems that can be solved.	Level 3 M4 L22, 29–30 Level 5 M3 L19–23
Define a simple design problem that can be solved through the development of an object, tool, or process, and includes several criteria for success and constraints on materials, time, or cost.	Level 4 M1 L12–17 Level 4 M2 L17–23 Level 4 M4 L14–17
Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.	Level 4 M1 L1–2, 23 Level 4 M2 L1–3, 8–9, 11, 25–26 Level 4 M3 L1–3, 6 Level 4 M4 L1–2

Developing and Using Models	**Aligned *PhD Science* Lessons**
Develop and revise models collaboratively to measure and explain frequent and regular events.	Level 4 M2 L15–16 Level 4 M4 L3–8, 10–13
Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.	Level 4 M1 L1–2, 26–27 Level 4 M2 L1–3, 8–11, 25–26 Level 4 M3 L1–3, 7–14, 30–31 Level 4 M4 L1–2
Use simple models to describe or support explanations for phenomena and test cause and effect relationships or interactions concerning the functioning of a natural or designed system.	Level 4 M3 L7–11 Level 4 M4 L10–13, 18–24
Identify limitations of models.	Level 4 M4 L14–17, 26–27
Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.	Level 4 M4 L26–27
Use a simple model to test cause and effect relationships concerning the functioning of a proposed object, tool, or process.	Level 4 M3 L7–11 Level 4 M4 L10–13, 18–24

Planning and Carrying Out Investigations	Aligned *PhD Science* Lessons
Design and conduct investigations collaboratively, using fair tests in which variables are controlled and the number of trials considered.	Level 4 M1 L8–11 Level 4 M2 L6–7 Level 4 M3 L15–19 Level 4 M4 L7–8, 18–21
Evaluate appropriate methods and/or tools for collecting data.	Level 4 M4 L7–8
Make observations and/or measurements, collect appropriate data, and identify to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.	Level 4 M1 L6–11, 21–22 Level 4 M2 L10–14 Level 4 M3 L15–19 Level 4 M4 L9, 26–27
Make measurements of two different models of the same proposed object, tool, or process to determine which better meets criteria for success.	Level 4 M4 L14–17

Analyzing and Interpreting Data	Aligned *PhD Science* Lessons
Display data in tables and graphs, using digital tools when feasible, to reveal patterns that indicate relationships.	Level 3 M1 L4–12 Level 3 M3 L7–8, 27–28 Level 3 M4 L4–9 Level 5 M2 L3–5, 10–11 Level 5 M3 L4–5, 14–16 Level 5 M4 L14–15
Use data to evaluate claims about cause and effect.	Level 4 M1 L8–11, 21–24 Level 4 M3 L21–23 Level 4 M4 L5–6, 10–13
Compare data collected by different groups in order to discuss similarities and differences in their findings.	Level 3 M3 L14–15, 19–20 Level 3 M4 L7–9 Level 5 M3 L14–16
Use data to evaluate and refine design solutions.	Level 4 M4 L14–17
Interpret data to make sense of and explain phenomena, using logical reasoning, mathematics, and/or computation.	Level 4 M1 L12–20, 23–24, 26–27 Level 4 M2 L25–26 Level 4 M4 L10–13
Analyze data to refine a problem statement or the design of a proposed object, tool, or process.	Level 4 M4 L14–17

Using Mathematics and Computational Thinking	Aligned *PhD Science* Lessons
Use mathematical thinking and/or computational outcomes to compare alternative solutions to an engineering problem.	Level 4 M4 L14–17
Organize simple data sets to reveal patterns that suggest relationships.	Level 3 M1 L4–12 Level 3 M2 L3, 16–19 Level 3 M3 L7–8 Level 5 M4 L25–26
Describe, measure, estimate, and graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.	Level 4 M2 L8–9
Decide if qualitative or quantitative data is best to determine whether a proposed object or tool meets criteria for success.	Level 3 M4 L23–27 Level 5 M4 L5–6

