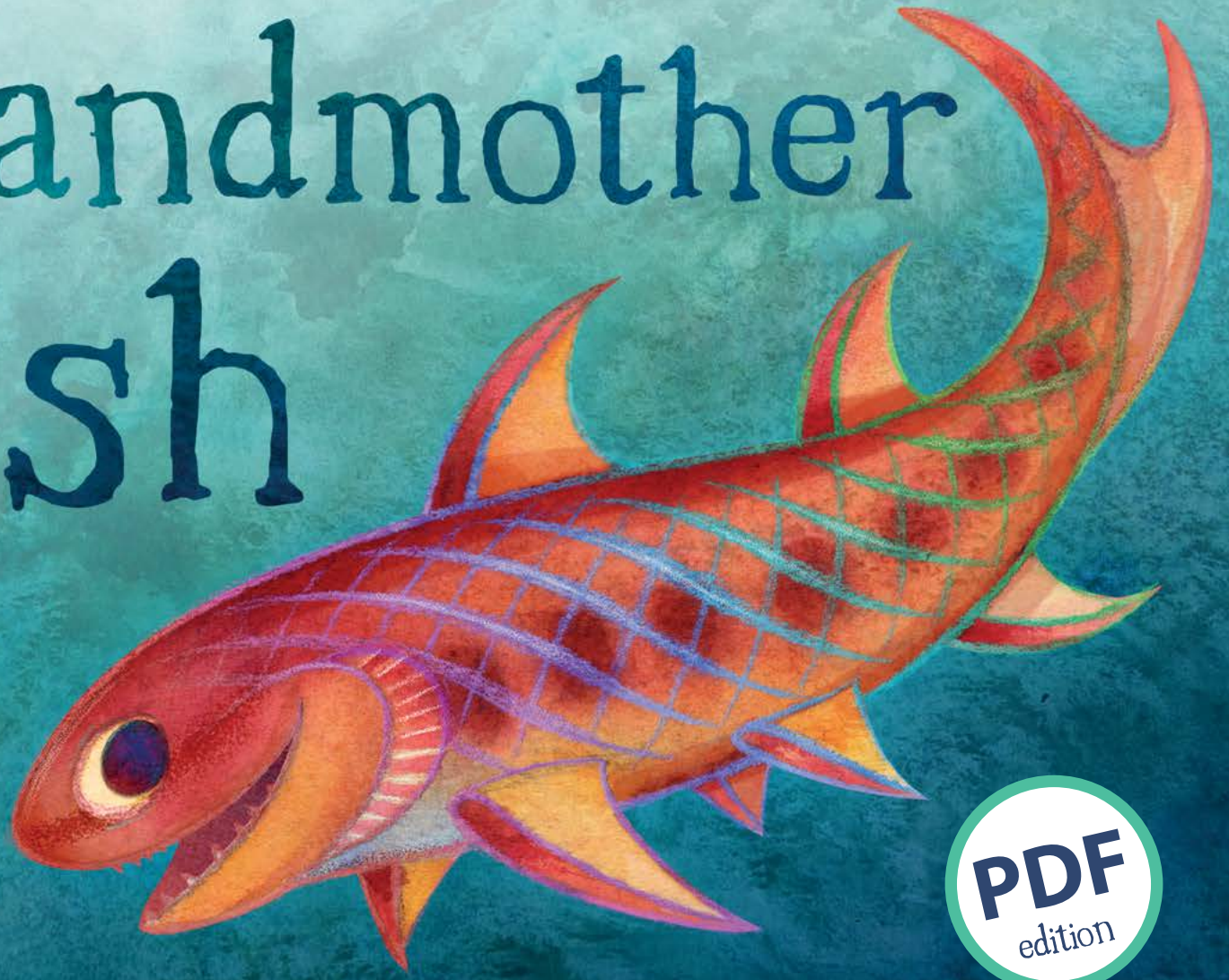


Grandmother Fish



a child's first book of Evolution
by Jonathan Tweet • illustrated by Karen Lewis

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For Tessa, my original inspiration. J.T.

For Kent and Sam with love. K.L.

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PDF edition

Grandmother Fish



a child's first book of Evolution

by Jonathan Tweet * illustrated by Karen Lewis



Fish



This is our Grandmother Fish.

She lived a **long, long, long, long, long** time ago.



She could **wiggle** and swim fast.

Can you wiggle?



And she had jaws to **chomp** with.

Can you chomp?

Grandmother Fish had many kinds of grandchildren.
They could **wiggle** and **chomp**.

Can you find our Grandmother Reptile?

