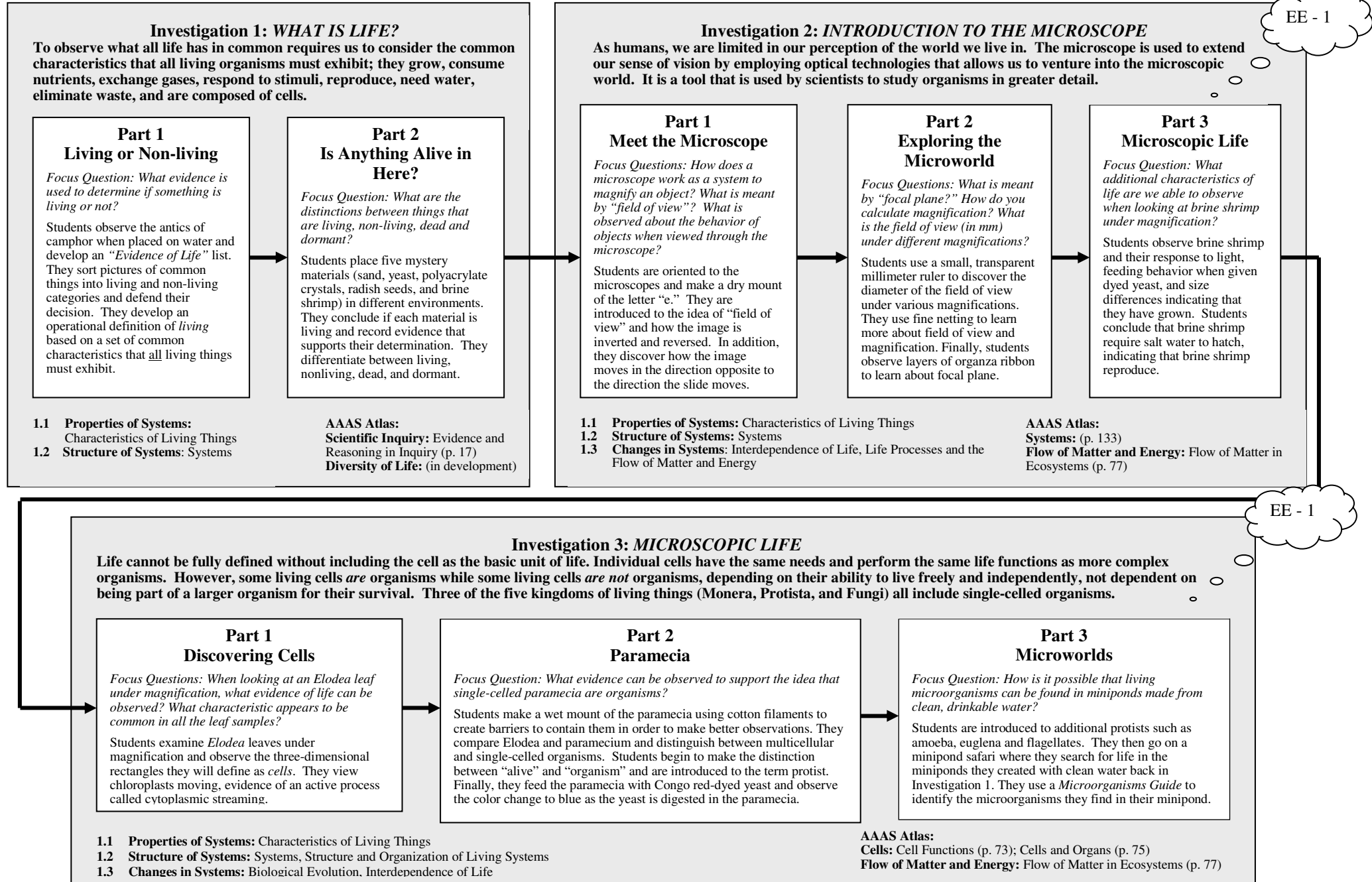


Conceptual Story: FOSS *DIVERSITY OF LIFE*



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Investigation 4: *THE CELL*

Life happens in cells. No matter how simple or complex an organism is, it is made of cells, and the cells are alive. Cells have defining structures, such as a membrane, cell wall, nucleus, chloroplasts, and cytoplasm. A major subdivision in cells is whether they have a nucleus (eukaryote) or not (prokaryote). The diversity of cells helps us understand the diversity of life on Earth.