Constructing Explanations and Designing Solutions	Aligned *PhD Science* Lessons
Construct explanations of observed relationships (e.g., the distribution of plants in the back yard).	Level 4 M1 L6–7, 26–27 Level 4 M2 L25–26 Level 4 M3 L30–31 Level 4 M4 L18–21, 26–27
Use evidence (e.g., measurements, observations, patterns) to construct a scientific explanation or design a solution to a problem.	Level 4 M1 L3–5, 25–27 Level 4 M2 L4–5, 15–16, 24–26 Level 4 M3 L4–5, 24–25, 29–31 Level 4 M4 L25–27
Identify the evidence that supports particular points in an explanation.	Level 4 M1 L3–5, 10, 18, 21–22, 25–27
Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.	Level 5 M4 L5–6
Apply scientific ideas to solve design problems.	Level 4 M2 L17–23 Level 4 M4 L14–17, 26–27
Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.	Level 4 M1 L12–17 Level 4 M4 L14–17, 22–24

Engaging in Argument from Evidence	Aligned *PhD Science* Lessons
Construct and/or support scientific arguments with evidence, data, and/or a model.	Level 4 M3 L21–23, 26–28, 30–31
Compare and refine arguments based on the strengths and weaknesses of the evidence presented.	Level 4 M3 L21–23 Level 4 M4 L7–8
Respectfully provide and receive critiques on scientific arguments with peers by citing relevant evidence and posing specific questions.	Level 4 M3 L21–23
Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	Level 3 M1 L21–26, 28–29 Level 3 M2 L20–21 Level 5 M3 L19–23

Obtaining, Evaluating, and Communicating Information	Aligned *PhD Science* Lessons
Compare and/or combine ideas across complex texts and/or other reliable media to acquire appropriate scientific and/or technical information.	Level 3 M2 L13–15 Level 5 M2 L6–7, 20 Level 5 M3 L25–27
Determine the main idea of a scientific text and explain how it is supported by key details; summarize the text.	Level 4 M1 L3–7 Level 4 M2 L1–3, 15–23 Level 4 M3 L1–3, 6, 10–11, 15–19, 24–25 Level 4 M4 L1–2
Combine information in written text with that contained in corresponding tables, diagrams, and/or charts.	Level 5 M4 L18–19
Use multiple sources to generate and communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.	Level 4 M1 L23–24
Use models to share findings or solutions in oral and/or written presentations and/or extended discussions.	Level 4 M1 L12–17, 21–24 Level 4 M2 L17–23 Level 4 M4 L14–17
Obtain and combine information from books and/or other reliable media about potential solutions to a specific design problem.	Level 4 M1 L3–5, 23–24 Level 4 M3 L4–6, 10–11, 20–23, 26–28

Crosscutting Concepts

1	**Patterns**	**Aligned *PhD Science* Lessons**
	Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena and designed products.	Level 4 M3 L7–9, 30–31 Level 4 M4 L22–27
	Patterns of change can be used to make predictions.	Level 4 M4 L1–2
	Patterns can be used as evidence to support an explanation.	Level 4 M1 L1–5, 18–20, 26–27 Level 4 M2 L4–5, 8–11, 24–26 Level 4 M3 L1–3, 7–11, 20, 24–31 Level 4 M4 L3–4, 7–8, 14–17

2	**Cause and Effect**	**Aligned *PhD Science* Lessons**
	Cause and effect relationships are routinely identified, tested, and used to explain change.	Level 4 M1 L6–17, 21–27 Level 4 M2 L1–7, 10–14, 24–26 Level 4 M3 L6–23, 30–31 Level 4 M4 L3–13, 18–21, 25–27
	Events that occur together with regularity might or might not be a cause and effect relationship.	Level 4 M1 L19–20, 25–27

3	**Scale, Proportion, and Quantity**	**Aligned *PhD Science* Lessons**
	Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.	Level 4 M1 L3–5
	Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.	Level 3 M1 L4–10 Level 3 M3 L1–3, 14–15 Level 5 M1 L3–4, 13–17, 23–26 Level 5 M3 L1–3, 10–11, 25–27

4	Systems and System Models	Aligned *PhD Science* Lessons
	A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.	Level 4 M1 L21–24 Level 4 M2 L15–23 Level 4 M4 L14–17, 26–27
	A system can be described in terms of its components and their interactions.	Level 4 M1 L1–2, 12–17 Level 4 M2 L1–11, 24–26 Level 4 M3 L7–9, 15–19, 21–23, 26–28, 30–31 Level 4 M4 L1–6, 10–13, 18–27

