Feathery Fun

Pet:	Class:
birds	**6-9**

Brief Overview: Students explore the structural wonders of bird feathers, analyzing their adaptations for flight, insulation, and waterproofing. This knowledge then applied to the design and construction of model wings incorporating these key principles.	**Lesson Breakdown** **Lesson 1:**Feather Investigation **Lesson 2:**Wing Construction **Lesson 3:** Testing and Analysis
Essential Question How do the structure and function of bird feathers enable flight, insulation, and waterproofing?	

Subjects	Stem Connections
☑ Science ☑ ELA ☑ Math ☑ STEM ☐ Art ☐ Other	**Science:** biological adaptations, forces and interactions, **Technology:** 3d modeling software (optional) **Engineering:** creation of a model wing **Math** patterns, drawing models, estimation, recognizing symmetry,

Performance Expectations/ Standards

NGSS

MS-LS4-3. Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy

MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

CCSS- Math

6.SP.A.3: Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.

7.G.A.1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

CCSS- English Language Arts:

RI.6.7: Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

W.6.7: Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.

SL.6.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.

L.6.1: Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

I CAN statements

- identify the key parts of a bird feather and explain their functions.
- analyze how feather structure relates to flight, insulation, and waterproofing.
- design a model wing incorporating these feather principles.
- build my model wing using appropriate materials and techniques.
- test and evaluate the effectiveness of my model wing design.
- communicate my findings and design choices to others.

Materials

- Birds of a Feather
- Feathery Fun Student Worksheet
- Variety of bird feathers (different species, sizes)(your local nature center may be a good place to obtain these)
- Microscope or Magnifier
- Scissors, tweezers, and needles
- Blank microscope slides, coverslips
- Paper, rulers, pencils
- Construction paper, cardboard, fabric scraps
- Craft sticks, straws, tape, glue
- Scissors
- Water and pipettes
- 3d modeling software (optional)

Teacher Background

Feathers are highly modified epidermal structures, originating from the same reptilian scales that gave rise to their dinosaur ancestors. This evolutionary journey sculpted feathers into lightweight yet remarkably robust marvels, composed primarily of the protein keratin. Each feather adheres to a precise blueprint, starting with a central shaft (rachis) from which radiate paired barbs. These barbs, in turn, bear microscopic barbules, interlocking like tiny hooks and zippers to create a smooth, aerodynamic vane.

Types of feathers:

- **Contour feathers:** The outer layer, these provide streamline for flight and insulation. Think of them as the bird's sleek jacket.
- **Flight feathers:** Primaries on the wings and secondaries on the tail, these are the airfoils that generate lift and propel birds through the sky.
- **Down feathers:** Soft and fluffy, these provide a layer of thermal insulation, keeping birds cozy during chilly nights.
- **Hair-like feathers:** Found on some species like owls and kiwis, these enhance sensory perception, aiding in silent flight and prey detection.
- **Bristles:** Stiff and often vibratile, these feathers play a role in tactile awareness and can even be used for preening.

Beyond Flight:
While flight undoubtedly takes center stage, feathers play a multitude of other roles. The vibrant hues and intricate patterns serve as communication tools, aiding in species recognition, courtship displays, and camouflage. Feathers offer protection from the elements, with water-repellent surfaces shielding birds from rain and snow. They even participate in parental duties, lining nests and insulating eggs and chicks.

A Window into Evolution:
Studying feathers unveils not only their remarkable adaptability but also the evolutionary pressures that shaped them. The wing feathers of penguins, modified for swimming, showcase evolution's capacity to repurpose structures. The vibrant iridescent feathers of hummingbirds, created by nanostructures rather than pigments, are a testament to nature's microscopic artistry.

In Conclusion:
Feathers are a testament to the exquisite interplay of form and function in the avian world. From enabling flight to fostering communication and providing warmth, these keratinous marvels orchestrate a symphony of survival. Studying feathers grants us not only a deeper understanding of birds but also a glimpse into the boundless creativity of evolution

Lesson 1: Feather Investigation

Time	Materials	Activity
5 mins	Feathery Fun Student Worksheet	Ask students what they already know about bird feathers and record their answers on the board.
10 mins	Birds of a Feather	Share the presentation on feathers.There are questions on the Student Worksheet to be completed as they watch the presentation. Lead a discussion about the functions of feathers in flight (lift, drag, air pockets), insulation (trapping air), and waterproofing (overlapping barbules). Show the presentation, Discuss the symmetrical patterns and geometric shapes found in different feather types (e.g., pennae, vanes,

		barbules). Introduce the essential question, “How do the structure and function of bird feathers enable flight, insulation, and waterproofing?”
	Feathery Fun Student Worksheet	Provide microscopes or magnifying glasses and allow students to closely examine a variety of feathers, identifying key parts (barbs, barbules, rachis). Discuss how these parts might contribute to function. 1. Remove a small piece of the feather using scissors and a tweezer. 2. Place the sample on your microscope slide and cover with the a cover slip (you may also add a drop of water) 3. Have the students draw what they see in their Student Worksheets 4. Have the students identify/classify the feathers
10mins	Feathery Fun Student Worksheet	Introduce the challenge: They will create a model wing incorporating feather principles for flight, insulation, and waterproofing. Allow the students time to begin brainstorming their ideas within their small groups.