EE - 1
HBS - 1

Part 1 Human Cells

Focus Questions: What are humans made of? What evidence do we have that humans not only have cells, but are cells?

Students stain and observe cheek cells under magnification. This suggests that humans are constructed of cells. They discuss how the millions of cells in the body get the resources, like food and water, that they need to stay alive. They conclude that all life is aquatic at the cellular level.

- 1.1 **Properties of Systems:** Characteristics of Living Things
- 1.2 **Structure of Systems:** Structure and Organization of Living Systems
- 1.3 **Changes in Systems:** Life Processes and the Flow of Matter and Energy

Part 2 Ribbon of Life

Focus Questions: What are the cellular structures that define cells? How are cells organized into more advanced levels or organization?

Students integrate cell theory into their developing concept of life through the use of the *Ribbon of Life* CD-ROM. The ribbon starts with atoms, advances to molecules, and goes on to cells. It highlights cellular structures and more advanced levels of organization: tissue, organ, organ system, and complex multi-sensory organism. All along, students reflect on the need for water, nutrients, gas exchange, and waste removal.

AAAS Atlas:
Cells: Cell Functions (p. 73);
Cells and Organs (p. 75)

Investigation 5: *SEEDS OF LIFE*

Seeds are living organisms in a dormant state. Inside the seed, one can observe the first developmental stages of a new plant in the form of the *embryo*. The cells in the tiny embryo are alive; they are filled with water, they are exchanging gases, consuming energy, and expelling waste, just like every other living cell, but the cells in the seed are doing it *very slowly*. Water is the key ingredient in the resumption of growth and development of the embryo into a new plant.

HBS - 2

Part 1 Lima Bean Dissection

Focus Questions: Are seeds living or nonliving? How do the three main parts of a seed work together to produce a new plant?

Students soak a dry lima bean in their mouth and notice the change in the outside seed coat. They split the seed in half and observe the embryo and cotyledons. They identify the *endosperm*, a starchy materials that supplies food to the plant as it starts to grow.

- 1.1 **Properties of Systems:** Characteristics of Living Things
- 1.2 **Structure of Systems:** Systems, Structure and Organization of Living Systems
- 1.3 **Changes in Systems:** Interdependence of Life, Life Processes and the Flow of Matter and Energy

Part 2 Sprouting Monocots and Dicots

Focus Questions: What is germination? What sequence of developments do you observe during the germination of radish and rye grass seeds?

Students plant radish and rye grass seeds in petri dish minisprouters. Over the course of three days, they observe the cotyledons and the orientation of the roots and shoots. They focus on the root as the first structure to emerge from the seed and its function in the developing plant. Some of the sprouting seeds are returned to the dark while others are left exposed to light.

Part 3 Root Cells

Focus Questions: Do all the cells in the root look alike? How are they different?

Students stain and observe a root tip with a microscope. They describe the regions of differentiation in a root: the root cap, a zone of elongation, and a zone of maturation. They discuss the vital functions performed by roots in the lives of plants. They are introduced to the idea of cell specialization within the root. Finally, students consider if a stalk of celery with no roots is able to take up water.

AAAS Atlas:
Cells: Cell Functions (p. 73)

Investigation 6: *TRANSPIRATION*

The study of *transpiration* in plants reinforces a basic life function, in this case the universal need for access to water. A plant that has adopted a terrestrial lifestyle must be equipped with an elaborate vascular system to transport water to all the cells throughout the plant. Stomates on leaves regulate the rate of water flow through a plant. This evaporation-driven process has given plants the evolutionary benefit to assume a seemingly unlimited diversity of growth forms. From a cactus to a dandelion, plants rely on a version of this water-delivery system to bring life to and nourish all its cooperating cells.

FV

Part 1 What Happened to the Water?

Focus Questions: What evidence supports the fact that the celery stalk caused the water to disappear? What evidence supports the fact that water did not collect in the celery stalk?

Students observe that after one day, the water level in the vial containing a stalk of celery went down. They are challenged to design an investigation to quantitatively show if the water went into the celery, spilled, or possibly evaporated.