5	Energy and Matter	Aligned *PhD Science* Lessons
	Matter is made of particles.	Level 5 M1 L5–8, 23–26 Level 5 M2 L6–9, 14, 25–26 Level 5 M4 L3–4
	Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.	Level 5 M2 L10–11 Level 5 M2 25–26
	Energy can be transferred in various ways and between objects.	Level 4 M2 L1–3, 8–26 Level 4 M3 L10–19, 30–31

6	Structure and Function	Aligned *PhD Science* Lessons
	Different materials have different substructures, which can sometimes be observed.	Level 4 M3 L4–5, 20, 24–25 Level 4 M4 L7–9, 25–27
	Substructures have shapes and parts that serve functions.	Level 4 M3 L4–6, 29–31

7	Stability and Change	Aligned *PhD Science* Lessons
	Change is measured in terms of differences over time and may occur at different rates.	Level 4 M1 L3–11, 18–20, 25–27
	Some systems appear stable, but over long periods of time will eventually change.	Level 3 M1 L8–10 Level 5 M2 L24–26 Level 5 M3 L14–16

PhD Science® Correlation to Arizona Science Standards: Level 5

The *PhD Science* 3–5 curriculum aligns with the Grade 5 Arizona Science Standards. A detailed analysis of alignment appears in the table below.

Key: Module (M), Lesson (L)

Grade 5 Standards

Physical Science		**Aligned *PhD Science* Lessons**
5.P1U1.1	Analyze and interpret data to explain that matter of any type can be subdivided into particles too small to see and, in a closed system, if properties change or chemical reactions occur, the amount of matter stays the same.	Level 5 M1 L5–17, 23–26
5.P1U1.2	Plan and carry out investigations to demonstrate that some substances combine to form new substances with different properties and others can be mixed without taking on new properties.	Level 5 M1 L1–2, 15–26
5.P2U1.3	Construct an explanation using evidence to demonstrate that objects can affect other objects even when they are not touching.	Level 3 M4 L19–21, 28–30 Level 4 M4 L3–4, 18–24, 25–27 Level 5 M4 L3–4, 24–26
5.P3U1.4	Obtain, analyze, and communication evidence of the effects that balanced and unbalanced forces have on the motion of objects.	Level 3 M4 L7–8, 10–18, 28–30
5.P3U2.5	Define problems and design solutions pertaining to force and motion.	Level 3 M4 L1–18, 22–30
5.P4U1.6	Analyze and interpret data to determine how and where energy is transferred when objects move.	Level 4 M2 L1–5, 8–9, 15–16, 24–26

Earth and Space Science		**Aligned *PhD Science* Lessons**
5.E2U1.7	Develop, revise, and use models based on evidence to construct explanations about the movement of the Earth and Moon within our solar system.	Level 5 M4 L1–2, 5–17, 20–26
5.E2U1.8	Obtain, analyze, and communicate evidence to support an explanation that the gravitational force of Earth on objects is directed toward the planet's center.	Level 5 M4 L3–4, 24–26

Life Science		Aligned *PhD Science* Lessons
5.L3U1.9	Obtain, evaluate, and communicate information about patterns between the offspring of plants, and the offspring of animals (including humans); construct an explanation of how genetic information is passed from one generation to the next.	Level 3 M3 L1–6, 14–18, 23–28
5.L3U1.10	Construct an explanation based on evidence that the changes in an environment can affect the development of the traits in a population of organisms.	Level 3 M3 L9–13, 19–20, 26–28
5.L4U3.11	Obtain, evaluate, and communicate evidence about how natural and human-caused changes to habitats or climate can impact populations.	Level 3 M2 L1–2, 9–12, 16–28 Level 5 M3 L14–27
5.L4U3.12	Construct an argument based on evidence that inherited characteristics can be affected by behavior and/or environmental conditions.	Level 3 M3 L9–13, 19–28

Core Ideas for Knowing Science

Physical Science

P1	All matter in the Universe is made of very small particles.	Aligned *PhD Science* Lessons
5.P1U1.1	Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means.	Level 5 M1 L5–10, 23–26
	The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish.	Level 5 M1 L9–17, 23–26
	No matter what reaction or change in properties occurs, the amount of matter does not change.	Level 5 M1 L9–17, 23–26
5.P1U1.2	When two or more different substances are mixed, a new substance with different properties may be formed. Other substances simply mix without changing permanently and can often be separated again.	Level 5 M1 L1–2, 15–26

