NUMBERS IN NATURE
A MIRROR MAZE

museum of
science+industry
chicago

TEACHER RESOURCE PACKET

Numbers in Nature: A Mirror Maze, an interactive and immersive exhibit created by the Museum of Science and Industry, Chicago, reveals and explains the mathematical patterns that abound in the natural world— from the delicate nested spirals of a sunflower's seeds, to the ridges of a majestic mountain range, to the layout of the universe. Through hands-on activities, an immersive film, a mirror maze and mathematical artifacts, *Numbers in Nature* provides a unique perspective of our daily surroundings.

EXHIBIT EXPERIENCES

Introduction to Patterns:

An immersive theater presentation of a large-format media piece features stunning footage of nature, the human body, and even art and architecture, with overlaid animation that uncovers mathematical patterns—spirals, the Golden Ratio (Φ), Voronoi patterns and fractal branching—beneath these familiar objects. Building upon the examples in the theater, an interactive area allows guests to identify patterns that surround them every day and to create numerical patterns of their own.

The Mirror Maze:

The centerpiece of the exhibit exposes guests to a pattern of triangles that repeat in a dizzying array of mirrors. This fascinating, yet challenging, space envelops guests within what appears to be an endless pattern—1,800 square feet of it! Guests encounter intriguing questions and activities to further immerse themselves in the repetition, symmetry and tessellation presented in the maze. Dead ends are scattered throughout, and hidden within this self-guided experience is a small secret room with bonus puzzles, imagery and artifacts.
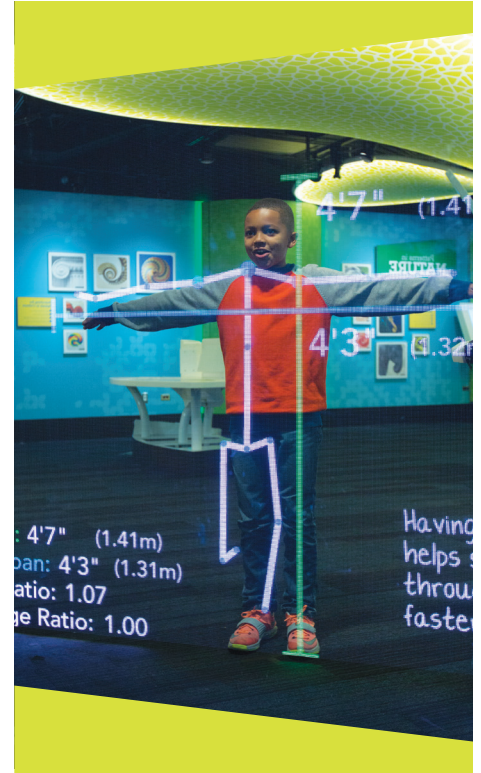
Hands-on Discovery:

Upon leaving the maze, guests have more opportunities for hands-on activities in a final gallery. Highlights include:

- Step in front of a large two-way mirror and strike various poses while a projection superimposes patterns and proportions on your body in real time.

- Observe just how much symmetry—or lack thereof—is present in the human face.

- Draw patterns on a digital screen—like connecting dots to draw spirals and creating Fibonacci rectangles—and see real-world objects that show that same pattern.

- Compose a piece of music using symmetry: vary a single musical motive and hear your creation.

CENTRAL IDEAS OF *NUMBERS IN NATURE*

Nature has an inherent structure that can be expressed through numeric and geometric patterns.

These mathematical tools help us understand, manipulate, and appreciate the world around us.
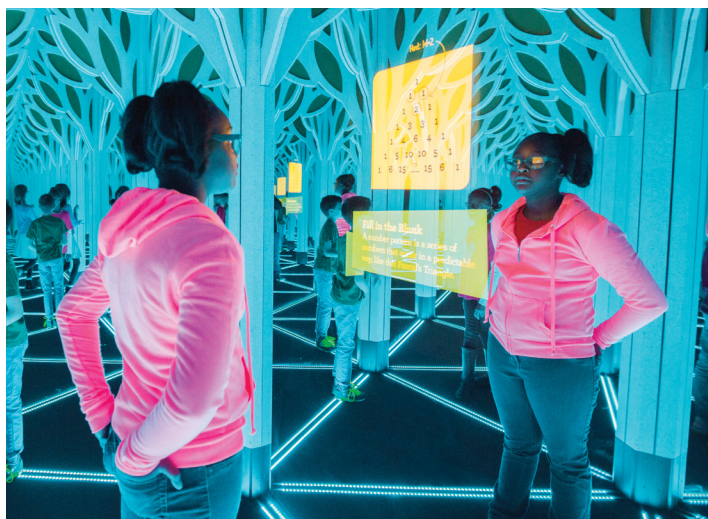
Patterns exist everywhere in nature and the designed world.

- A pattern is a set of shapes or numbers that repeats in a characteristic way and can be described mathematically.

- Patterns are an expression of math.

- There are many types of patterns.

Patterns help us understand, manipulate and appreciate the world around us.

- Patterns describe relationships between objects or systems.

- The pattern and shape of natural and designed objects are related to their function.

- Patterns can be used for a variety of practical applications in the designed world.

Guests visiting *Numbers in Nature* can:

- Identify patterns in nature.

- Recognize that nature has an inherent, underlying structure that can be described mathematically.

- Experience a sense of wonder and excitement around math by participating in fun and experimental activities that allow them to create, experience and manipulate patterns.

- Recognize that patterns can be described using math.

- Feel engaged and excited enough to seek opportunities to learn more about math.

NEXT GENERATION SCIENCE STANDARDS

Numbers in Nature is aligned with the following Next Generation Science Standards.

Science and Engineering Practices:
- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Obtaining, evaluating and communicating information

Crosscutting Concepts:
- Patterns
- Scale, proportion and quantity
- Structure and Function

Disciplinary Core Ideas:
- LS1: From Molecules to Organisms: Structures and Processes
- LS3: Heredity: Inheritance and Variation of Traits
- ETS1: Engineering Design
- PS4: Waves and their Applications in Technologies for Information Transfer

CLASSROOM LESSONS

To enhance a *Numbers in Nature* visit, teachers can use these free classroom lessons before and after their visit.

1

Patterns Everywhere
Explore what patterns are and the many places they can be found.

2

Patterns in DNA
Use everyday materials to extract DNA from your cheek cells and learn about the patterns found in DNA.

3

It's a Secret
Utilize patterns to help decode messages.

In addition, the *Numbers in Nature* Patterns Museum Exploration Guide lesson focuses your field trip visit. Students use a worksheet to record their observations and experiences in the exhibit then complete a follow-up activity back in the classroom.

Numbers in Nature Additional Resources

WEBSITES

Codes and Code Breaking
nrich.maths.org/2197

Computer Science Unplugged
csunplugged.org/activities

Cryptology Club
cryptoclub.org

Fibonacci Math for Kids
mathsisfun.com/numbers/fibonacci-sequence

Fractal Foundation
fractalfoundation.org

Numbers in Nature
msichicago.org/numbers

Make Your Own Geometric Drawing
nathanfriend.io/inspirograph/

Vi Hart (a self-described "recreational mathemusician")
vihart.com/

BOOKS

By Nature's Design: An Exploratorium Book
Diane Ackerman

The Golden Section: Nature's Greatest Secret
Scott Olson

Growing Patterns: Fibonacci Numbers in Nature
Sarah C. Campbell

Mathematics: The Science of Patterns

The Search for Order in Life, Mind and the Universe
Keith Devlin

Symmetry: The Ordering Principle
David Wade