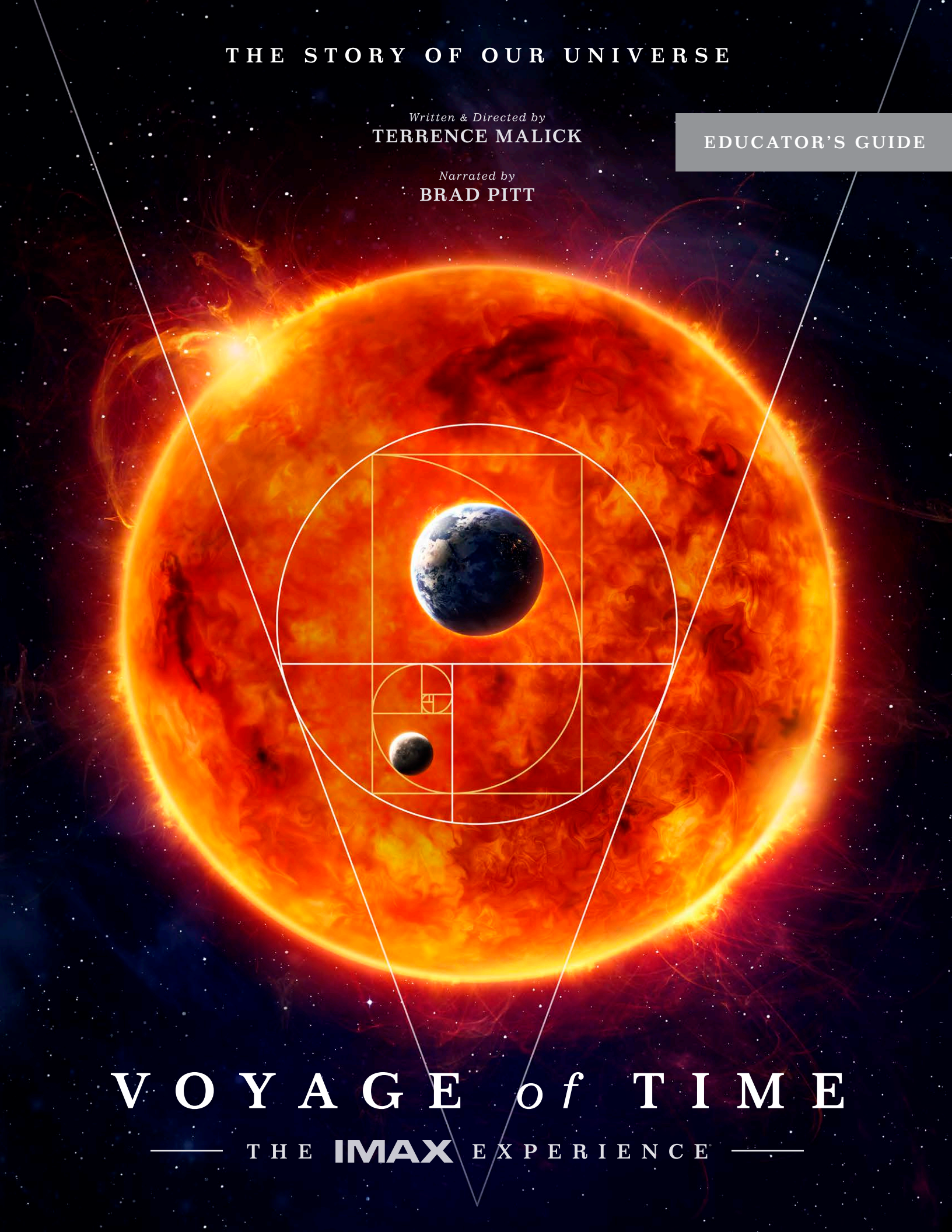
THE STORY OF OUR UNIVERSE

Written & Directed by
TERRENCE MALICK

Narrated by
BRAD PITT

EDUCATOR'S GUIDE



VOYAGE *of* TIME

THE IMAX EXPERIENCE

VOYAGE of TIME

THE IMAX EXPERIENCE®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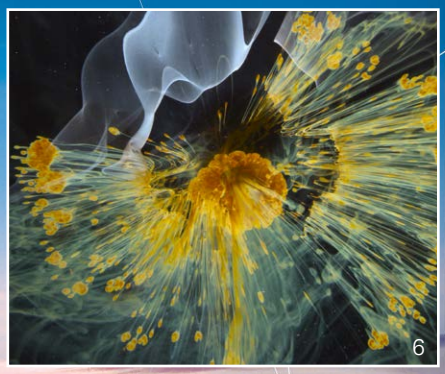
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1. Cuttlefish egg nestled in coral
2. Moss-covered lava
3. Seeing the world through a child's eyes
4. Forest
5. The sun strips away the atmosphere
6. Formation of membrane

Bottom left: A Muttaburrasaurus, a dinosaur that lived millions of years ago

Voyage of Time: The IMAX Experience is a one-of-a-kind celebration of life and the grand history of the cosmos from acclaimed filmmaker Terrence Malick. The accompanying Educator's Guide supplements the film, offering students a better understanding of their time and place in the universe and an appreciation of the diversity and beauty of life on Earth.

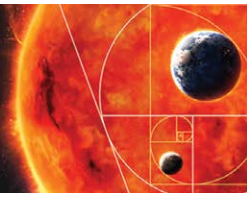
1. Solar energies
2. An asteroid enters Earth's atmosphere

Voyage of Time presents a beautiful and inspiring journey through the history of time — from the earliest star formations to the development of land and life on Earth to the future of our universe. The film prompts questions about consciousness, the relationship between reproduction and death, and humanity's relationship with nature. The activities in this guide ground the concepts presented in *Voyage of Time* and provide students with the background and tools to achieve a deeper understanding of evolutionary biology, geology, and astronomy.

The guide contains activities for grades 3-8, but we encourage you to adapt the activities to suit your group of students. Five of the seven activities in this guide connect to the Next Generation Science Standards (NGSS), covering topics in Life Sciences, Space Science, and Geology and Earth Science. One activity focuses on analytical writing based on Common Core Standards, and one activity connects to the National Core Arts Standards for creating, presenting, and responding. All activities focus on STEAM (Science, Technology, Engineering, Arts, and Mathematics).

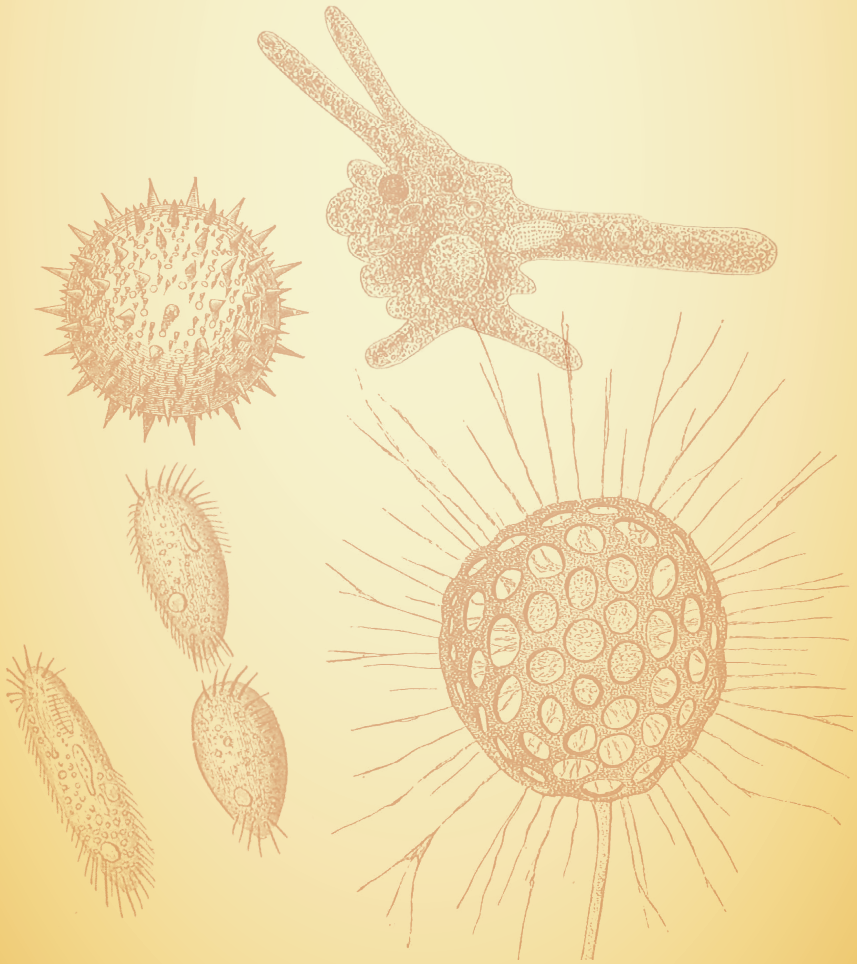
EDUCATOR'S GUIDE CONTENTS

1 The Scale of Time



Voyage of Time depicts the history of our universe – from the first stars through the geological and biological **evolution** of Earth. The film illustrates a process that took billions of years.