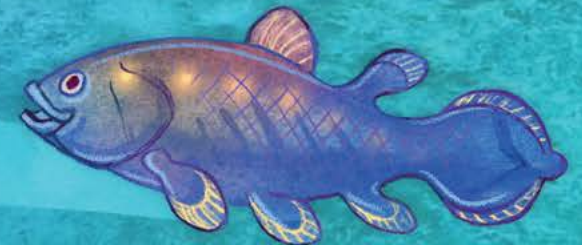


Grandmother Fish



Cousin Shark

Cousin Lobe-Finned Fish



Cousin
Ray-Finned Fish



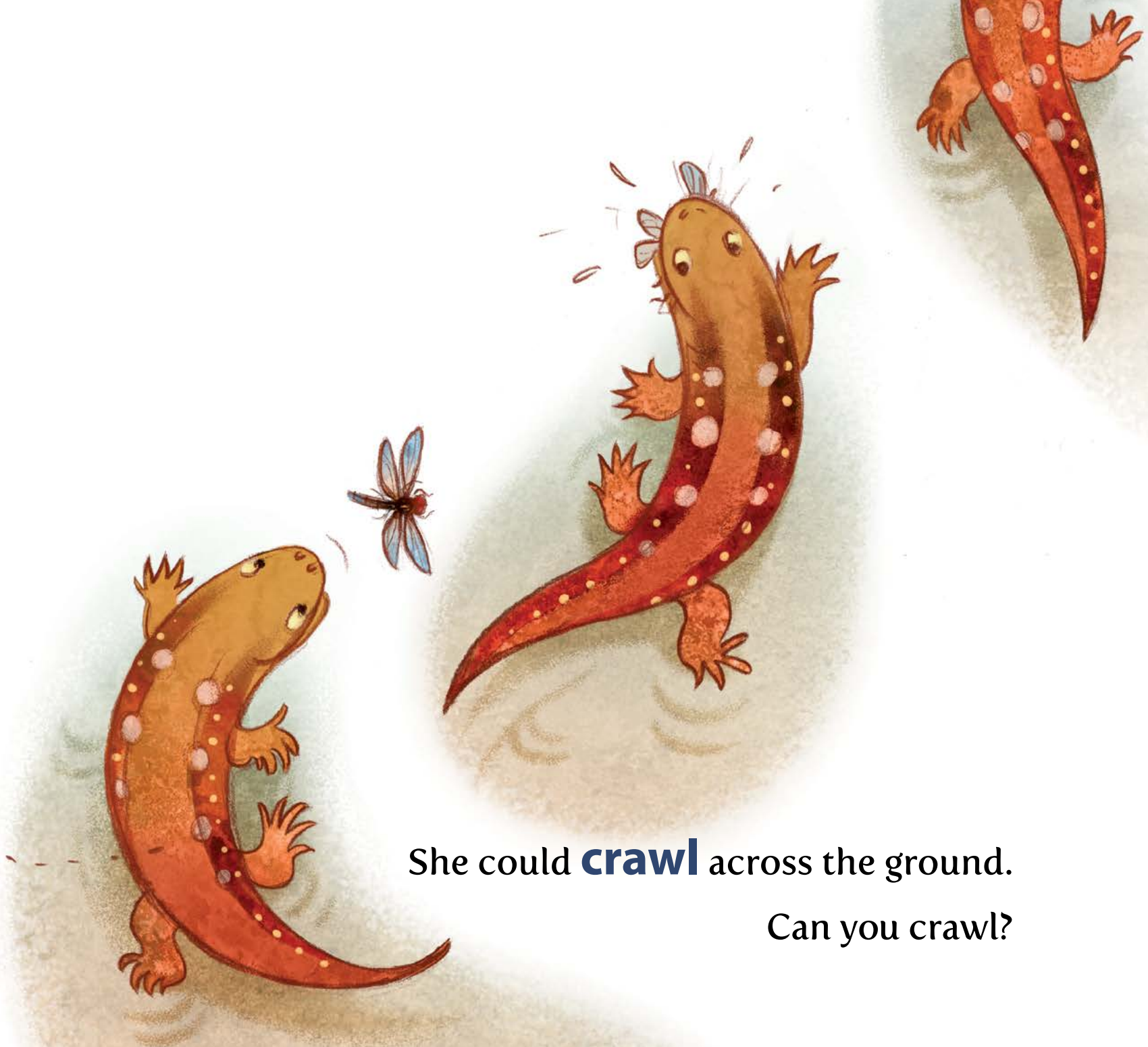
Grandmother Reptile

Reptile



This is our Grandmother Reptile.