Lesson 2: Wing Construction		
Time	**Materials**	**Activity**
10 mins	Feathery Fun Student Worksheet	Guide students through the design process, brainstorming ideas, sketching their wing designs, and labeling key features based on feather functions.
35 mins	Feathery Fun Student Worksheet 3d modeling software (optional) Construction paper, cardboard,	Allow students to construct their model wings, using appropriate materials and techniques. Encourage collaboration within groups. 3d modeling may also be used as desired.

	fabric scraps Craft sticks, straws, tape, glue Scissors	

Lesson 3: Testing and Analysis		
Time	**Materials**	**Activity**
35 mins	Feathery Fun Student Worksheet Thermometer Pipettes	• Flight simulation: Hold the wings up and blow on them, observing lift and stability. Flight Distance Estimation: Have students estimate the potential flight distance of their feathered creature based on wing size and weight. Compare wingspan-to-distance. • Waterproofing test: using a pipette, drop small water droplets on the wings, observing how they repel or absorb the water. • Insulation test: Compare the temperature increase inside an uninsulated cup versus one with a model wing "blanket covering it Classroom Management Tip : Set these up as stations to allow students to test more efficiently.
10 mins	Feathery Fun Student Worksheet	Have students discuss their successes and challenges, analyzing how their design choices impact function. If time permits, encourage modifications and improvements based on their observations.

Differentiation

For students who need additional support:

- Simplify the feather structure explanation and provide clear step-by-step instructions for model wing construction; Provide pre-cut templates or simpler materials
- Visual learners: Provide labeled diagrams of feathers, pictures of different bird species, and videos of birds in flight.
- Auditory learners: Use audio recordings of bird calls and discuss the connection between feather structure and sound production.
- Kinesthetic learners: Let students explore different feathers by touch, build model wings with various materials, and act out bird movements.

For students who need additional challenges:

- Encourage independent research on specific bird species and their feather adaptations. Challenge them to design model wings with additional features like flaps or tail feathers.
- Introduce the concept of biomimicry and its applications in engineering. Have them compare and contrast different wing designs from birds and airplanes.
- Explore the feathers of other flying animals, like bats and insects, and compare their adaptations to birds.
- Research the evolution of feathers and how they have helped birds succeed in different environments.
- Investigate the cultural significance of feathers in different societies throughout history.
- Create a scale drawing of their design

Assessment

Criteria	4 Points (Exceeds Expectations)	3 Points (Meets Expectations)	2 Points (Approaches Expectations)	1 Point (Needs Improvement)
Accuracy and Completeness	Thoroughly describes the wing construction, including all key elements	Accurately describes most of the wing's components and their interrelationships.	Describes some aspects of the wing construction, but may be missing key elements or contain some inaccuracies.	Description of the wing construction is vague, inaccurate, or incomplete.
Clarity and Understanding	Presents a clear and concise explanation of how the wing	Provides a generally understandable explanation of the	Explanation of the wing's function is unclear or confusing.	Little or no connection is made between the wing's structure

	functions based on its structure.	wing's functionality.		and its function.
Originality and Insight	Offers insightful analysis of the wing's design and its implications for flight or adaptation.	Makes at least one interesting observation about the significance of the wing's structure.	- Describes the wing construction in a basic way without offering any original analysis.	- Analysis is absent or superficial.

Extension

Field trip: Visit a zoo, bird sanctuary, or wildlife center to observe different bird species and their feathers.
Art project: Students can create bird sculptures or paintings, focusing on capturing the intricate details of feathers and their colors.
Math connection: Calculate the surface area of feathers, wing shapes, and lift forces based on model wing tests.
Creative writing: Ask students to write poems or stories from the perspective of a bird, describing their experience of flight and the role of feathers.
Debate: Organize a debate on the ethics of biomimicry and using animal adaptations for human technology.
Community outreach: Partner with a local environmental organization to raise awareness about bird conservation and the threats to birds from oil spills and habitat loss.
Create a digital presentation or video sharing their findings and model wings with the class or school community.