In this activity, students will place significant events on a timeline in order to gain perspective on the Earth's development and humanity's time and place in the universe.



TARGET AGE GROUP

6th – 8th Grade

OBJECTIVE

Students will place historical events visualized in *Voyage of Time* onto a timeline to learn about the order of evolution and the scale of time.

MATERIALS

- Copies of The Scale of Time worksheet in the Appendix
- Safety scissors
- Glue or tape

PREPARATION

Photocopy the Timeline in Appendix and distribute copies to each student.

Students can complete the Timeline one of two ways: either by adding the event, indicated by letters A – L, above the year bubbles on the timeline or by cutting out the individual event (A – L) and moving each to the proper locations on the timeline.

GEOLOGY, HISTORY OF THE EARTH, SPACE SCIENCE

NGSS

- MS-ESS1-4: Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6 billion year old history.
- MS-ESS2-2: Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

PART 1 Students create evolution timelines by placing the events where they think they belong on the timeline. There is one event for each date on the timeline.

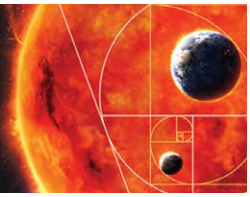
PART 2 After students make their own timelines, go through the timeline as a class. Ask students to reveal their answers and discuss before you disclose the correct date for each event.

PART 3 Discuss the scale of time with students. What surprises them? What do they have questions about? Students may be surprised how long the universe existed prior to life on Earth, and especially prior to humans. If your students are willing, feel free to open up the discussion to why life needs very special conditions in order to exist. We could not have survived on an Earth covered in lava or on a planet that was not the right distance from the Sun. Do students think that life might have arisen on another planet? Or elsewhere in the universe?

ACTIVITY ANSWER KEY: THE SCALE OF TIME

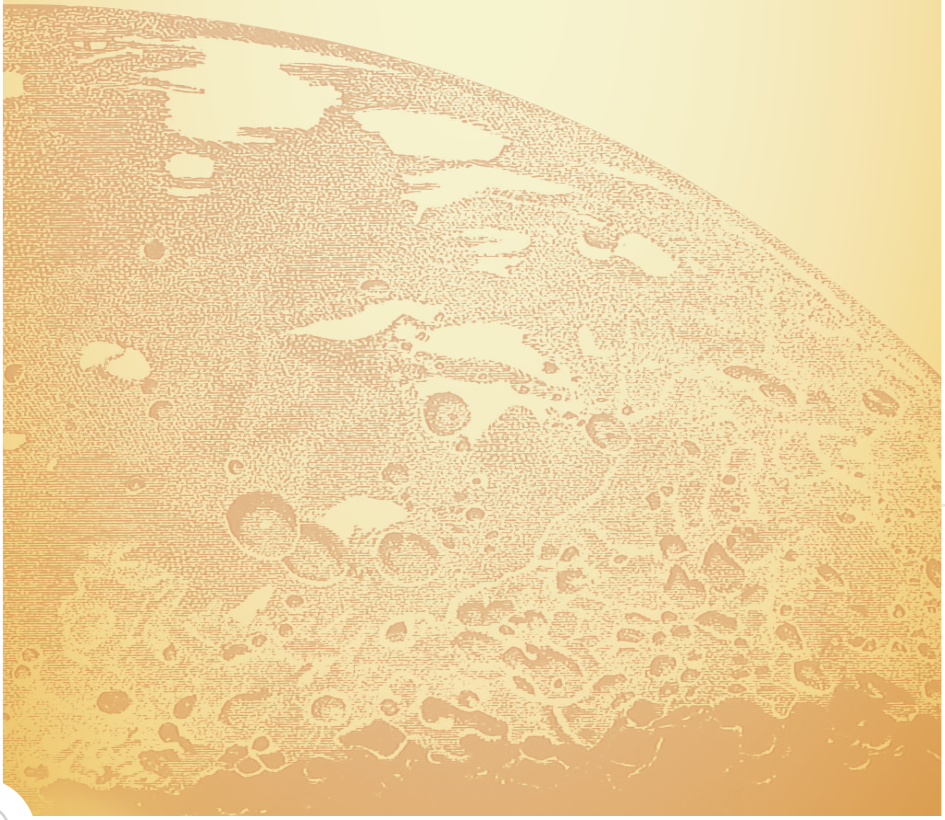
13.7 billion years ago	L	*Our Universe begins*
4.5 billion years ago	A	*The Earth forms*
4.4 – 4.1 billion years ago	C	*Continental crust forms*
3.8 billion years ago	I	*Life appears on Earth, as bacteria*
2.7 - 2.4 billion years ago	E	*Cyanobacteria appears and begins to release oxygen into the atmosphere*
450 million years ago	H	*First evidence of organisms on land (scorpions, spiders, and plants)*
370 million years ago	F	*First evidence of animals on land (Amphibians)*
230 million years ago	B	*Dinosaurs appear*
66 million years ago	G	*Dinosaurs become extinct and mammals become abundant*
7 million years ago	D	*Hominids split from African apes*
1 million years ago	J	*Homo erectus builds fire*
200,000 years ago	K	*Homo sapiens appear on Earth*

2 Gravity in Space



When we picture astronauts in space, they are floating, weightless. This image leads us to believe that **gravity** does not exist in space. But if there was no gravitational pull in outer space, our **galaxy,** solar system, and planet would not exist. *Voyage of Time* begins with astronomical simulations of star and galaxy formations. Gravity pulls dust and gas together and we see our solar system and our Earth form.

In this activity, students will confront the misconception that gravity does not exist in space and then model how gravity holds our solar system together.



TARGET AGE GROUP

5th – 8th Grade

OBJECTIVE

Students will learn that gravity exists between objects with mass, and the amount of gravitational pull an object exerts is directly related to its mass. This physics phenomenon causes star formation, galaxy formation, solar system formation, and orbits.

MATERIALS

A jump rope, folded in half, or a similar length of rope.

SPACE SCIENCE

NGSS

- 5-PS2-1: Support an argument that the gravitational force exerted by Earth on objects is directed down.
- MS-ESS1-2: Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.

PART 1 To capture your students' existing knowledge of gravity, ask them what gravity is and if it exists in space. Many students will believe that gravity does NOT exist in space, because of previous exposure to floating astronauts in space stations.

If students believe that gravity does not exist, point out evidence of gravity in space. Gravity causes the Moon's orbit around the Earth and the Earth's orbit around the Sun. The amount of gravitational pull that an object exerts is directly related to its mass. Tell students that everything has a gravitational pull – including them – but the Earth's gravitational pull is so much stronger because it is so much bigger than them.

PART 2 Now, students will model this gravitational pull. Ask for a volunteer to be the Sun. Explain that the Sun is very massive and has a lot of gravitational pull. Whoever is the Sun has to hold a rope, which represents this gravitational pull. The Sun will stand in a clear space in the room.

