STEM Lesson Plan:

How Animals Use Magnetic Fields to Survive (High School)

Purpose:

By the end of the lesson, students will be able to:

- Explain how animals use magnetic fields for navigation and survival.
- Identify specific animal species that rely on geomagnetic fields for migration or homing.
- Understand the role of Earth's magnetic field in ecosystems and its significance in animal behavior and survival.

Next Generation Sunshine State Standards:

- **SC.912.L.17.8**: Recognize the consequences of the loss of biodiversity due to catastrophic events, climate changes, human activity, and the introduction of invasive, non-native species.
- **SC.912.L.17.9:** Use a food web to identify and distinguish producers, consumers, and decomposers. Explain the pathways of energy transfer through trophic levels and the reduction of available energy at successive trophic levels.
- **SC.912.E.7.3**: Differentiate and describe various mechanisms and interactions between the Earth's systems and life on Earth.

Time: 60 minutes

Vocabulary:

- Geomagnetic field
- Magnetoreception
- Migration
- Homing behavior
- Electromagnetic spectrum

Lesson Activity Steps:

1. Introduction (10 minutes)
    a. Hook: Begin with a thought-provoking question: "How do birds know where to fly during migration without a GPS?"
    b. Show a short video clip (1-2 minutes) of migratory animals like sea turtles or birds traveling long distances. https://youtu.be/tdXb_4EkYtU?si=59nbtfeW_bm39gjM

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   c. Explain the Earth's magnetic field and introduce the concept of *magnetoreception*, the ability of animals to detect magnetic fields and use them for navigation.

2. Direct Instruction (15 minutes)
   a. Use a PowerPoint or diagram to explain Earth's geomagnetic field. (attached)
   b. Discuss the concept of magnetoreception and how animals like sea turtles, birds, and certain fish use this ability.
      i. Example: Loggerhead sea turtles use magnetic cues to return to the beaches where they were born to lay eggs.
      ii. Example: Birds like the Arctic Tern migrate thousands of miles using the magnetic field as a guide.
      iii. Example: Honeybees use magnetic fields for orientation.
   c. Explain how Earth's magnetic field interacts with the environment and is affected by solar radiation.

3. Classroom Demonstration (10 minutes)
   a. Use a magnetic compass to demonstrate how animals might use Earth's magnetic field for direction.
   b. Ask students to experiment with the compass and observe how it aligns with the Earth's magnetic poles.
   c. Discuss how changes in the magnetic field might confuse animals' migratory paths.

4. Group Activity (15 minutes)
   a. Animal Research Activity: Divide students into small groups. Assign each group a specific animal (e.g., sea turtles, homing pigeons, monarch butterflies, sharks). Each group will research how their assigned animal uses magnetic fields for navigation or survival and create a short 3-5 minute presentation. Allow students to use worksheets to organize their findings.

5. Presentation & Discussion (10 minutes)
   a. Have each group present their findings to the class.
   b. Engage the class in a discussion about how environmental changes (e.g., climate change, human interference) might impact the magnetic fields and the animals that rely on them.
   c. Review the key points about magnetoreception and its ecological significance.

6. Closing & Assessment (5 minutes)

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a. Summarize the key points: How animals use magnetic fields, the importance of magnetoreception, and the consequences of disruptions to this natural mechanism.
b. Assessment: Have students complete a short exit ticket or quiz with the following:
    i. Name two animals that use magnetic fields for migration.
    ii. Explain how Earth's magnetic field aids these animals in survival.
    iii. Predict how human activities might interfere with animal navigation.

Extension Activity:

As an extension to the main activity, students can delve deeper into the real-world implications of magnetoreception by exploring how human-made electromagnetic interferences, such as cell towers, power lines, and urban infrastructure, may disrupt the natural navigation abilities of animals like birds, sea turtles, and insects. This investigation encourages students to consider the intersection of technology and ecology. For extra credit, students can research current scientific studies on magnetoreception, examining how animals detect and respond to Earth's magnetic fields. This could include reading recent journal articles, summarizing findings, or presenting on emerging technologies used to study this phenomenon. These extensions foster critical thinking and connect classroom learning to broader environmental and scientific issues.