P2	Objects can affect other objects at a distance.	Aligned *PhD Science* Lessons
5.P2U1.3	All objects have an effect on other objects without being in contact with them. In some cases the effect travels out from the source to the receiver in the form of radiation (e.g., visible light).	Level 4 M4 L3–4, 18–24, 25–27
	Electric, magnetic, and gravitational forces between a pair of objects do not require that the objects be in contact.	Level 3 M4 L19–27, 28–30
	The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	Level 5 M4 L3–4, 24–26

P3	Changing the movement of an object requires a net force to be acting on it.	Aligned *PhD Science* Lessons
5.P3U1.4	Each force acts on one particular object and has both a strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.	Level 3 M4 L10–18, 28–30
	Objects in contact exert forces on each other.	Level 3 M4 L10–18, 28–30
	How quickly an object's motion is changed depends on the force acting and the object's mass. The greater the mass of an object, the longer it takes to speed it up or slow it down.	Level 3 M4 L7–8, 10–18, 28–30
5.P3U2.5	Each force acts on one particular object and has both a strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion.	Level 3 M4 L10–18, 28–30
	The patterns of an object's motion in various situations can be observed and measured; when past motion exhibits a regular pattern, future motion can be predicted from it.	Level 3 M4 L1–9, 28–30
	How quickly an object's motion is changed depends on the force acting and the object's mass. The greater the mass of an object, the longer it takes to speed it up or slow it down.	Level 3 M4 L10–18, 28–30

P4	The total amount of energy in a closed system is always the same but can be transferred from one energy store to another during an event.	Aligned *PhD Science* Lessons
5.P4U1.6	The faster a given object is moving, the more energy it possesses.	Level 4 M2 L1–5, 8–11, 15–16, 24–26
	Energy can be moved from place to place by moving objects.	Level 4 M2 L1–5, 8–9, 24–26
	When objects collide, the contact forces transfer energy so as to change the objects' motions.	Level 4 M2 L1–5, 8–9, 24–26
	Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.	Level 4 M2 L1–5, 8–9, 24–26

Earth and Space Science

E2	The Earth and our solar system are a very small part of one of many galaxies within the Universe.	Aligned *PhD Science* Lessons
5.E2U1.7	The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.	Level 5 M4 L1–2, 5–17, 20–26
5.E2U1.8	Gravity is the universal attraction between all objects, however large or small, although it is only apparent when one of the objects is very large.	Level 5 M4 L3–4, 24–26
	The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	Level 5 M4 L3–4, 24–26

Life Science

L3	Genetic information is passed down from one generation of organisms to another.	Aligned *PhD Science* Lessons
5.L3U1.9	Many characteristics of organisms are inherited from their parents.	Level 3 M3 L14–18, 26–28
	Different organisms vary in how they look and function because they have different inherited information.	Level 3 M3 L1–6, 14–18, 23–28
5.L3U1.10	Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment.	Level 3 M3 L9–13, 19–20, 26–28
	The environment also affects the traits that an organism develops. Differences in where they grow or in the food they consume may cause organisms that are related to end up looking or behaving differently.	Level 3 M3 L9–13, 19–20

L4	The unity and diversity of organisms, living and extinct, is the result of evolution.	Aligned *PhD Science* Lessons
5.L4U3.11	Populations of organisms live in a variety of habitats and change in those habitats affects the organisms living there.	Level 3 M2 L16–28
	Changes in an organism's habitat are sometimes beneficial to it and sometimes harmful. For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	Level 3 M2 L1–2, 9–12, 16–19, 22–28
5.L4U3.12	Sometimes the differences in characteristics between individuals of the same species provide advantage sin surviving, finding mates, and reproducing.	Level 3 M3 L21–28
	Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment.	Level 3 M3 L9–13, 19–20, 26–28 Level 5 M3 L14–27