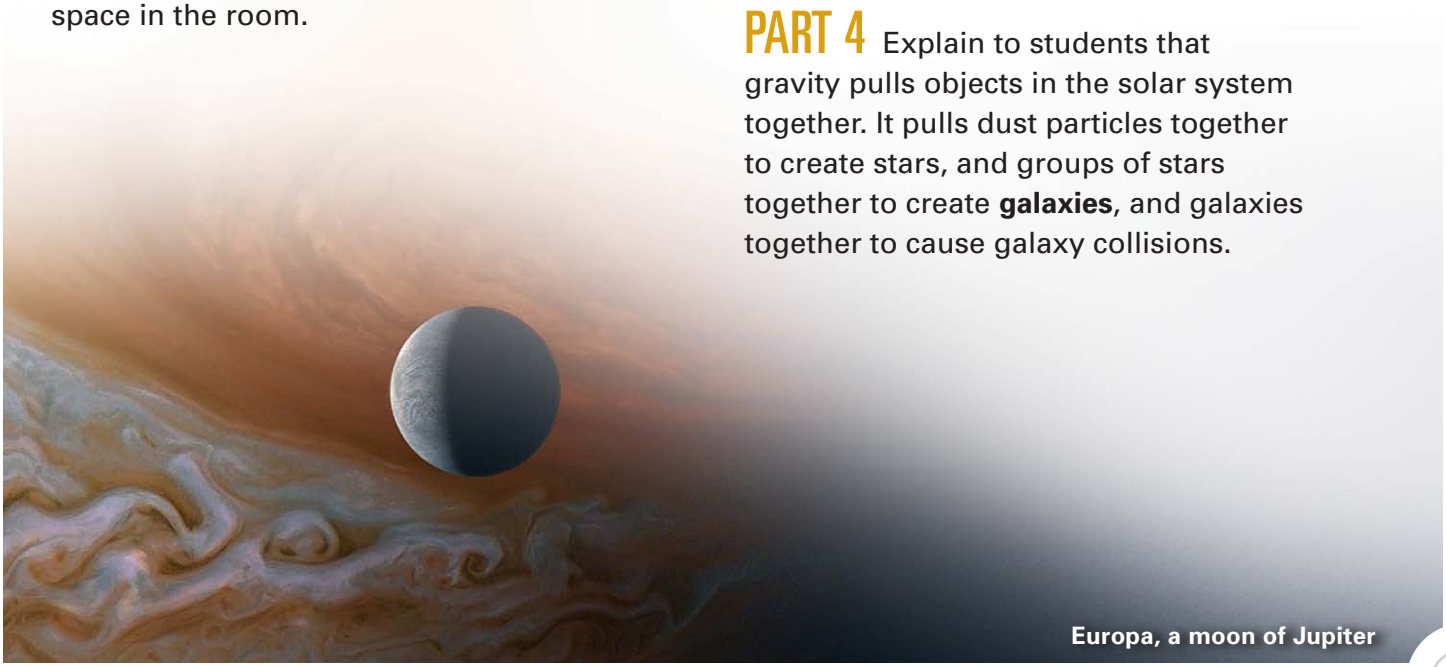
Ask for another student to volunteer to be Mercury. This is the planet closest to the Sun. It is much smaller than the Sun, and so is influenced by the Sun's gravity. Mercury will take the other end of the Sun's rope.

Instruct the Sun to stand in place, hold on to the rope tightly, and rotate slightly in place if needed to keep the rope straight.

Mercury pulls on the other end of the rope and attempts to walk forward. Since the Sun is standing in place, Mercury will have to circle around the Sun. This is how **orbits** work! The planets try to go straight, but the Sun's gravity acts like a rope, so the planets end up circling the Sun.

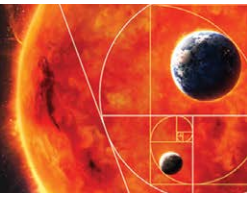
PART 3 The rest of the students in the class can try this same phenomenon with ropes or just holding hands. One partner will stand in place, rotating slightly, while the other tries to walk straight, but ends up circling the first partner.

PART 4 Explain to students that gravity pulls objects in the solar system together. It pulls dust particles together to create stars, and groups of stars together to create **galaxies**, and galaxies together to cause galaxy collisions.



Europa, a moon of Jupiter

3 Chocolate Magma



How did land form on Earth? In the early phases of the Earth, there was no dry land. The Earth was so hot that rock was actually molten, as **magma**. The Earth slowly cooled, and the magma hardened into rock within the Earth. In *Voyage of Time*, we see evidence of this process through images of boiling magma beneath a dark surface of **igneous rock**. Gradually, as the Earth cools, the rock transforms into the beautiful landscapes we see in the film.

TARGET AGE GROUP

4th – 5th Grade

OBJECTIVE

The teacher will model how magma cooled into igneous rocks to form the early landmasses on Earth.

MATERIALS

- Heat source (Microwave, stovetop, hot plate)*
- Chocolate (chips or bar, good for melting)
- Baking sheet
- Cooking pot or microwave-safe dish
- Wax paper

PREPARATION

Place wax paper on baking sheet. Break up the chocolate bar or pour chocolate chips into a microwave-safe dish or pot for stovetop use.

*This activity requires adult supervision.

GEOLOGY AND EARTH SCIENCE

NGSS

- 4-ESS-1-1: Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.
- 4-ESS-2-2: Analyze and interpret data from maps to describe patterns of Earth's features.

PART 1 Ask students, "After seeing *Voyage of Time,* where do you think our land came from? It formed from somewhere -- how did it form?" Students will make predictions and reveal their misconceptions.

PART 2 With your heat source, heat some chocolate until it melts. Pour out the melted chocolate onto a baking sheet covered in wax paper as your students watch.

PART 3 Wait as the chocolate cools, and solidifies. Tell students that Earth's crust was formed in similar manner. These kinds of rocks, formed from magma, are called igneous rocks. It is important to emphasize that the Earth's earliest landmasses formed from magma that cooled within the Earth instead of lava that cooled on top of the Earth from volcanic explosions.

PART 4 Ask students to reflect on their predictions. Are they surprised that land formed from magma? How did their original ideas differ from this new idea?

PART 5 Feel free to share the newly formed igneous rocks with your students as a snack!

Inspired by: http://www.earthsciweek.org/classroom-activities/chocolate-rock-cycle

Volcanic Caldera

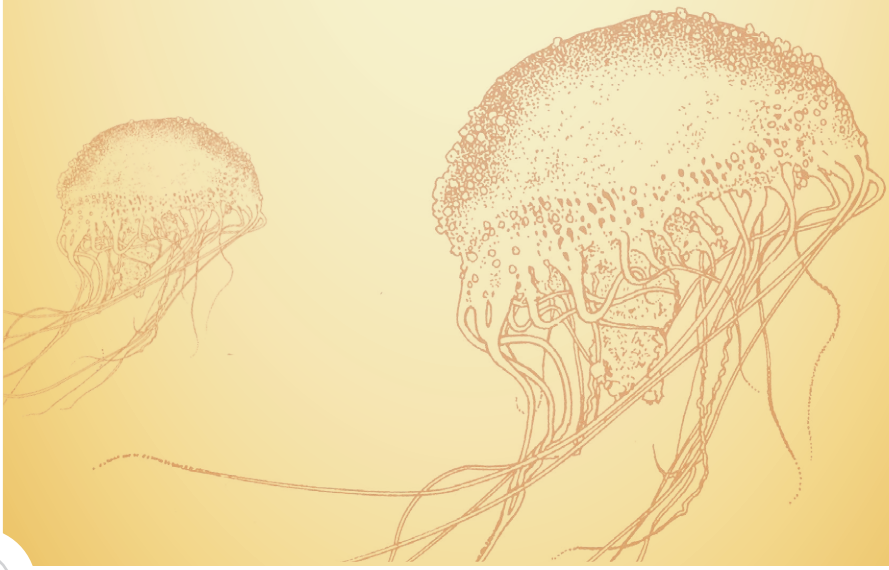
Lava, hardening into a rock

4 Environment & Adaptation

In *Voyage of Time*, we see a wide variety of **organisms** in different habitats – from jellyfish in the ocean to chimpanzees on land. Each creature has special qualities that allow it to live in its habitat. Jellyfish thrive in the ocean but would suffer on dry land; whereas chimpanzees survive on land but would have trouble if they had to live in the water.