- 1.1 **Properties of Systems:** Characteristics of Living Things
- 1.2 **Structure of Systems:** Structure and Organization of Living Systems
- 1.3 **Changes in Systems:** Life Processes and the Flow of Matter and Energy, Biological Evolution, Interdependence of Life

Part 2 Looking at Leaves

Focus Questions: How does water move throughout the plant? If water does not collect in the plant, how does it escape?

Students observe that red food coloring flows through the vascular system (xylem) of a celery stalk. This suggests that water moves through the stalk and to the leaves and escapes. Students study the leaves of the Wandering Jew plant under the microscope and discover stomates. They explain how stomates open and close to regulate the rate of transpiration by observing wilted and crisp celery leaves. They discover the *Elodea* plant has no stomates, as they have no need to regulate water loss.

Part 3 Trees and Shrubs

Focus Questions: What role does transpiration play in the earth's water cycle?

Students attempt to provide concrete evidence that water, in the form of vapor, is escaping from a plant, possibly through the stomates. As evidence of transpiration, they wrap a portion of a growing plant in a plastic bag in an effort to capture the water vapor that leaves the plant and condenses inside the bag.

AAAS Atlas:
Evolution of Life: Biological Evolution (p. 81); Natural Selection (p. 83)

Conceptual Story: FOSS *DIVERSITY OF LIFE*

PE
EE - 1

Investigation 7: PLANT REPRODUCTION
 Flowers are serious investments of energy and material resources for plants and involve the survival of the species. The reproductive system in flowers helps us to understand the origin of seeds. This involves cells from two different sources (pollen on the stamens and eggs in the ovary) coming together and fusing into one cell. That cell is alive. From this union, seeds are produced. A plant's adaptations for seed dispersal help guarantee the survival of the species.

**Part 1
Flower Dissection**

Focus Questions: What are the major structures of flowers? What is the function of flowers and pollination in the sexual reproduction in plants?

Students dissect flower to learn about their parts and their role in sexual reproduction. They study pollination and the diverse structures and elaborate relationships that lead to fertilization.

**Part 2
Seed Dispersal**

Focus Questions: How is a seed produced? What are some seed dispersal mechanisms? How do seed dispersal mechanisms contribute to a plant's survival?

Students review pollination and how seeds are the result of sexual reproduction. They discuss the ultimate measure of an organism's success is its ability to survive until it reproduces. They are introduced to seed-dispersal features as a plant's means to move and get away from the parent plant. Students conduct a seed hunt and organize the seeds according to the different seed dispersal features.

PE
EE - 2

1.1 Properties of Systems: Characteristics of Living Things
1.2 Structure of Systems: Structure and Organization of Living Systems, Molecular Basis of Heredity
1.3 Changes in Systems: Biological Evolution, Interdependence of Life

AAAS Atlas:
Evolution of Life: Natural Selection (p. 83)
Heredity: DNA and Inherited Characteristics (p. 69)

Investigation 8: SNAILS
 Snails offer an opportunity to observe and analyze the structures and behaviors of this invertebrate animal and to appreciate what it does and how it does it in order to survive and reproduce. From this comes an understanding of what type of habitat is required to secure and support a snail. It also allows for the exercise of scientific objectivity as students critically review their thinking and report behaviors they observe as snails go about their life-perpetuating business.

**Part 1
Meet the Land Snail**

Focus Questions: What can you observe about a snail's structures and movement? How does a hand lens and flashlight enhance your observations?

Students handle and observe land snails to familiarize themselves with some of the internal and external structures and how snails move. They record what they know about snails and what they would like to find out about them.

**Part 2
Snail Habitats**

Focus Questions: How would you design a fair test to observe the different preference of a snail? What would a model habitat include that would meet the needs of snails?

Students are challenged to discover the elements of a good habitat for snails. They investigate how snails interact with surface substrates, food, water, and each other. They learn about a snail's preferences for a number of environmental variables. Students discuss *anthropomorphism*, giving human characteristics, emotions, or thoughts to nonhuman objects.

**Part 3
Snail Comparisons**

Focus Questions: What are some similarities and differences between snails and other organisms?

Students observe how snails eat chalk and discuss their constant need for calcium to make their shells. Students look at a variety of seashells and identify those that are from marine snails. Students complete Venn diagrams to show similarities and differences between different organisms.