Core Ideas for Using Science

U1	**Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.**	**Aligned *PhD Science* Lessons**
	Science investigations use a variety of methods, tools, and techniques.	Level 5 M2 L8–9
	Science findings are limited to questions that can be answered with empirical evidence.	Level 5 M3 L10–11 Level 5 M4 L5–8
	Science findings are based on recognizing patterns.	Level 5 M4 L14–15
	Science explanations can change based on new evidence.	Level 5 M4 L14–15
	Science theories are based on a body of evidence and many tests.	Level 3 M4 L12–14
	Science explanations describe the mechanisms for natural events.	Level 5 M2 L14 Level 5 M4 L1–2, 7–8, 13
	Science is both a body of knowledge and processes that add new knowledge.	Level 5 M3 L6–8
	Science assumes consistent patterns in natural systems.	Level 5 M1 L7–8
	Basic laws of nature are the same everywhere in the universe.	Level 5 M4 L9–12, 16–17

U2	**The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.**	**Aligned *PhD Science* Lessons**
	Possible solutions to a problem are limited by available materials and resources (constraints).	Level 5 M2 L21–23
	The success of a designed solution is determined by considering the desired features of a solution(criteria.).	Level 5 M2 L21–23
	Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	Level 5 M2 L21–23
	Research on a problem should be carried out before beginning to design a solution.	Level 5 M3 L19–23
	Testing a solution involves investigating how well it performs under a range of likely conditions.	Level 5 M3 L19–23
	At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.	Level 5 M2 L21–23 Level 5 M3 L19–23
	Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.	Level 5 M1 L18–22
	Technologies are developed using engineering, which involves identifying problems and using ideas of science and other ideas to design and develop possible solutions.	Level 3 M4 L23–27

U3	**Applications of science often have both positive and negative ethical, social, economic, and/or political implications.**	**Aligned *PhD Science* Lessons**
	People's needs and wants change over time, as do their demands for new and improved technologies.	Level 5 M2 L21–23
	Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.	Level 5 M2 L21–23 Level 5 M3 L19–23
	When new technologies become available, they can bring about changes in the way people live and interact with one another.	Level 3 M4 L22–27
	There are generally both positive and negative consequences of the applications of science.	Level 5 M3 L14–18
	While technological solutions have improved the lives and health of many people in countries across the world, it has to be recognized that they may use materials from the natural world which may be in short supply or may be detrimental to the environment.	Level 5 M3 L14–18, 24–27

Science and Engineering Practices

Asking Questions and Defining Problems	**Aligned *PhD Science* Lessons**
Identify scientific (testable) and non-scientific (non-testable) questions.	Level 3 M3 L12–13 Level 3 M4 L15–16, 19–21
Ask questions based on careful observations of phenomena and information.	Level 5 M1 L1–3, 8–10, 22–26 Level 5 M2 L1–2, 6–7, 24–26 Level 5 M3 L1–3, 8, 13, 24–27 Level 5 M4 L1–2, 14–15, 24–26
Ask questions to clarify ideas or request evidence.	Level 5 M1 L1–2 Level 5 M2 L1–2, 21–23 Level 5 M3 L1–3, 19–23 Level 5 M4 L1–2, 13
Ask questions that relate one variable to another variable.	Level 5 M1 L5–6, 18–22 Level 5 M2 L1–5, 8–9 Level 5 M3 L10–11 Level 5 M4 L1–2, 5–8, 14–19, 22–23
Ask questions to clarify the constraints of solutions to a problem.	Level 5 M1 L18–22 Level 5 M2 L21–23 Level 5 M3 L19–23
Use prior knowledge to describe problems that can be solved.	Level 5 M3 L19–23
Define a simple design problem that can be solved through the development of an object, tool, or process, and includes several criteria for success and constraints on materials, time, or cost.	Level 5 M2 L21–23
Formulate questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.	Level 5 M1 L1–2 Level 5 M2 L1–2 Level 5 M3 L1–3 Level 5 M4 L1–2, 13

Developing and Using Models	Aligned *PhD Science* Lessons
Develop and revise models collaboratively to measure and explain frequent and regular events.	Level 5 M1 L5–6 Level 5 M2 L1–2, 6–7 Level 5 M4 L1–2, 7–8, 14–17
Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.	Level 5 M1 L7–8 Level 5 M2 L20, 25–26 Level 5 M3 L6–8, 10–11, 24–27 Level 5 M4 L3–4, 24–26
Use simple models to describe or support explanations for phenomena and test cause and effect relationships or interactions concerning the functioning of a natural or designed system.	Level 5 M3 L12–13 Level 5 M4 L9–12
Identify limitations of models.	Level 5 M1 L5–6 Level 5 M2 L14 Level 5 M3 L6–8, 25–27
Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.	Level 5 M3 L19–23
Use a simple model to test cause and effect relationships concerning the functioning of a proposed object, tool, or process.	Level 5 M3 L12–13 Level 5 M4 L9–12