Other creatures we see in the film no longer exist, such as the **Gorgonopsid**, which is a protomammal, **Muttaburrasauruses**, or the **Diplocaulus**. These **organisms** thrived in their time and place – but environmental changes impacted their existence. Some species adapt when their environments change, but others become extinct.

In this activity, students will consider how the traits of plants and animals interact with their particular environments. Then, students will imagine adaptations to those plants and animals after an environmental change.



TARGET AGE GROUP

3rd – 5th Grade

OBJECTIVE

Students will consider traits of organisms and how they relate to their habitat. When the habitat changes, students will consider how those organisms need to adapt or move to a new environment.

MATERIALS

- Safety scissors
- Cards from Appendix of organisms and habitats

PREPARATION

Make copies of the **organism** cards and the **habitat** cards from Appendix. Place your students in pairs or in small groups and give each group the page of cards and scissors. Ask them to cut out the cards.

LIFE SCIENCE

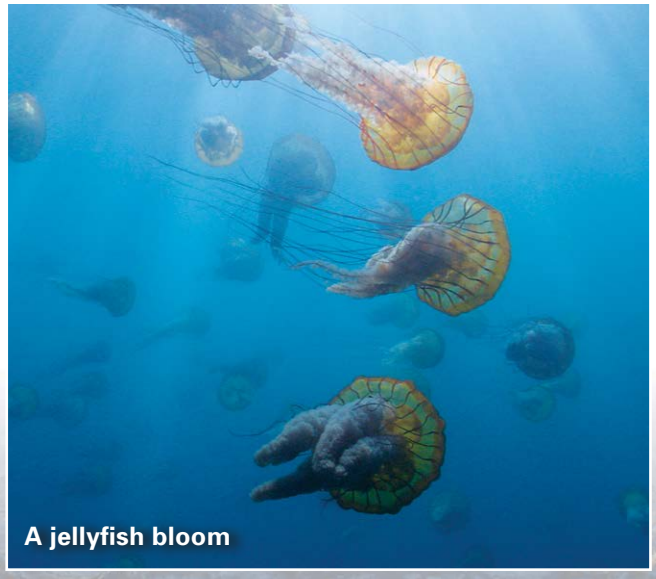
NGSS

- 3-LS4-3: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
- 3-LS4-4: Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.
- 3-LS3-2: Use evidence to support the explanation that traits can be influenced by the environment.
- 4-LS-1: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
- 5-LS1-1: Support an argument that plants get the materials they need for growth chiefly from air and water.

PART 1 Ask students to match the organisms with the appropriate habitat. Students should explain why they made the choices they did in their small groups.

PART 2 Now, have students rotate their organisms, so that every organism is in a different habitat. Students pick one of the new combinations to write about. Ask, "What would happen to the organism in its new habitat? What traits does the organism have that would make the habitat a difficult place to live? Does it have any traits that would help it in its new environment?"

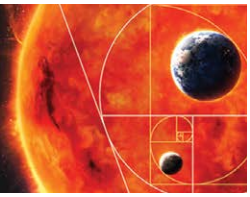
PART 3 Explain that over very long periods of time, species evolved to adapt to new habitats. In *Voyage of Time*, we see the diversity of organisms in a wide variety of habitats. Some of those organisms do not exist anymore. Ask your students to write a short story considering what traits the organism could develop that would allow them to thrive in its new habitat. (Example: A lion could develop gills, to breathe underwater.)



A jellyfish bloom

Gorgonopsid, a protomammal

5 Organize your Organisms



Voyage of Time depicts a wide variety of living **organisms**, from the first simple cells to the large and complex plants and animals found today. Some of these organisms no longer exist, but do share traits with modern life forms. For example, the people we see in the film are early representatives of the Hominid family. Biologists use the traits that living and extinct organisms share to organize, or "classify" them. The practice of giving these groups formal names is called taxonomy.

In this activity, students will learn about the taxonomic system and practice sorting specific organisms into groups.

TARGET AGE GROUP

5th – 8th Grade

OBJECTIVE

Students will learn about the taxonomic system based on shared traits among organisms. Students will organize species into taxonomic categories.

MATERIALS

- Organize your Organisms worksheet in Appendix.
- Scissors / paper cutter

PREPARATION

Photocopy the worksheet in the Appendix: Organize your Organisms to give one to each of your students.

LIFE SCIENCE

NGSS

- MS-LS4-2: Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.
- MS-LS1-1: Conduct an investigation to provide evidence that living things are made of cells, either one cell or many different numbers and types of cells.
- MS-LS4-6: Use mathematical representations to support explanations of how natural selection may lead to increases or decreases of specific traits in populations over time.

PART 1 Explain to your students, "As you saw in *Voyage of Time*, there are many different forms that life can take on Earth. To keep track of everything, scientists have developed a system that groups organisms based on shared traits. For example, plants are in one category, and animals in another. Our current system of naming, or taxonomy is based on one developed by Swedish botanist, Carl Linnaeus, in the mid 1700s.

PART 2 Ask students, "Why do you think it is important to put living things into categories? How may it help scientists study these creatures?"

PART 3 Go through the following hierarchy with your students, emphasizing that each level contains fewer and fewer organisms:

▶ TAXONOMIC ORDER:

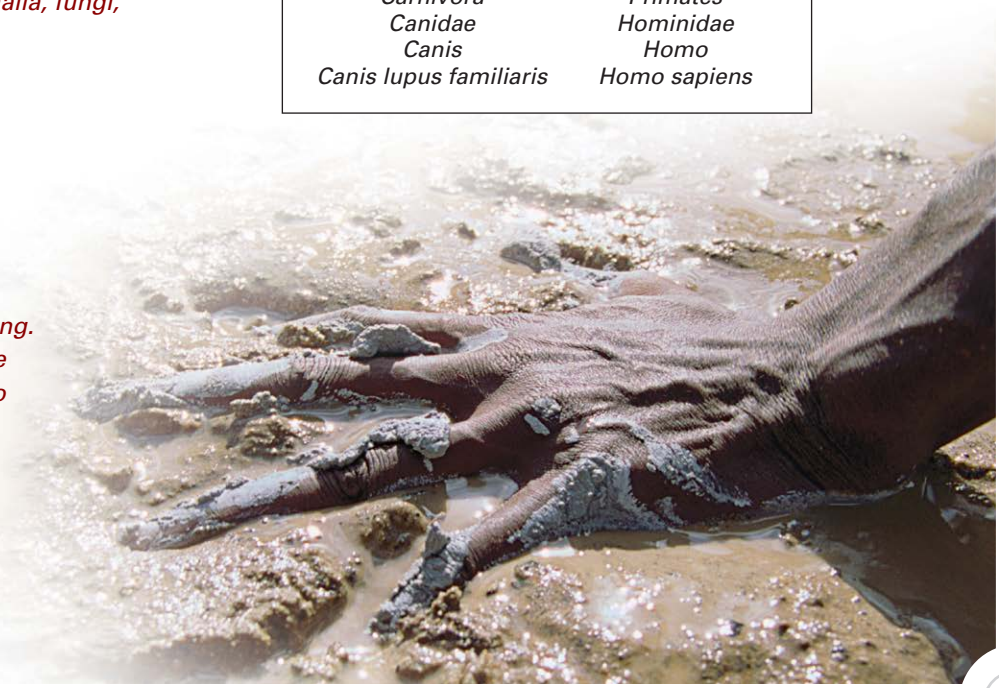
- **Kingdom** – *Kingdoms include the broader categories that students are most familiar with – including animalia, fungi, and plantae.*
- **Phylum**
- **Class**
- **Order**
- **Family**
- **Genus**
- **Species** - *The most specific group within taxonomic ranking. A group of organisms capable of breeding with each other to produce fertile offspring.*

PART 4 Give students the worksheet, in which they will try to guess the taxonomic order of two species: **Homo sapiens** (human) and **Canis lupus familiaris** (dog).

PART 5 Review the correct answers with the students and ask what similarities and differences they see in the taxonomic order. What does this tell them about dogs and humans compared with other organisms, such as apes, wolves, fish, or trees? Students should reach a place where they can see that humans and dogs are more closely related to each other than they are to plants or fish, but are not as closely related as humans are to chimpanzees or dogs are to wolves.

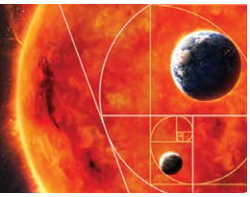
ACTIVITY ANSWER KEY: ORGANIZE YOUR ORGANISMS

DOG:	HUMAN:
Animalia	*Animalia*
Chordata	*Chordata*
Mammalia	*Mammalia*
Carnivora	*Primates*
Canidae	*Hominidae*
Canis	*Homo*
Canis lupus familiaris	*Homo sapiens*



6 THOUGHTS ON THOUGHT

HUMAN AND ANIMAL CONSCIOUSNESS



How did consciousness come into being? When did thoughts first form? With the diversity of life on Earth, are humans special? These are questions that Director Terrence Malick poses in *Voyage of Time*.

In this activity, students will practice film analysis by comparing images from the film to explore these questions.

TARGET AGE GROUP

5th – 8th Grade

OBJECTIVE

Students will write a short essay comparing and contrasting two scenes from the *Voyage of Time*.

PREPARATION

After viewing the film, share the images of the **Gorgonopsid** (protomammal) and the early human with students.

LIFE SCIENCE

COMMON CORE STANDARDS

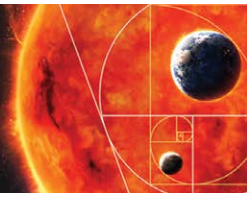
- CCSS.ELA-LITERACY.W.6.1 Write arguments to support claims with clear reasons and relevant evidence.
- CCSS.ELA-LITERACY.W.8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
- CCSS.ELA-LITERACY.W.8.2.A Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
- CCSS.ELA-LITERACY.RL.8.5 Compare and contrast the structure of two or more texts and analyze how the differing structure of each text contributes to its meaning and style.

PART 1 Share the images and definitions of the **Gorgonopsid** and early human with your students.

PART 2 Ask students to write a short essay comparing and contrasting these images. In what ways are the situations similar? In what ways are they different? What point does the director make based on the similarities and differences?

In separate scenes from *Voyage of Time*, a Gorgonopsid and an early human gaze into a pool of water.

7 VISUALIZING THE *VOYAGE OF TIME*



Voyage of Time is just that – a history of time. Director Terrence Malick made very deliberate choices in his use of imagery to tell a story of time passing. Malick chose to depict an evolutionary history, a geological history, and an astronomical history; but there are many other histories or stories of time that can be told.

In this activity, students will consider creative ways to depict the passage of time, thinking about the filmmaking process and the choices made by the film's director. Then, they will create their own voyages of time.

TARGET AGE GROUP

7th – 8th Grade

OBJECTIVE

Students will consider creative ways to depict the passage of time. Students will create their own vision of a voyage of time – through video, photography, drawings, or other media.

MATERIALS

- Cameras / phones / tablets
  Alternative methods students can use to depict the passage of time include drawing, pantomime and creative writing.

ART

NATIONAL CORE ARTS STANDARDS:

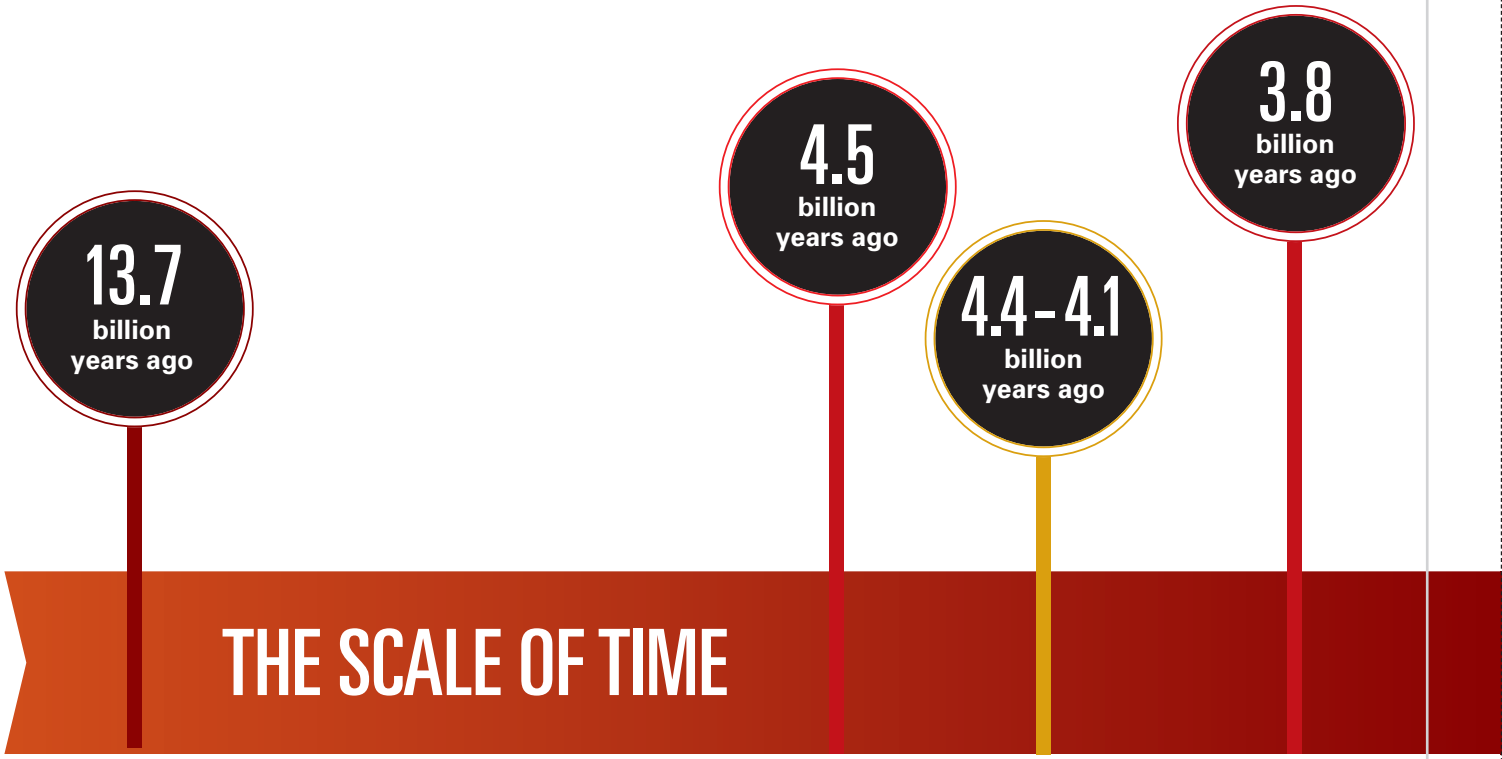
- 8th VA:Cr1.2.8a: Collaboratively shape an artistic investigation of an aspect of present-day life using a contemporary practice of art and design.
- 8th VA:Cr2.1.8a: Demonstrate willingness to experiment, innovate, and take risks to pursue ideas, forms, and meanings that emerge in the process of art-making or designing.
- 7th VA:Cr3.1.7a: Reflect on and explain important information about personal artwork in an artist statement or another format.
- 8th VA:Re8.1.8a: Interpret art by analyzing how the interaction of subject matter, characteristics of form and structure, use of media, art-making approaches, and relevant contextual information contributes to understanding messages or ideas and mood conveyed.

PART 1 Discuss the choices that director Terrence Malick made in the *Voyage of Time*. Why did he decide upon that title? How did he represent the passage of time? What kinds of stories did he choose to tell?

PART 2 Ask students to brainstorm, "What are other ways that we depict time in our society? How do we know that time is passing? How do we know what time it is?" The point of this is to get students to think beyond clocks – to things like the sun moving across the sky, night and day, aging, growing, etc. Brainstorm a few ideas as a class.

PART 3 Now, ask students to choose how they would like to represent the passage of time. Students can create a short video, a series of pictures, drawings, or any other media. This assignment can be a quick activity with smartphones, or a more extended activity done out of class.

PART 4 Review students' submissions in class, encouraging students to discuss their choices. Analyze all the different ways that the class may have represented the passage of time.



Time intervals not to scale

A The Earth forms

B Dinosaurs appear

C Continental crust forms

D Hominids split from African apes

E Cyanobacteria appears and begins to release oxygen into the atmosphere

F First evidence of animals on land (Amphibians)

G Dinosaurs become extinct and mammals become abundant

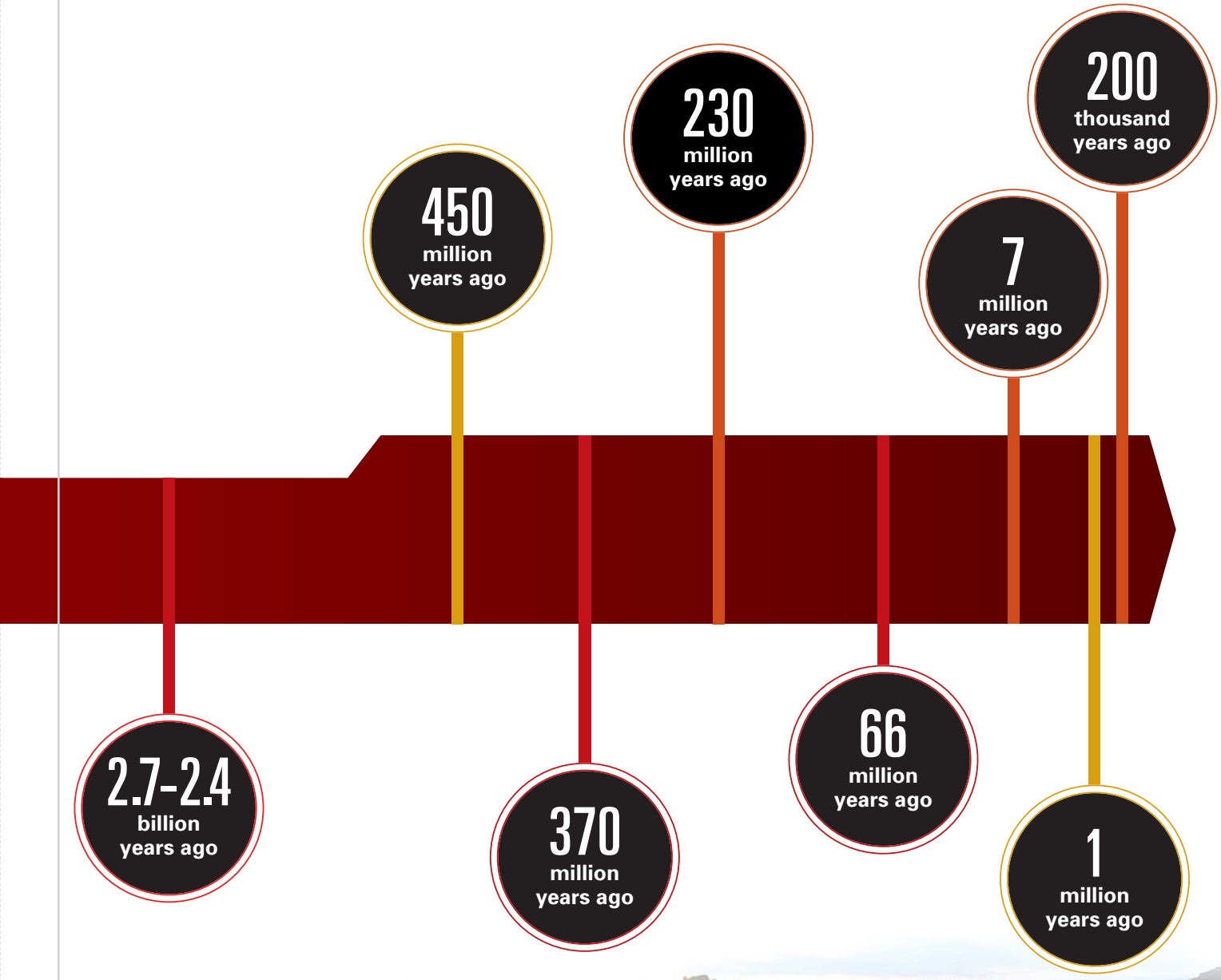
H First evidence of organisms on land (scorpions, spiders, and plants)

I Life appears on Earth, as bacteria

J Homo erectus builds fire

K Homo sapiens appear on Earth

L Our Universe begins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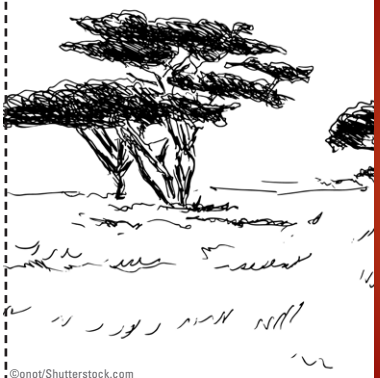
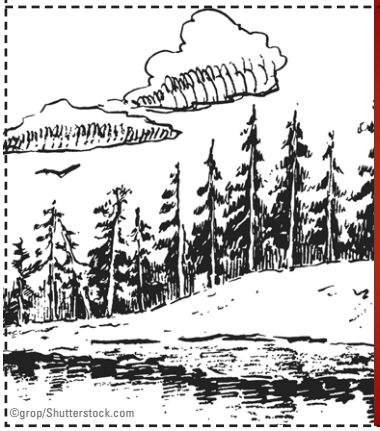
ACTIVITY 4 WORKSHEET: ENVIRONMENT & ADAPTATION

HABITAT CARDS

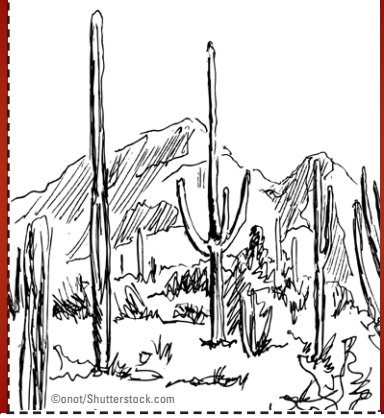


HABITAT:
GRASS-LANDS

HABITAT:
OCEAN

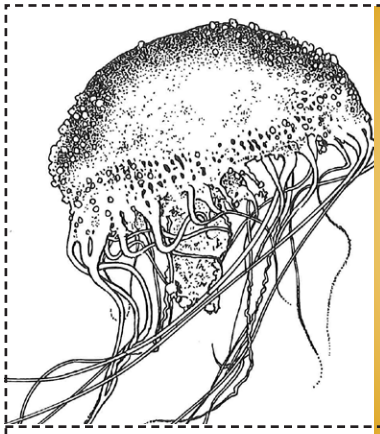


HABITAT:
FOREST

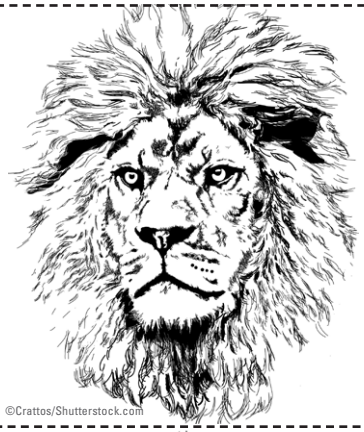


HABITAT:
DESERT

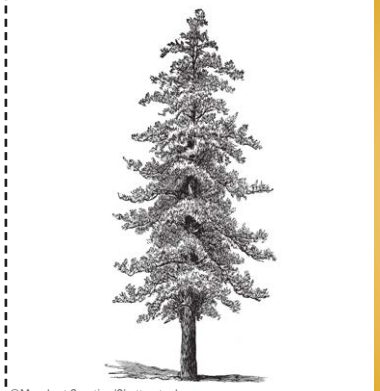
ORGANISM CARDS



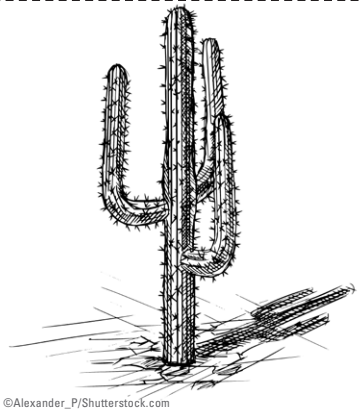
ORGANISM:
JELLY-FISH



ORGANISM:
LION

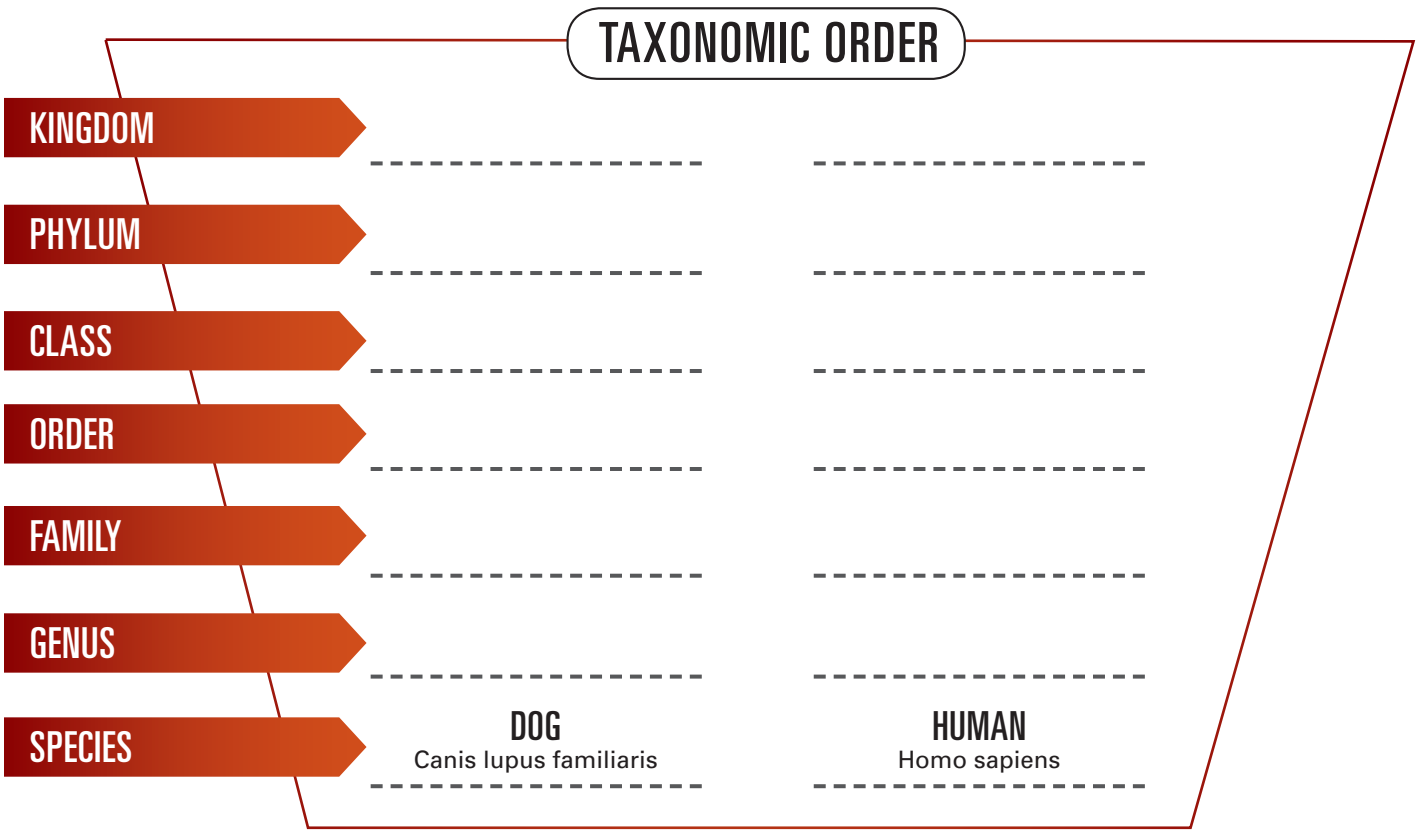


ORGANISM:
PINE TREE



ORGANISM:
CACTUS

ACTIVITY 5 WORKSHEET: ORGANIZE YOUR ORGANISMS



Match the words below with where they belong above. If a word has x 2 next to it, it means it is used in both the human and the dog taxonomy.

Animalia x 2 ..... Multicellular. Move on their own. Rely on other organisms for food.

Chordata x 2 ..... Bilaterally symmetrical (the right and the left are symmetrical). Have a rod of cartilage or bones that runs down the back.

Canidae ..... Have a strong sense of smell and hearing. Have four legs and hairy tails. Catch prey by outlasting long-distance chases with superior endurance.

Carnivora ..... Have strong teeth that enable them to eat meat.

Homo ..... Initially included only Homo sapiens, but now fossils of earlier forms of humans have been found.

Primates ..... Mostly arboreal (reside in trees). Have larger brains than most other mammals. Usually have opposable thumbs and large toes.

Mammalia x 2 .... Have hair. Females produce milk to feed offspring. Regulate their own body temperature.

Canis ..... Have strong canine teeth. Have four long legs. Have comparatively short ears and tails. Non-retractable claws. Prefer to live in packs.

Hominidae ..... Upright or semi-upright stance. Two-legged walking. Extended period of bi-parental care.

RESOURCES

NOVA Labs: Evolution Lab by PBS' NOVA is an online science lab complete with educational games, interviews with scientists, and background videos. The site also includes a "Deep Tree" developed by researchers at the Harvard School of Engineering that contains a record of 70,000 known species and their evolutionary links. *http://www.pbs.org/wgbh/nova/labs/lab/evolution/research#/chooser*

Smithsonian Museum of Natural History: Dinosaurs in our Backyard discusses fossils and how paleontologists have learned about the characteristics of dinosaurs. *http://naturalhistory.si.edu/exhibits/backyard-dinosaurs/*

Animal Diversity Web comes from the Museum of Zoology at the University of Michigan and contains a wealth of information on species within the Animalia Kingdom. Search by name to learn more about the taxonomy of various species. *http://animaldiversity.org/*

NASA's website contains many lesson plans and resources for educators who wish to teach astronomy. *https://www.nasa.gov/education/resources/#.VzEHTsd9IhY*

The Harvard-Smithsonian Center for Astrophysics' MicroObservatory is a network of educational robotic telescopes freely available for anyone who has internet access to take images of the night sky. *http://mo-www.cfa.harvard.edu/OWN/index.html*

The Encyclopedia of Life was founded in 2007 by the Field museum, Harvard University, the Smithsonian, the Marine Biological Laboratory and the Missouri Botanical Garden to create a database of all known organisms in all six Kingdoms. *http://eol.org*

The United States Geological Survey (USGS) website contains many resources for educators to teach lessons on geological history. *http://education.usgs.gov*

Smithsonian Museum of Natural History: What does it mean to be human? contains resources on human characteristics and a catalogue of all known human species. *http://humanorigins.si.edu*

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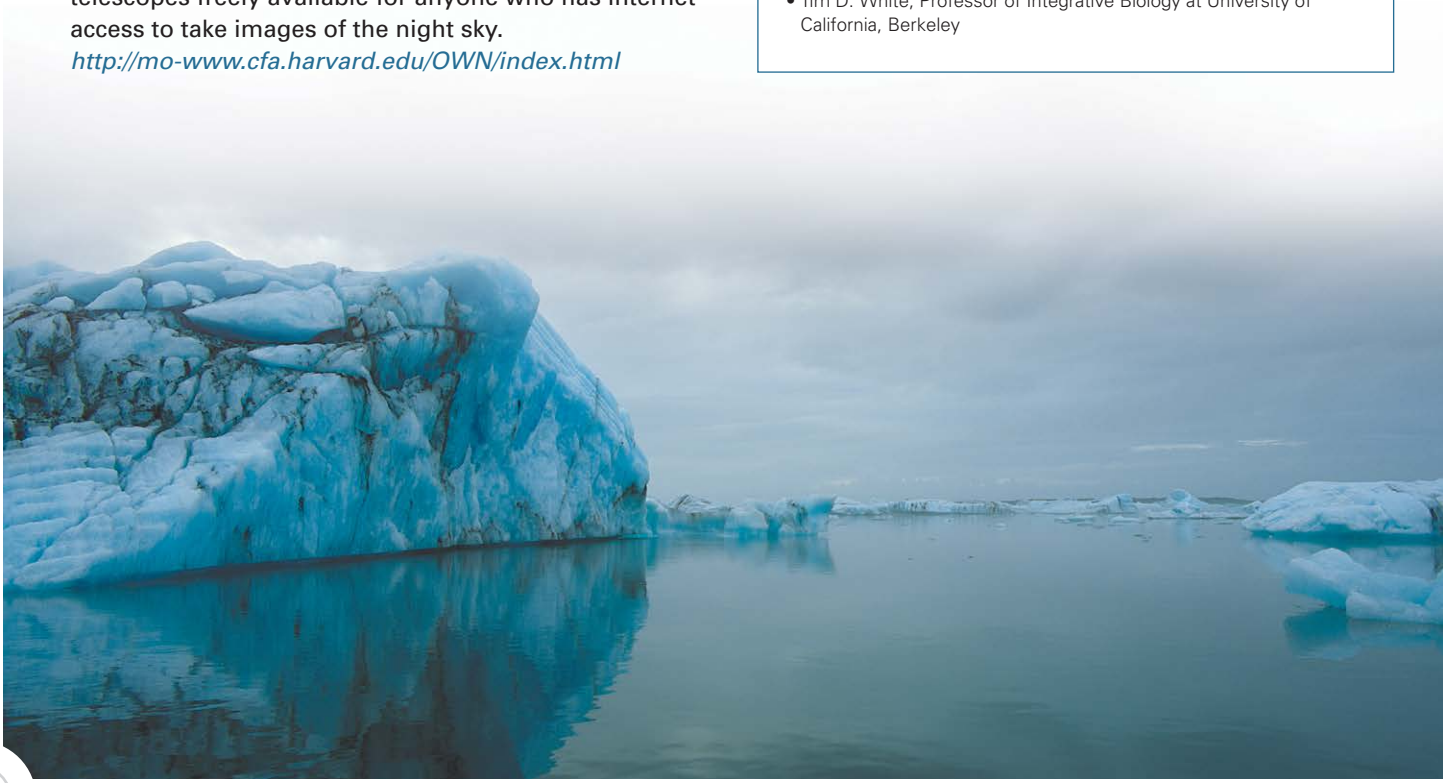


GLOSSARY

ADAPTATION – In biology, a process by which an organism changes to adjust to a change in environment.

ALGAE – Small plants, often with only one cell, that are usually found in water. Algae are among the oldest organisms on Earth, appearing about 3 billion years ago.

ANIMALIA – A kingdom in the taxonomic hierarchy that includes organisms that are multicellular, move on their own, and rely on other organisms for food.

CANIDAE – A genus in the taxonomic hierarchy that includes mammals with four legs, hairy tails that have a strong sense of smell and hearing that help them catch prey.

CANIS LUPUS FAMILIARIS – Latin name for the household dog. ***Canis*** is the genus and ***lupus familiaris*** is the species. This format of naming is called binomial nomenclature.

CARNIVORA – An order in the taxonomic hierarchy that includes mammals with strong teeth that enable them to eat meat. Dogs belong in this family.

CHORDATA – A phylum in the taxonomic hierarchy that includes animals that are symmetrical and have a rod of cartilage or bones that runs down their backs.

CLASS – The third highest rank in taxonomy.

CYANOBACTERIA – Bacteria that produce their own energy through photosynthesis. Cyanobacteria are among the oldest organisms on Earth, appearing about 2.7 billion years ago.

DIPLOCAULUS – An extinct amphibian that lived about 250 million years ago.

EVOLUTION – The process by which organisms genetically develop and change over long periods of time.

FAMILY – The fifth rank in taxonomic hierarchy.

GALAXY – A group of stars, planets, and nebulae in space held together by gravity. Galaxies can include trillions of stars.

GENUS – The sixth rank in taxonomy.

GORGONOPSID, or **PROTOMAMMAL** – An extinct species of reptile that lived roughly 250 – 299 million years ago. The Gorgonopsid had mammal-like qualities, such as being warm-blooded.

GRAVITY – A force that attracts objects of mass to each other. The pull of gravity is directly proportional to the amount of mass.

HABITAT – A place where an organism lives, including all living and non-living features.

HOMINIDAE – A family in the taxonomic hierarchy that includes the genus ***Homo***. All hominids walk on two legs.

HOMO – A genus in the taxonomic ranking that includes human beings.

HOMO ERECTUS – A species of human that existed from roughly 2 million years ago to 150,000 years ago. Homo erectus built fires to cook meat.

HOMO SAPIENS* –** Latin name for the modern human being. ***Homo is the genus and ***sapiens*** is the species. This format of naming is called binomial nomenclature.

IGNEOUS ROCK – Rock formed when lava cools.

KINGDOM – The highest rank in taxonomy. Groups together organisms based on very broad characteristics.

LAVA – Liquid rock when it reaches above the surface of the Earth. When it cools, it forms igneous rock.

MAGMA – Liquid rock below the surface of the Earth.

MAMMALIA – A class in the taxonomic hierarchy that includes animals that have hair, the ability to regulate their own body temperature (warm-blooded) and females that produce their own milk to feed their offspring.

MASS – The amount of matter in an object. Takes into account the size of an object and how dense that object is.

MUTTABURRASAURUS – A dinosaur that lived in what is now Australia, 97.5 – 113 million years ago.

NEBULA – A cloud of dust and gas in space. Often is the location for new star formation.

ORBIT – A path of a celestial body in motion around a more massive body.

ORDER – The fourth highest rank in taxonomy.

ORGANISM – Anything that is living.

PHYLUM – The second highest rank in taxonomy.

PRIMATES – An order in the taxonomic hierarchy that includes mammals that have large brains, are usually arboreal, rely on sight more than hearing or smell, and often have opposable thumbs.

PROTO-MAMMAL – A reptilian ancestor of modern day mammals.

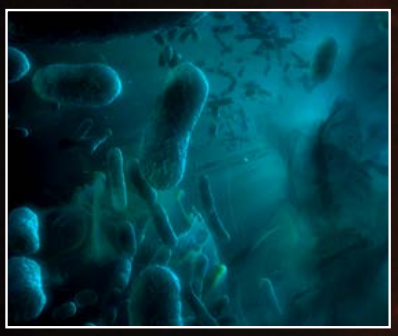
SPECIES – The most specific group within taxonomic ranking. A group of organisms capable of breeding with each other to produce fertile offspring.

STAR – A body of gas in space that produces light through nuclear fusion in its core.

TAXONOMY – The practice of naming organisms.

TRAIT – A characteristic of an organism.

TIKTAALIK – One of the first organisms to leave the ocean and move onto land 370 million years ago. It looks like a fish with four legs.



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