Where Wild Microbes Grow can be used to meet both language arts and science standards for all grade levels.

It is a nonfiction book that can be used to meet **Common Core Standards** related to **Reading Informational Texts**.

It can also be used to introduce and reinforce a variety of science standards, and to **teach science concepts such as habitats, adaptations, the difference between living and nonliving things, energy flow though ecosystems, and the methods and technology used in scientific research**. Below are specific science concepts reached by *Where Wild Microbes Grow*. This list of concepts is drawn from the Ocean Literacy Principles, the Earth Science Literacy Principles, and the Next Generation Science Standards.

Ocean Literacy: Essential Principles and Fundamental Concepts

http://oceanservice.noaa.gov/education/literacy/ocean_literacy.pdf

Principle 1: The Earth has one big ocean with many features.

B. Ocean basins are composed of the seafloor and all of its geological features (such as islands, trenches, mid-ocean ridges, and rift valleys) and vary in size, shape and features due to the movement of Earth's crust (lithosphere). Earth's highest peaks, deepest valleys and flattest plains are all in the ocean.

Principle 5: The ocean supports a great diversity of life and ecosystems.

A. Ocean life ranges in size from the smallest living things, microbes, to the largest animal on Earth, blue whales.

B. Most of the organisms and biomass in the ocean are microbes, which are the basis of all ocean food webs. Microbes are the most important primary producers in the ocean. They have extremely fast growth rates and life cycles, and produce a huge amount of the carbon and oxygen on Earth.

D. Ocean biology provides many unique examples of life cycles, adaptations, and important relationships among organisms (symbiosis, predator-prey dynamics, and energy transfer) that do not occur on land.

E. The ocean provides a vast living space with diverse and unique ecosystems from the surface through the water column and down to, and below, the seafloor. Most of the living space on Earth is in the ocean.

F. Ocean ecosystems are defined by environmental factors and the community of organisms living there. Ocean life is not evenly distributed through time or space due to differences in abiotic factors such as oxygen, salinity, temperature, pH, light, nutrients, pressure, substrate, and circulation. A few regions of the ocean support the most abundant life on Earth, while most of the ocean does not support much life.

G. There are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms. Hydrothermal vents, submarine hot springs, and methane cold seeps, rely only on chemical energy and chemosynthetic organisms to support life.

Principle 6: The ocean and humans are inextricably interconnected.

B. The ocean provides food, medicines, and mineral and energy resources. It supports jobs and national economies, serves as a highway for transportation of goods and people, and plays a role in national security.

Principle 7: The ocean is largely unexplored.

A. The ocean is the largest unexplored place on Earth—less than 5% of it has been explored. The next generation of explorers and researchers will find great opportunities for discovery, innovation, and investigation.

D. New technologies, sensors, and tools are expanding our ability to explore the ocean. Scientists are relying more and more on satellites, drifters, buoys, subsea observatories, and unmanned submersibles.

F. Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, physicists, animators, and illustrators. And these interactions foster new ideas and new perspectives for inquiries.

Earth Science Literacy Principles
http://www.earthscienceliteracy.org

BIG IDEA 1. Earth scientists use repeatable observations and testable ideas to understand and explain our planet.

1.1 **Earth scientists find solutions to society's needs.** Earth scientists work on challenging problems that face humanity on topics such as climate change and human impacts on Earth. Earth scientists successfully predict hazards to humans and locate and recover natural resources, making possible the flourishing of humans on Earth.

1.2 **Earth scientists use a large variety of scientific principles to understand how our planet works.** Earth scientists combine study of Earth's geology with aspects of biology, chemistry, physics, and mathematics in order to understand the complexities of the Earth system.

1.3 **Earth science investigations take many different forms.** Earth scientists do reproducible experiments and collect multiple lines of evidence. This evidence is taken from field, analytical, theoretical, experimental, and modeling studies.

1.7 **Technological advances, breakthroughs in interpretation, and new observations continuously refine our understanding of Earth.** This Earth Science Literacy framework must be a living document that grows along with our changing ideas and concepts of Earth.

BIG IDEA 3. Earth is a complex system of interacting rock, water, air, and life.

3.2 All Earth processes are the result of energy flowing and mass cycling within and between Earth's systems. This energy is derived from the sun and Earth's interior. The flowing energy and cycling matter cause chemical and physical changes in Earth's materials and living organisms. For example, large amounts of carbon continually cycle among systems of rock, water, air, organisms, and fossil fuels such as coal and oil.

3.4 Earth's systems interact over a wide range of temporal and spatial scales. These scales range from microscopic to global in size and operate over fractions of a second to billions of years. These interactions among Earth's systems have shaped Earth's history and will determine Earth's future.

BIG IDEA 5. Earth is the water planet.

5.1 Water is found everywhere on Earth, from the heights of the atmosphere to the depths of the mantle. Early in Earth's history, surface water accumulated through both outgassing from its interior and the capture of some extraterrestrial ice. Water vapor in the atmosphere condensed and rained out as the planet cooled.

5.2 Water is essential for life on Earth. Earth is unique in our Solar System in that water has coexisted at Earth's surface in three phases (solid, liquid, and gas) for billions of years, allowing the development and continuous evolution of life.

5.5 Earth's water cycles among the reservoirs of the atmosphere, streams, lakes, ocean, glaciers, groundwater, and deep interior of the planet. The total amount of water at Earth's surface has remained fairly constant over geologic time, although its distribution among reservoirs has varied.

BIG IDEA 6. Life evolves on a dynamic Earth and continuously modifies Earth.

6.3 Biological diversity, both past and present, is vast and largely undiscovered. New species of living and fossil organisms are continually found and identified. All of this diversity is interrelated through evolution.

6.5 Microorganisms dominated Earth's early biosphere and continue today to be the most widespread, abundant, and diverse group of organisms on the planet. Microbes change the chemistry of Earth's surface and play a critical role in nutrient cycling within most ecosystems.

6.8 Life changes the physical and chemical properties of Earth's geosphere, hydrosphere, and atmosphere. Living organisms produced most of the oxygen in the atmosphere through photosynthesis and provided the substance of fossil fuels and many sedimentary rocks. The fossil record provides a means for understanding the history of these changes.

6.9 Life occupies a wide range of Earth's environments, including extreme environments. Some microbes live in rocks kilometers beneath the surface, within glacial ice, and at seafloor vents where hot fluids escape from the oceanic crust. Some of these environments may be similar to the conditions under which life originated, and to environments that exist on other planets and moons.

Next Generation Science Standards

http://www.nextgenscience.org/next-generation-science-standards

Crosscutting Concepts:

3. Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

5. Energy and matter: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

6. Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

Nature of Science Concepts

- Scientific Investigations Use a Variety of Methods
- Scientific Knowledge is Based on Empirical Evidence
- Scientific Knowledge is Open to Revision in Light of New Evidence
- Scientific Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- Science is a Way of Knowing
- Scientific Knowledge Assumes an Order and Consistency in Natural Systems
- Science is a Human Endeavor
- Science Addresses Questions About the Natural and Material World

Science, Technology, Society and the Environment Concept

- The Interdependence of Science, Engineering, and Technology

Life Science Disciplinary Core Ideas

- Matter and Energy in Organisms and Ecosystems
- Natural Selection and Adaptations
- Interdependent Relationships in Ecosystems