Planning and Carrying Out Investigations	Aligned *PhD Science* Lessons
Design and conduct investigations collaboratively, using fair tests in which variables are controlled and the number of trials considered.	Level 5 M1 L18–22 Level 5 M2 L3–5 Level 5 M4 L25–26
Evaluate appropriate methods and/or tools for collecting data.	Level 5 M2 L3–5
Make observations and/or measurements, collect appropriate data, and identify to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.	Level 5 M1 L13–14, 24–26 Level 5 M3 L10–11 Level 5 M4 L18–19
Make measurements of two different models of the same proposed object, tool, or process to determine which better meets criteria for success.	Level 4 M4 L14–17

Analyzing and Interpreting Data	Aligned *PhD Science* Lessons
Display data in tables and graphs, using digital tools when feasible, to reveal patterns that indicate relationships.	Level 5 M2 L3–5, 10–11 Level 5 M3 L4–5, 14–16 Level 5 M4 L14–15
Use data to evaluate claims about cause and effect.	Level 5 M1 L5–6, 9–10 Level 5 M2 L12–13, 18–19 Level 5 M3 L14–16
Compare data collected by different groups in order to discuss similarities and differences in their findings.	Level 5 M3 L14–16
Use data to evaluate and refine design solutions.	Level 4 M4 L14–17
Interpret data to make sense of and explain phenomena, using logical reasoning, mathematics, and/or computation.	Level 5 M1 L15–17, 24–26 Level 5 M2 L8–9, 12–13, 15–17, 25–26 Level 5 M3 L4–5, 25–27
Analyze data to refine a problem statement or the design of a proposed object, tool, or process.	Level 4 M4 L14–17

Using Mathematics and Computational Thinking	Aligned *PhD Science* Lessons
Use mathematical thinking and/or computational outcomes to compare alternative solutions to an engineering problem.	Level 4 M4 L14–17
Organize simple data sets to reveal patterns that suggest relationships.	Level 5 M4 L25–26
Describe, measure, estimate, and graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.	Level 5 M1 L3–4, 15–17 Level 5 M3 L10–11, 24–27
Decide if qualitative or quantitative data is best to determine whether a proposed object or tool meets criteria for success.	Level 5 M4 L5–6

Constructing Explanations and Designing Solutions	Aligned *PhD Science* Lessons
Construct explanations of observed relationships (e.g., the distribution of plants in the back yard).	Level 5 M2 L12–13, 25–26 Level 5 M4 L22–26
Use evidence (e.g., measurements, observations, patterns) to construct a scientific explanation or design a solution to a problem.	Level 5 M1 L5–6, 23–26 Level 5 M2 L15–17, 24–26 Level 5 M3 L17–18 , 25–27 Level 5 M4 L24–26
Identify the evidence that supports particular points in an explanation.	Level 5 M1 L11–12, 23–26 Level 5 M2 L24–26 Level 5 M4 L20–21, 24–26
Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.	Level 5 M4 L5–6
Apply scientific ideas to solve design problems.	Level 5 M4 L9–12
Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.	Level 5 M1 L18–22 Level 5 M2 L21–23 Level 5 M3 L19–23 Level 5 M4 L3–4

Engaging in Argument from Evidence	Aligned *PhD Science* Lessons
Construct and/or support scientific arguments with evidence, data, and/or a model.	Level 5 M1 L3–4, 24–26 Level 5 M2 L3–5, 8–11, 25–26 Level 5 M3 L25–27 Level 5 M4 L13–17, 20–21, 24–26
Compare and refine arguments based on the strengths and weaknesses of the evidence presented.	Level 3 M3 L16–18 Level 4 M3 L21–23 Level 4 M4 L7–8
Respectfully provide and receive critiques on scientific arguments with peers by citing relevant evidence and posing specific questions.	Level 5 M2 L3–5, 21–23, 25–26
Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	Level 5 M3 L19–23