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RUBRIC – Animal Magnetoception Group Presentation

Criteria	4 – Excellent	3 – Proficient	2- Needs Improvement	1 – Inadequate
Understanding of Topic	Demonstrates thorough understanding of how the animal uses the Earth's magnetic field. All facts are accurate and clearly explained.	Shows good understanding of the topic with only minor gaps or inaccuracies.	Demonstrates some understanding but with noticeable gaps or inaccuracies.	Shows little to no understanding of the topic; information is unclear or inaccurate.
Research & Evidence	Well-researched with strong, accurate evidence. Includes multiple examples and/or scientific facts to support findings.	Good research with sufficient evidence. Some examples provided to support the claims.	Limited research or insufficient evidence provided. Few examples are used.	Minimal research or evidence. Lacks examples or supporting facts.
Presentation Skills	Clear, confident, and engaging delivery. Group members speak audibly and maintain good eye contact with the audience.	Delivery is mostly clear and understandable. Most group members speak clearly.	Delivery is somewhat unclear, with moments of mumbling or reading off notes.	Delivery is unclear or difficult to follow. Little engagement with the audience.
Collaboration & Participation	All group members participate equally and contribute to the presentation. Excellent teamwork displayed.	Most group members contribute, though some are less involved. Good teamwork overall.	Some group members dominate the presentation, while others contribute minimally.	Little evidence of collaboration; one or two members dominate the presentation.
Organization & Structure	Presentation is well-organized, flows logically, and stays within the time limit. Transitions between topics are smooth.	Presentation is organized and mostly flows well. A few transitions may be unclear.	Somewhat disorganized; lacks clear flow or transitions between topics.	Presentation is disorganized, hard to follow, or significantly over/under the time limit.
Creativity & Engagement	Engages the audience through visuals, examples, or creative elements. The presentation is interesting and memorable.	Engages the audience with some visuals or examples. Presentation is mostly interesting.	Limited use of visuals or creative elements. The presentation may lack engagement.	Presentation is dull or lacks creativity. Does not engage the audience.

Scoring Guide

- **Total Points**: ____ / 24
- **Rating Key**: **22-24**: Excellent; **18-21**: Proficient; **13-17**: Needs Improvement; **12 or below**: Inadequate

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Animal Magnetoreception

Name: _____

Date: _____

Class Period: _____

DIRECTIONS: fill out this worksheet during both the lesson and the group activity.

Part 1: Understanding Magnetic Fields and Animal Navigation

1. What is the Earth's magnetic field?

Provide a brief description of Earth's magnetic field and how it is generated.

_____

_____

_____

2. Define magnetoreception:

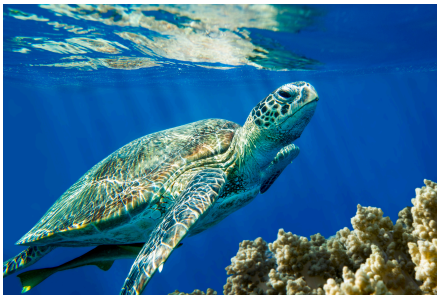
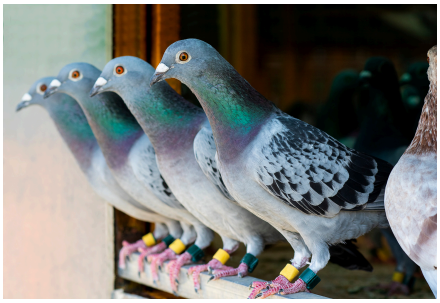
What is magnetoreception and how do animals use it?

_____

_____

_____

3. Match the following animals to how they use the magnetic field for survival:

Animal	How they use the magnetic field	
	#_____	1) Use magnetic fields to navigate during migration
	#_____	2) Use magnetic fields to return to their birthplace
	#_____	3) Use magnetic fields to find their way back to their hive
	#_____	4) Migrate across North America using the magnetic field

<u>Part 2: Group Research Activity</u>

In your assigned group, research how your animal uses the Earth's magnetic field. Use the space below to take notes on your research.

Animal Assigned: _____

4. How does your assigned animal use the Earth's magnetic field?

_____

_____

_____

5. What specific challenges or threats could affect how this animal uses the magnetic field (e.g., human activity, environmental changes)?

_____

_____

_____

6. List any interesting facts or discoveries about your animal's magnetoreception ability:

_____

_____

_____

Part 3: Reflection

7. How do you think human activities, like the use of technology or climate change, might interfere with animals that rely on magnetoreception?

_____

_____

_____

8. Imagine you are a scientist studying the migration of birds. What experiment would you design to test how birds use magnetic fields to navigate?

Outline a simple experimental plan or hypothesis:_

_____

_____

_____

Part 4: Exit Quiz

9. Name two animals that use magnetic fields for migration:

a) _____

b) _____

10. Explain how Earth's magnetic field helps these animals navigate: