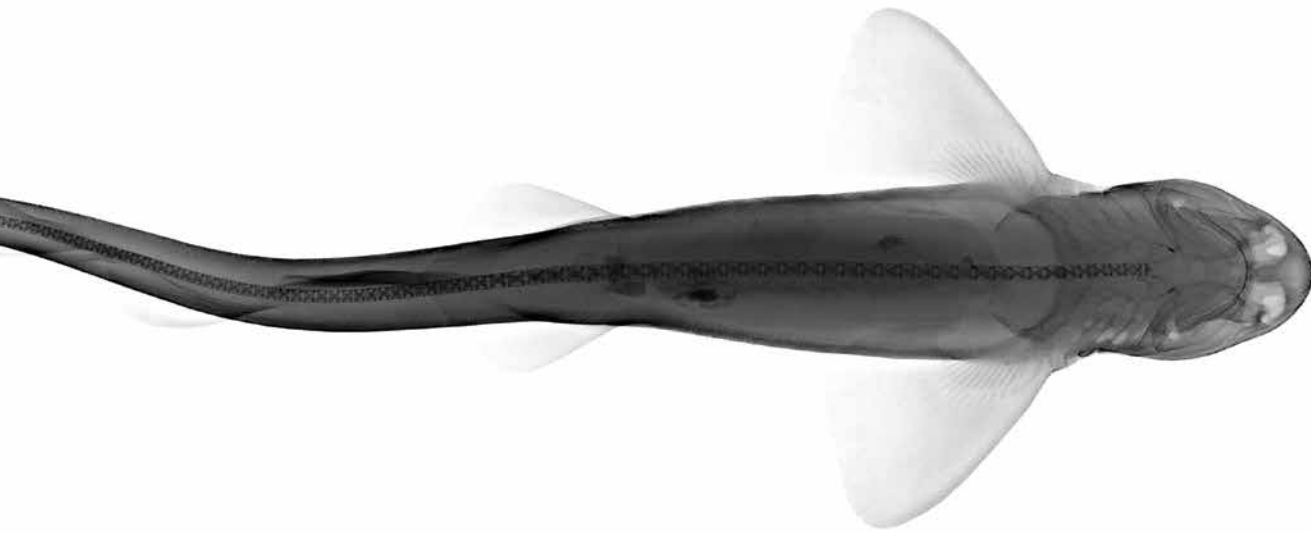


INSIDE IN

The background is a solid teal color. It features several X-ray images of nature. A large flower is on the left side, with its stem and leaves extending towards the center. In the bottom right corner, there is a detailed X-ray of a bird, showing its skeletal structure, including the beak, wings, and legs. The overall aesthetic is scientific and naturalistic.

X-Rays of Nature's
Hidden World

A Companion Guide for
Teachers and Parents



TITLE: *Inside In: X-Rays of Nature's Hidden World*

AUTHOR: Jan Paul Schutten

PHOTOGRAPHER: Arie van 't Riet

GENRE: Nonfiction

THEMES: Nature, animals, scientific method, biology, body systems (skeletal system), electromagnetic radiation

SUITABLE FOR: Ages 8-12, Grades 2-7

GUIDED READING LEVEL: Q

LEXILE LEVEL: 840L

COMMON CORE STANDARDS:

RI.4.1, 2, 3, 4, 5, 6, 7, 8, 9

W.4.1.1a, 1b, 1c, 1d, 2, 2a, 2b, 2c, 2d, 2e, 4, 5, 6, 7, 8, 9b.10

SL.4.1, 1a, 1b, 1c, 1d, 2, 3, 4, 5, 6

L.4.1, 2, 2a, 2b, 2c, 2d, 3, 3a, 3b, 3c, 4, 4a, 4b, 4c, 5c, 6

NEXT GENERATION SCIENCE STANDARDS:

4-LS1-1 From Molecules to Organisms: Structures & Processes

4-LS1-2 From Molecules to Organisms: Structures & Processes

SUMMARY

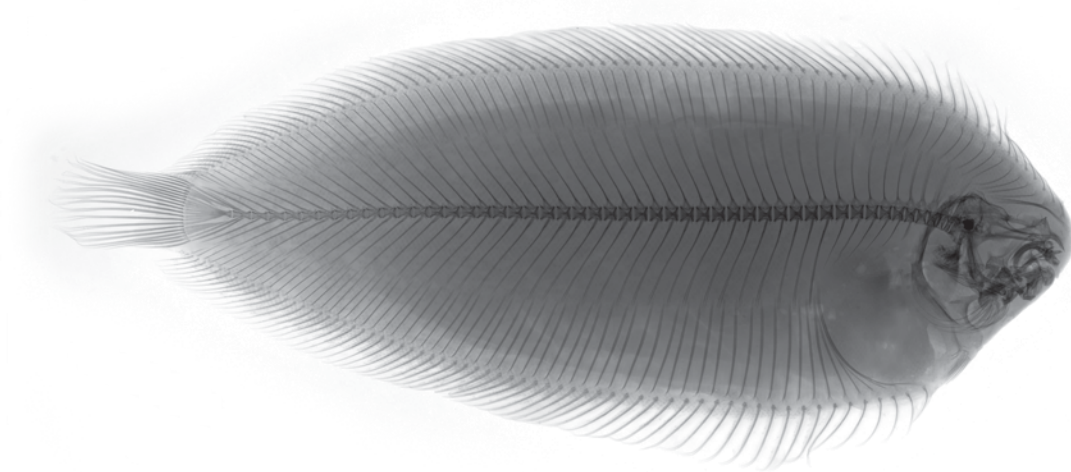
Inside In is a collection of “bioramas,” X-ray photographs of animals in different types of settings. Arie van ’t Riet, a former medical physicist, creates stunning compositions of animals, insects, and delicate flowers, grasses, and other plants in their natural environment. Vertebrate and invertebrate animals are grouped according to class or phylum: arthropods and mollusks, fish, amphibians, reptiles, birds, and mammals.

Next to every image, easy-to-follow text helps kids to understand the hidden details behind each biorama. A foreword and afterword explain what an X-ray is and some historical information about Wilhelm Röntgen, who first discovered X-rays.

ABOUT THIS GUIDE

These discussion questions and activities are designed to help students explore *Inside In*, the science presented in the book, and their own creativity.

The themes in this book will appeal to a range of age groups, from intermediate to middle school and early high school grades. Not all the questions and activities in this guide will be appropriate for every class.



BEFORE READING

The following questions and activities build the context, introduce the topic of the book, and establish prior knowledge and interest.

1. Before reading, look at the cover photograph and book title.
What information does the photo and book title give the reader?
2. Do you think this is a fictional story or an informational book?
What are the clues that lead you to your answer?
3. Open the book and review the table of contents. Make a list of the sections or chapters that look interesting or unusual.
Mark the sections you want to read.
4. How does the author use language in the table of contents?
What clues does the language give you about the tone of the book?
5. Ask the group if anyone has had an X-ray. If so, what was their experience like?



Language Arts: Text Types and Features

1. What is the difference between a book of fiction and a book of nonfiction?
2. Discuss how the author structures the book.
3. Why is it important to think about the structure of nonfiction?

X-ray Photography

Read the author's note and introduction before discussing the following questions:

- What is an X-ray?
- What is the difference between an X-ray and a photograph?
- What are X-rays used for?
- How are X-rays in this book different than usual ones?
What do you think the photographer's purpose is?





Vertebrates and Invertebrates

- What is the difference between a vertebrate and an invertebrate?
- Name some examples of vertebrates and invertebrates.
- Quickly flip through *Inside In* and look at the images. Are the images primarily of vertebrates or invertebrates?

Exoskeletons and Endoskeletons

- What do you know about the skeletal system?
- How many bones do you think you have in your body?
- Do you think animals have the same number of bones as humans?
- What is the difference between an exoskeleton and an endoskeleton?
- Name animals that have exoskeletons and those that have endoskeletons. Which kind of skeleton do humans have?
- What is the function of the skeletal system?

Animal Groups

Review the table of contents and then discuss the definition of the following terms:

- o Arthropods
- o Mollusks
- o Fish
- o Amphibians
- o Reptiles
- o Birds
- o Mammals



Give examples of animals that belong in these different groups.

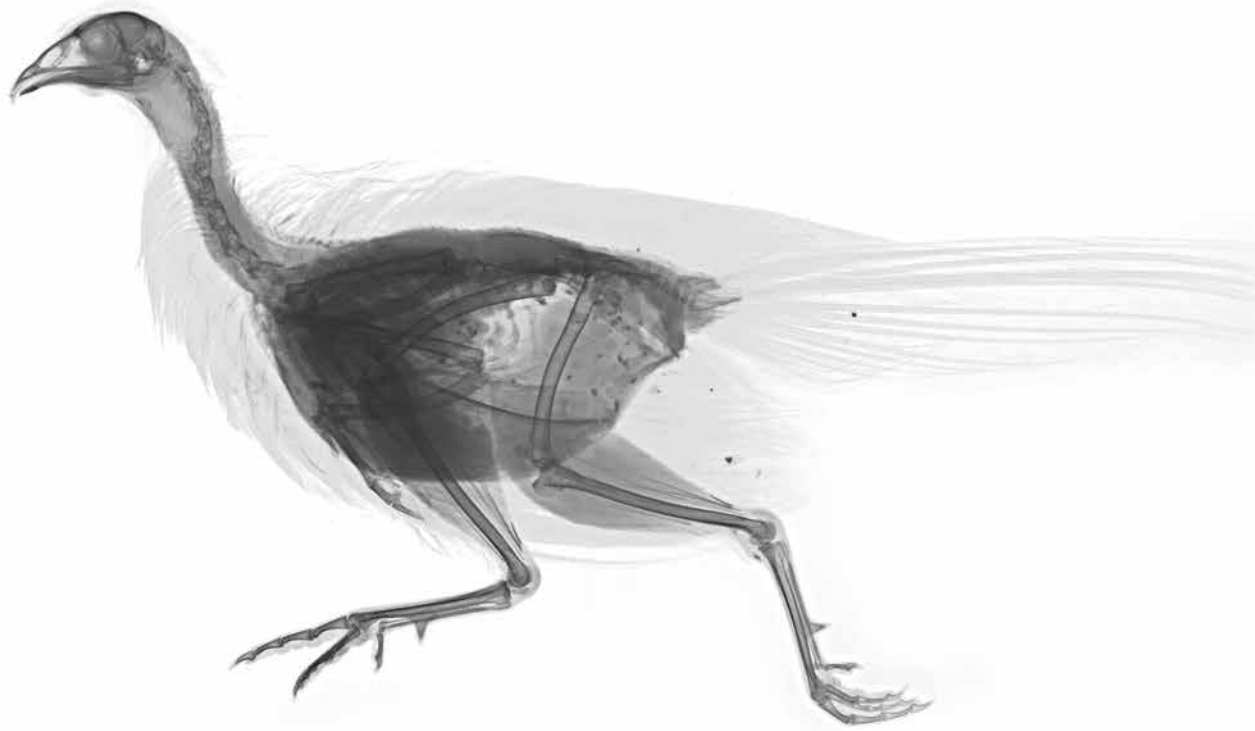
DURING READING

These activities check comprehension, stimulate interest, involve readers in reflection as they read, and encourage consideration of other readers' reactions.

Compare and Contrast (Comprehension Strategy)

Pick two different animals featured in *Inside In*. Read the text that accompanies the photo of each animal. Choose one animal from the “Arthropods and mollusks” section (animals with exoskeletons) and one from a later section (animals with endoskeletons).

Using the Comparison and Contrast Chart or the Comparison and Contrast Venn Diagram at the end of this activity guide, note the similarities and differences between the two animals you've chosen.



Light and Electromagnetic Radiation

The following suggestions can be used to complement a unit on electromagnetic radiation and light.

If the class is already familiar with these subjects, students can review what they already know about the types and effects of electromagnetic radiation, and the properties, behaviors, and ways to sense light.

If the class is beginning these units, you may wish to view some of all of the videos from the series “Tour of the Electromagnetic Spectrum <https://science.nasa.gov/ems/>” from NASA Science, including “Introduction to the Electromagnetic Spectrum https://science.nasa.gov/ems/01_intro” and “X-rays https://science.nasa.gov/ems/11_xrays.”

- A) Using the Electromagnetic Spectrum activity sheet at the end of this guide, match each *source* and *size* to its respective wavelength within the spectrum and arrange them in order from largest (on the far left) to smallest (on the far right).

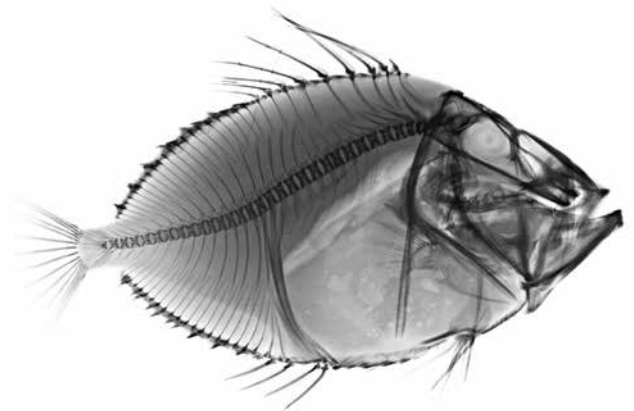
Materials: Each student will need a copy of the activity sheet, a clean piece of letter-sized paper, scissors, and tape or glue.

- B) Find out more about X-rays. You can start by reading “About the inventor” on pages 124-25 of *Inside In*. You can watch the NASA X-ray video mentioned above, or read about X-rays in an encyclopaedia or other reference book. Then write down your answers to the following, or discuss them as a group:

List three different ways X-rays are used.

What information can we get from X-rays?

List two sources of X-rays.





AFTER READING

These activities inspire continued reflection and response to the text, bring conclusion to reading this particular text, and stimulate further discussions.

A New Way to Look at Animals

Review the X-ray photographs in *Inside In* again and think about the following questions:

- Which skeletons surprised you?
- Pick ten animals in the book at random and list their names on a piece of paper. If you only saw the skeleton of these animals, would you be able to guess what it was?
- What did you learn about animals from reading this book?
- What did you learn about your own skeleton?

Jot down your answers to any or all of the questions above. Be as specific as possible. Share your responses by writing a paragraph or two, putting together a slide presentation, or making a short video.

Mix-and-Match Skeletons

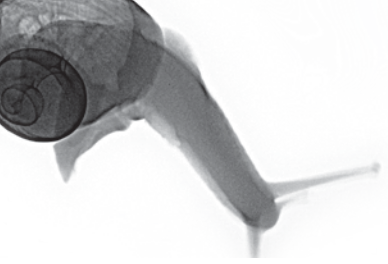
If you could change part of your skeleton for part of an animal's skeleton, what would you change? Why?

Fold a clean piece of paper in half lengthways. On one half, draw a picture of your new skeleton. On the other half, draw the outside of your new body.

Write a sentence or two about what you could do because of your new skeleton.



EXTENSION
ACTIVITIES



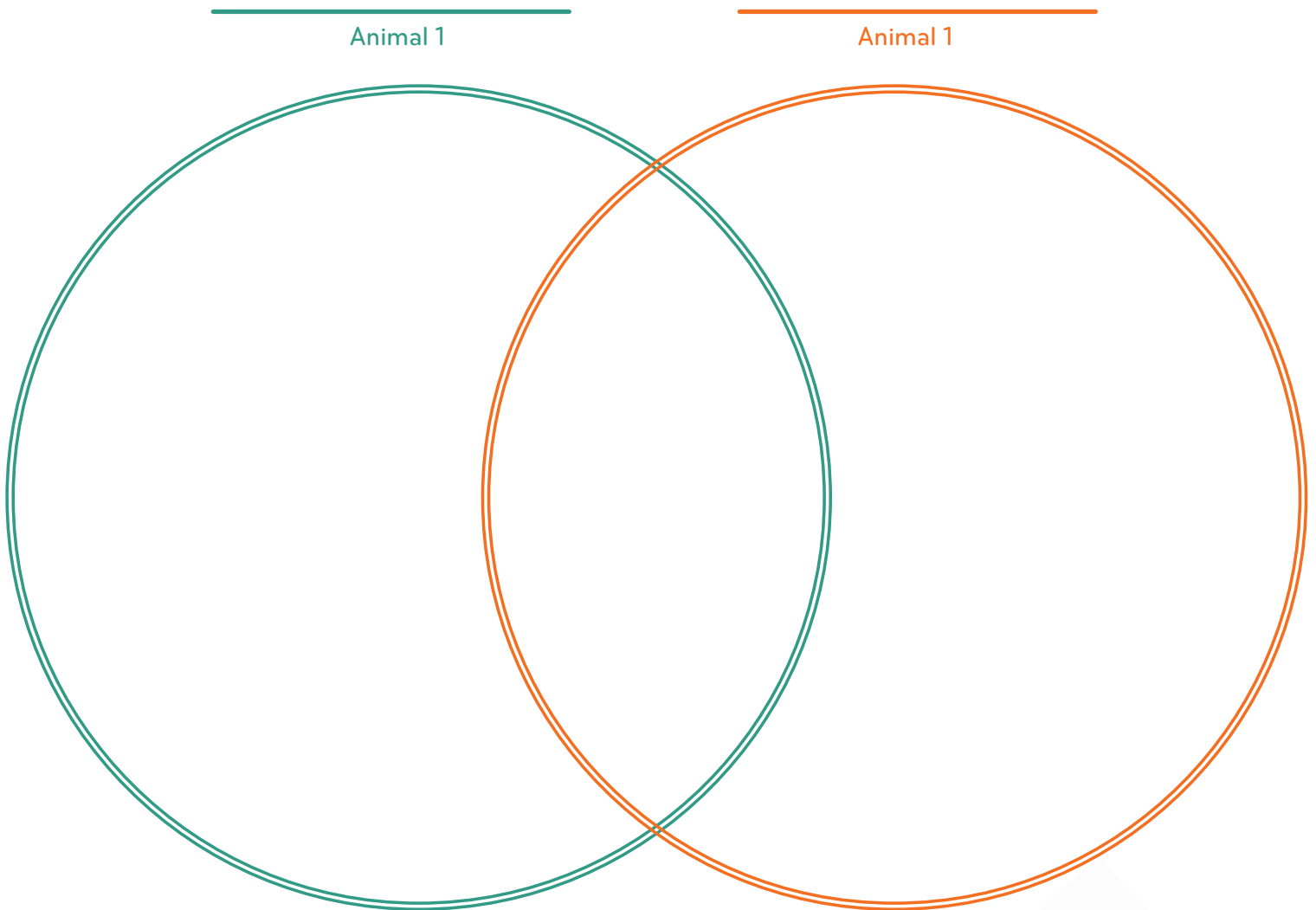
COMPARISON AND CONTRAST CHART

Animal 1 SIMILARITIES Animal 2

Animal 1 DIFFERENCES Animal 2

Animal 1	Points of interest	Animal 2

COMPARISON AND CONTRAST VENN DIAGRAM



BUILD AN ANIMAL SKELETON



Create a model of a chameleon, mole, or squirrel skeleton using different kinds of dried pasta. You can glue your pasta bones to the photos at the end of this guide. Alternatively, you can use the photos as inspiration and create your own animal skeleton on black construction paper. You will need:

- Printout of photos or black construction paper
- Glue
- Paintbrush (for applying glue)
- Pasta, of at least four types of different shapes. (Spaghetti can be used for straight bones, and spiral pastas—like rotini—for vertebrae. Macaroni can also be used for vertebrae, as well as for ribs).

Label the bones that you can identify. You can choose terms that you recognise from the following list:

skull

teeth

incisors

clavicle (collarbone)

scapula (shoulder blade)

ribs

vertebrae

humerus (upper arm bone)

ulna (forearm bone)

radius (forearm bone)

wrist

phalanges (finger and toe bones)

femur (thigh bone)

pelvis (hip bones)

patella (kneecap)

tibia (lower leg bone)

Which parts of the animal skeleton look similar to a human skeleton? Which parts look different? How is the animal's skeleton adapted to its needs?

INSIDE AND OUTSIDE

This activity builds on the previous pasta-skeleton activity by drawing the shape of your animal's exterior body and creating a lift-the-flap illustration. It's best for students to do step 1 for this activity (drawing the outline) before attaching pasta pieces, as directed in "Build an Animal Skeleton."

Before starting this activity, research what the exterior of your animal looks like online or by using a reference book like an encyclopedia.

Materials

White bond paper (for the chameleon)

Colored construction paper—brown, tan, or black (for the mole and squirrel)

Construction paper in other colors (for grass, leaves, flowers, sky, etc.)

Pencils and crayons or felts (for adding details)

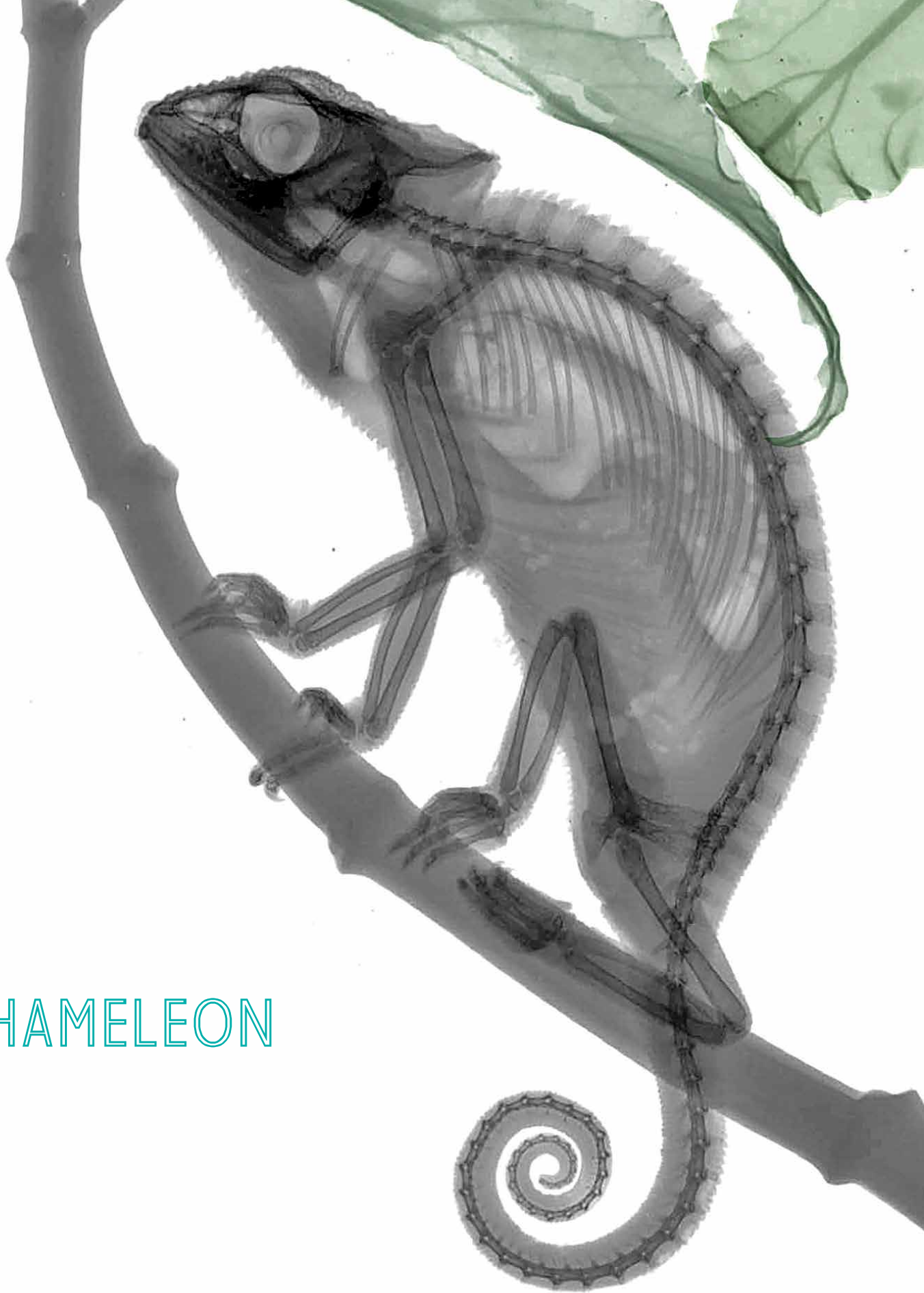
Scissors

Tape (for attaching exterior body shape to skeleton image)

Optional: rubber band (for chameleon's tongue)

- 1) Draw an outline of the exterior shape of your animal's body. You can do this by drawing freehand, or you can tape the original picture of the animal to a window or light table. Then place a clean sheet of white paper over the original picture and secure it with tape. With a pencil, trace the animal's outline. Don't worry if the shape isn't exactly like the photo.
- 2) With crayons or felts, add color and details to your animal's exterior body.
- 3) For the chameleon, you can cut a rubber band—to make it one long piece—and then tape or glue one end to the reverse side of the paper, where the chameleon's mouth is. You can tuck the other end of the rubber band behind the body and then pull it out to show how your chameleon can catch its prey.
- 4) Place your animal's exterior body over the pasta skeleton. Attach half of a strip of tape to the reverse side of your animal's body and the other half to the page with the skeleton to create a lift-the-flap illustration.
- 5) If you want, add details of your animal's surroundings, like grass or trees or flowers or other animals. Use crayons, felts, or cut out shapes from construction paper. You can look through *Inside In* for ideas.



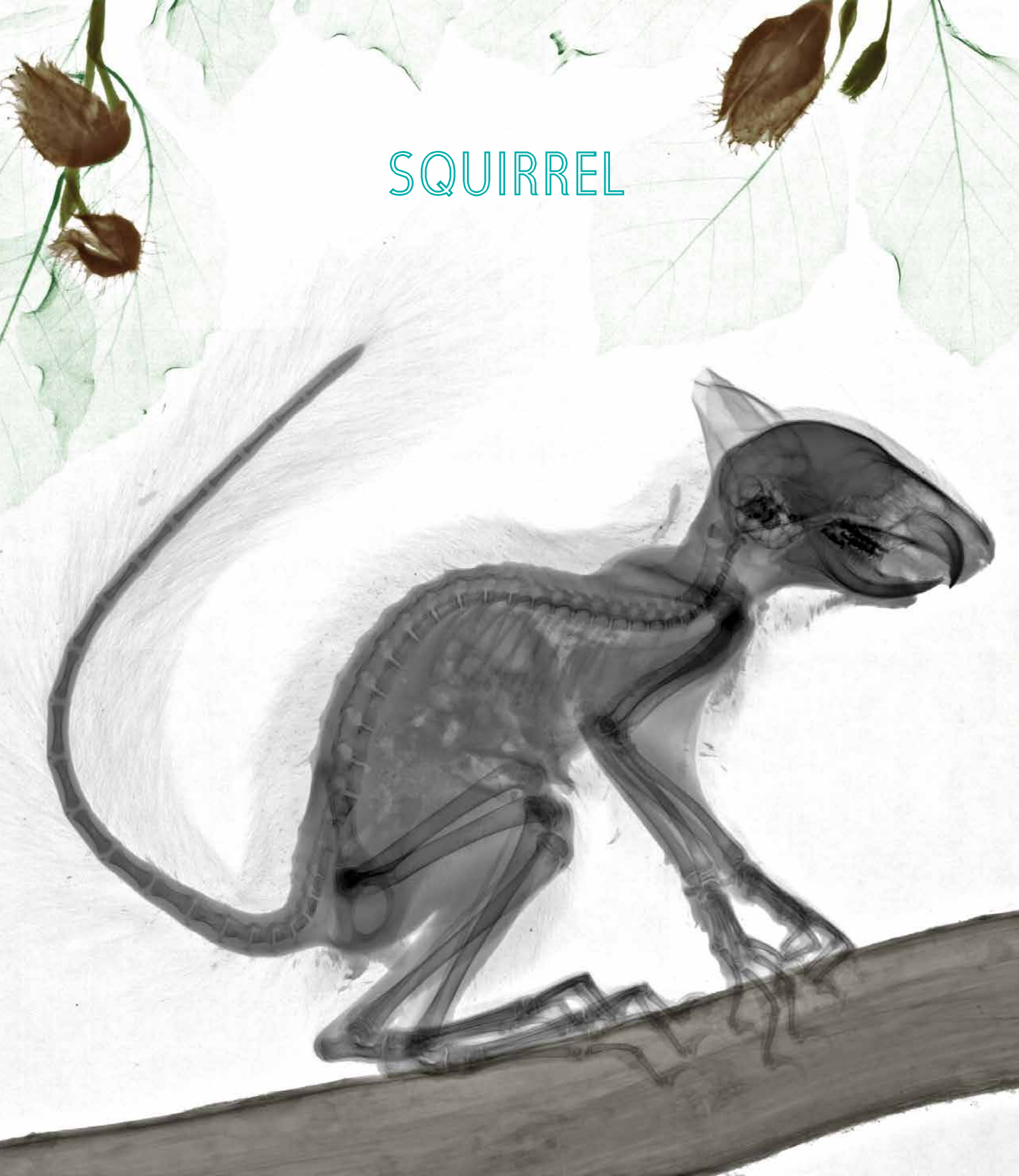


CHAMELEON

MOLE



SQUIRREL



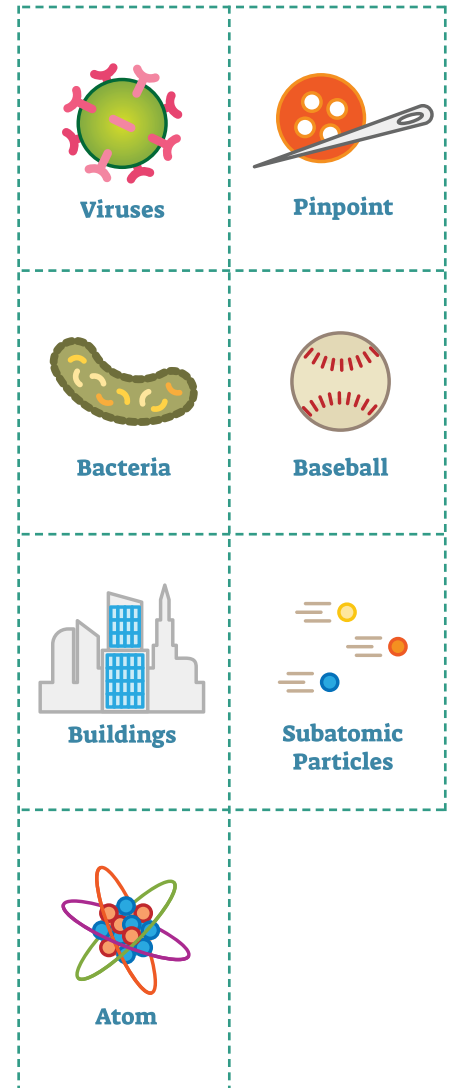
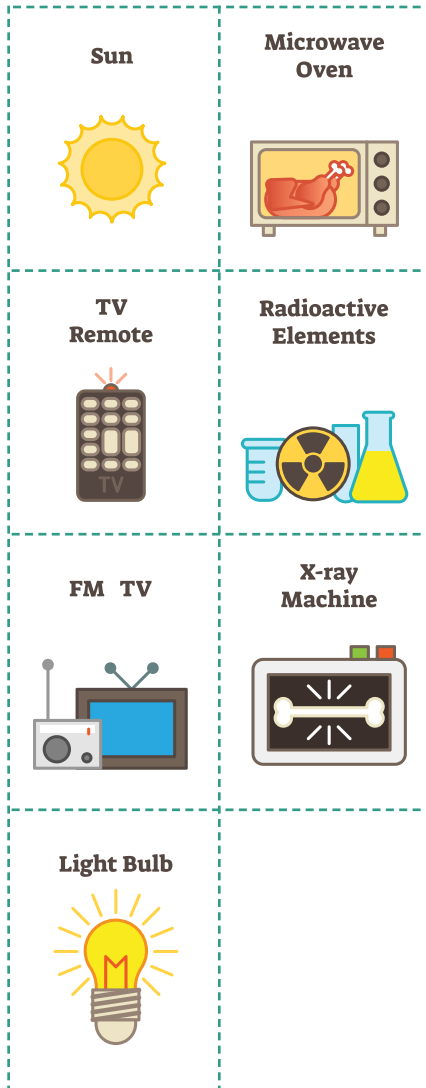
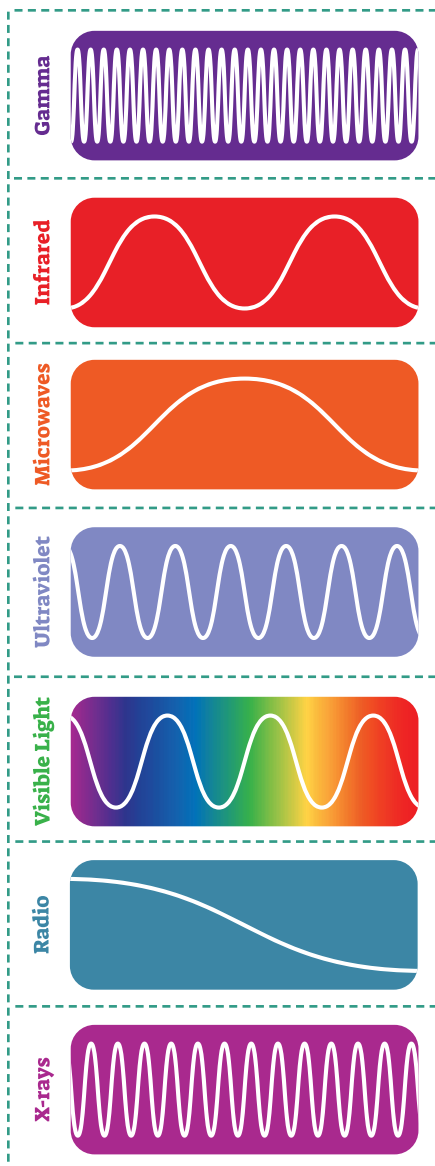
ELECTROMAGNETIC SPECTRUM

THE ELECTROMAGNETIC SPECTRUM: TYPES OF WAVES, SOURCES, AND SIZES

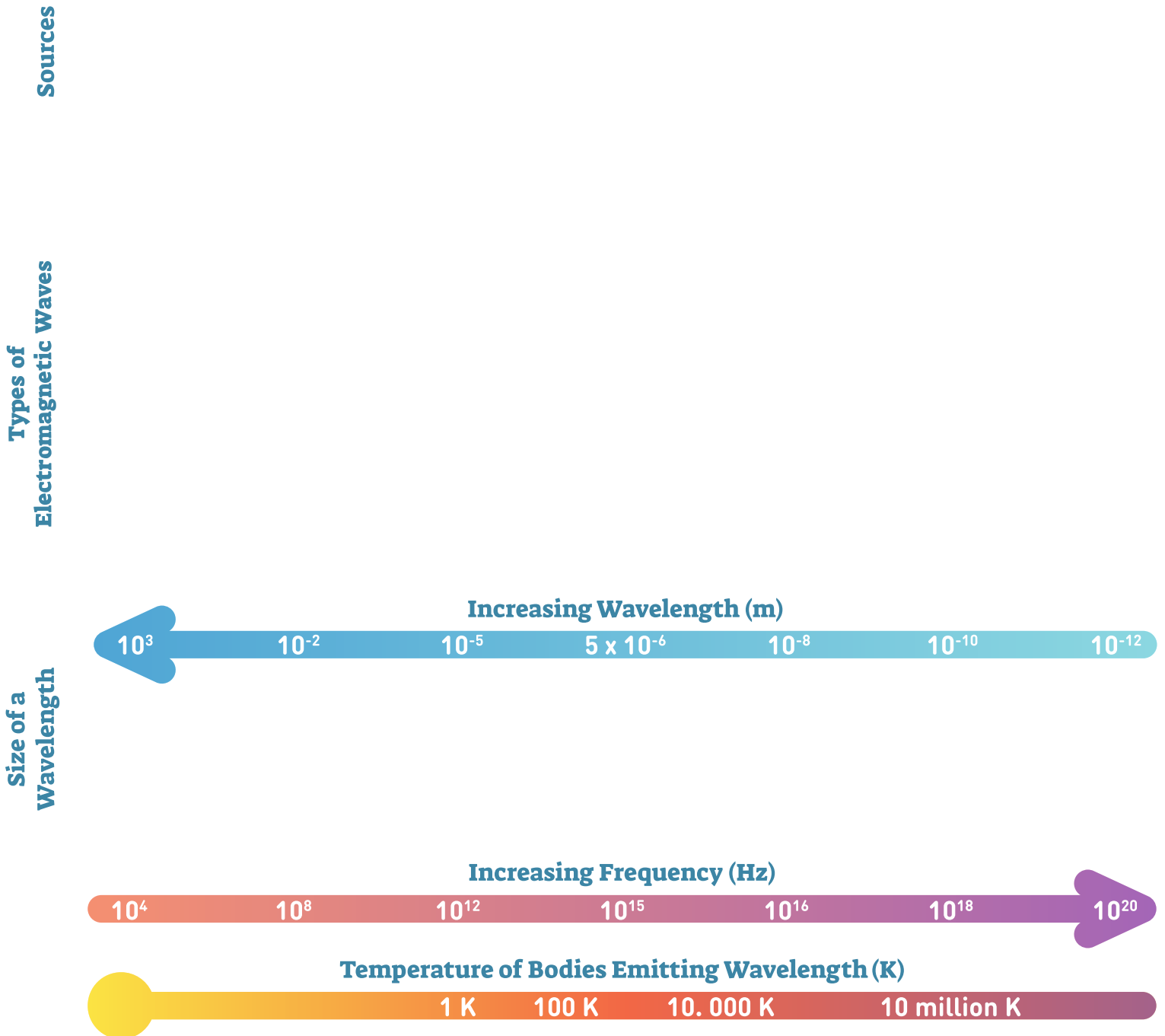
1. Cut out the pictures of the different types of electromagnetic waves and arrange in order of slowest to fastest along the Increasing Wavelength arrow.

2. Cut out the pictures of the sources of electromagnetic radiation from the list below. Arrange them from slowest to fastest along the top of the page, above the different types of electromagnetic waves.

3. Cut out the pictures of the size of wavelengths from the list below. Arrange them from the largest to smallest between the Increasing Wavelength arrow and the Increasing Frequency arrow.



THE ELECTROMAGNETIC SPECTRUM



THE ELECTROMAGNETIC SPECTRUM, ANSWER KEY