Obtaining, Evaluating, and Communicating Information	Aligned *PhD Science* Lessons
Compare and/or combine ideas across complex texts and/or other reliable media to acquire appropriate scientific and/or technical information.	Level 5 M2 L6–7, 20 Level 5 M3 L25–27
Determine the main idea of a scientific text and explain how it is supported by key details; summarize the text.	Level 5 M1 L1–2, 15–17 Level 5 M2 L1–2, 6–7, 14, 18–23 Level 5 M3 L1–2, 6–8, 10–11, 19–23 Level 5 M4 L1–2, 16–17, 24–26
Combine information in written text with that contained in corresponding tables, diagrams, and/or charts.	Level 5 M4 L18–19
Use multiple sources to generate and communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.	Level 3 M2 L20–21 Level 4 M1 L23–24
Use models to share findings or solutions in oral and/or written presentations and/or extended discussions.	Level 5 M1 L18–22 Level 5 M3 L19–23 Level 5 M4 L9–12
Obtain and combine information from books and/or other reliable media about potential solutions to a specific design problem.	Level 5 M3 L9, 14–16, 19–27

Crosscutting Concepts

1	**Patterns**	**Aligned *PhD Science* Lessons**
	Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena and designed products.	Level 5 M4 L5–6, 13–17, 22–23
	Patterns of change can be used to make predictions.	Level 5 M4 L9–12, 20–21, 24–26
	Patterns can be used as evidence to support an explanation.	Level 5 M1 L7–8 Level 5 M2 L1–5, 8–9, 15–17, 25–26 Level 5 M3 L6–9 Level 5 M4 L1–4, 7–8, 24–26

2	**Cause and Effect**	**Aligned *PhD Science* Lessons**
	Cause and effect relationships are routinely identified, tested, and used to explain change.	Level 5 M1 L1–2, 5–6, 9–10, 18–22, 24–26 Level 5 M2 L3–7, 12–13, 18–19, 21–23, 25–26 Level 5 M3 L6–8, 12–13, 17–18, 25–27 Level 5 M4 L5–6, 24–26
	Events that occur together with regularity might or might not be a cause and effect relationship.	Level 5 M2 L20 Level 5 M3 L14–16

3	**Scale, Proportion, and Quantity**	**Aligned *PhD Science* Lessons**
	Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.	Level 5 M1 L23–26 Level 5 M2 L10–11 Level 5 M3 L4–5, 24–27 Level 5 M4 L18–19, 24–26
	Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.	Level 5 M1 L3–4, 13–17, 23–26 Level 5 M3 L1–3, 10–11, 25–27

4	**Systems and System Models**	**Aligned *PhD Science* Lessons**
	A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.	Level 5 M2 L14, 18–19, 24–26 Level 5 M3 L6–8
	A system can be described in terms of its components and their interactions.	Level 5 M1 L3–4, 15–17 Level 5 M2 L1–2, 6–11, 24–26 Level 5 M3 L1–9, 12–13, 19–27 Level 5 M4 L1–2, 7–26

5	**Energy and Matter**	**Aligned *PhD Science* Lessons**
	Matter is made of particles.	Level 5 M1 L5–8, 23–26 Level 5 M2 L6–9, 14, 25–26 Level 5 M4 L3–4
	Matter flows and cycles can be tracked in terms of the weight of the substances before and after a process occurs. The total weight of the substances does not change. This is what is meant by conservation of matter. Matter is transported into, out of, and within systems.	Level 5 M2 L10–11 Level 5 M2 25–26
	Energy can be transferred in various ways and between objects.	Level 5 M1 L13–14 Level 5 M2 L15–19, 24–26 Level 5 M3 L10–11

6	**Structure and Function**	**Aligned *PhD Science* Lessons**
	Different materials have different substructures, which can sometimes be observed.	Level 3 M2 L1–3 Level 4 M3 L4–5, 20, 24–25 Level 4 M4 L7–9, 25–27
	Substructures have shapes and parts that serve functions.	Level 3 M2 L9–12 Level 3 M3 L4–6, 21–28 Level 4 M3 L4–6, 29–31

7	**Stability and Change**	**Aligned *PhD Science* Lessons**
	Change is measured in terms of differences over time and may occur at different rates.	Level 5 M1 L1–2, 9–12, 18–26 Level 5 M2 L12–13, 20, 25–26 Level 5 M3 L17–18 Level 5 M4 L5–6, 9–12, 24–26
	Some systems appear stable, but over long periods of time will eventually change.	Level 5 M2 L24–26 Level 5 M3 L14–16