PE
EE - 1

1.1 Properties of Systems: Characteristics of Living Things
1.2 Structure of Systems: Structure and Organization of Living Systems
1.3 Changes in Systems: Interdependence of Life

AAAS Atlas:
Diversity of Life: (under development)

Investigation 9: ROACHES
 Insects are the most successful and most diverse category of animals on Earth, and they are far and away the most numerous. Variation and evolution are responsible for structural and behavioral adaptations that allow insects, and in particular roaches, to survive and reproduce in just about any habitat on Earth. Genetics is responsible for diversity. Who will survive depends on who is best adapted to survive in a stressful environment. Insects rule the land. Their diversity is phenomenal. A roach's natural history and habitat is a study in adaptation. Roaches are so successful due to their size, mobility, reproductive potential, and structure.

**Part 1
Introducing Insects**

Focus Questions: What are examples of behavioral and structural adaptations that have allowed some insects to survive and reproduce?

Students read *The Insect Empire* and complete the student sheet, *Insect Adaptations*. They learn about insect parts and observe multimedia insects. They are introduced to cockroaches and make a list about what they know about these insects.

**Part 2
Cockroaches**

Focus Questions: How do cockroaches respond to such stimuli as wind, water, smells, food, antennae handling, and movement? What questions do you have about cockroaches that you'd like to investigate?

Students observe Madagascar hissing cockroaches. After the initial observations of cockroach structures and behaviors, students generate questions and attempt to answer them by designing and conducting controlled experiments.

**Part 3
Cockroach Habitat**

Focus Questions: What is the natural habitat of a cockroach? How do cockroaches live in their natural environment?

Students gather information from the CD-ROM, the readings, and direct experiences with cockroaches to solidify the concept of adaptation. They infer things about an organism's habitat by studying its physical and behavioral adaptations.

EE
PE

1.1 Properties of Systems: Characteristics of Living Things
1.2 Structure of Systems: Structure and Organization of Living Systems
1.3 Changes in Systems: Biological Evolution, Interdependence of Life

AAAS Atlas:
Evolution of Life: Biological Evolution (p. 81); Natural Selection (p. 83)

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Investigation 10: *KINGDOMS OF LIFE*

Microscopic life is busily acquiring the resources needed to survive and reproduce. The fact remains that the vast majority of the Monera (bacteria), Protista (algae), and Fungi kingdoms are content to pursue lifestyles that do not conflict with ours, but rather benefit our well being in transforming foods and recycling nutrients through decomposition. *Microbe* is the general name for microscopic bacteria and fungi. While few microbes cause disease, most are harmless or beneficial to life on Earth. The metabolic activities of these tiniest living organisms are essential to maintaining the ecological balance of the planet.

Part 1 Bacteria and Fungi

Focus Questions: Where do you find bacteria and fungi? In order to grow and reproduce, what will bacteria and fungi need? How is it possible to see bacteria and fungi with the naked eye?

Students discuss microbes and where they might be found. They inoculate sterile nutrient agar with bacterial from the local environment. They then inoculate bread with fungus spores from the environment. They observe their agar plates and bread over several days and look for evidence of bacteria and fungus.

Part 2 Exponential Growth

Focus Questions: How long do you think it will take for one bacterium to reproduce to become a colony of one million? What other information would you need to make a reasonable prediction?

Students grapples with just how large a million is, and experience the potential of exponential growth when the doubling time is small, as it is for bacteria. They watch a video, *The Unknown World*, and work with the CD-ROM to learn about microorganisms in their environment.

Part 3 Microbes We Eat

Focus Questions: What is the role of microorganisms in transforming foods and recycling nutrients through decomposition?

Students consider the influence that microscopic organisms have on our contemporary cuisine through the sampling of such foods as cheese, yogurt, root beer, ice cream, sourdough bread, sour cream, apple cider vinegar, etc.

1.1 Properties of Systems: Characteristics of Living Things
1.3 Changes in Systems: Life Processes and the Flow of Matter and Energy, Interdependence of Life

AAAS Atlas:
Flow of Matter and Energy: The Flow of Matter in Ecosystems (p. 77)
The Nature of Mathematics: Mathematical Models (p. 29)
Physical Health: Disease (p. 87)