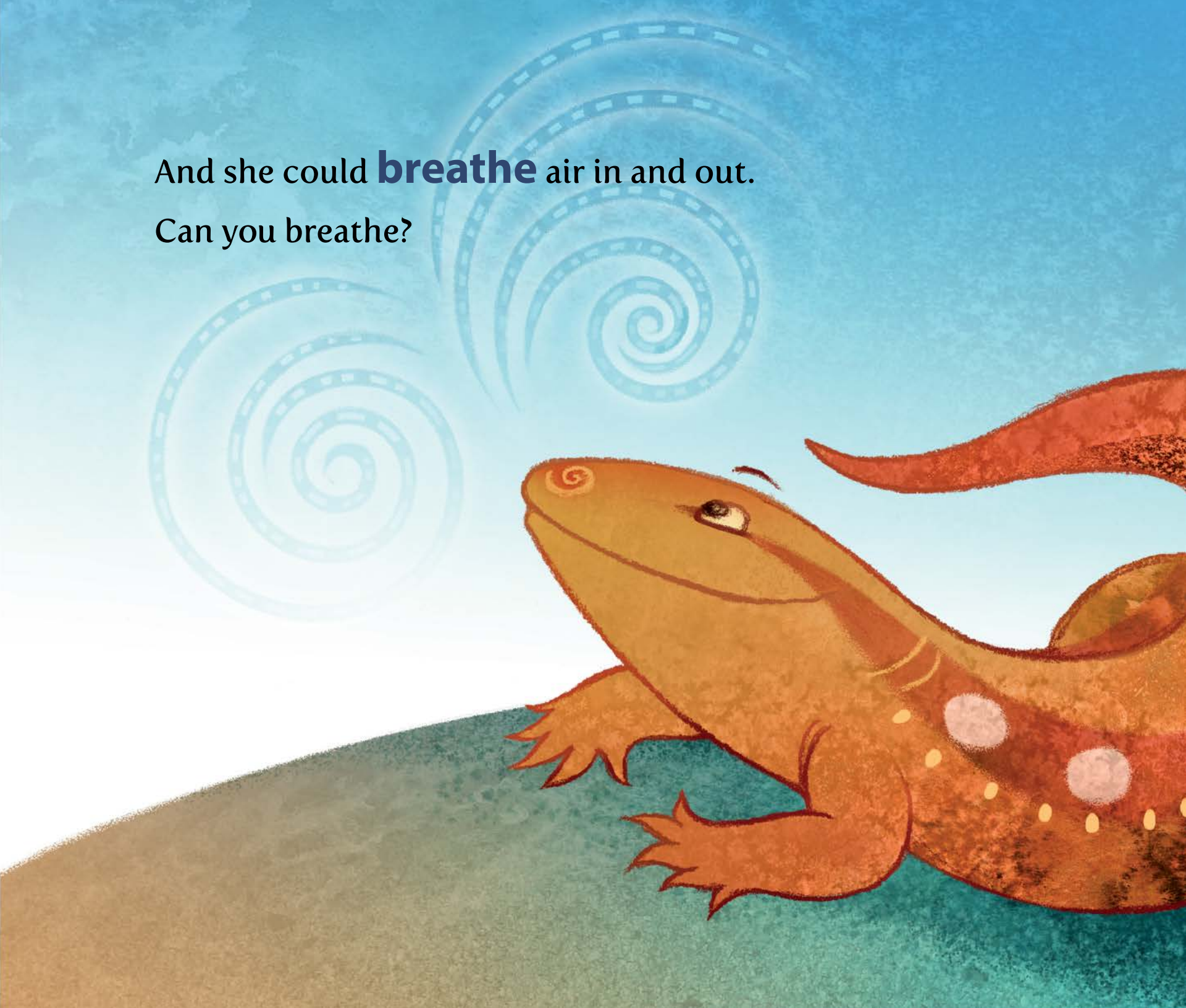
She lived a **long, long, long, long** time ago.



She could **crawl** across the ground.

Can you crawl?

And she could **breathe** air in and out.
Can you breathe?



Grandmother Reptile had many kinds of grandchildren.
They could **wiggle** and **chomp** and **crawl** and **breathe**.

Can you find our Grandmother Mammal?



Grandmother
Reptile

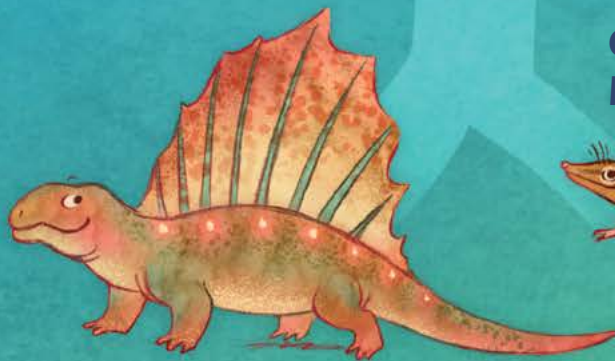
Cousin
Bird



Cousin
Triceratops



Cousin
Dimetrodon



Grandmother
Mammal



Cousin Lizard





Mammal



This is our Grandmother Mammal.

She lived a **long, long, long** time ago.



Her babies could **squeak** when they were hungry.

Can you squeak?



And she could **cuddle** with her babies and feed them milk.

Can you cuddle?

Grandmother Mammal had many kinds of grandchildren.

They could **wiggle** and **chomp** and **crawl** and **breathe** and **squeak** and **cuddle**.

Can you find our Grandmother Ape?



Grandmother Mammal

Cousin Elephant



Grandmother Ape



Cousin Carnivore

Cousin Horse



Cousin Whale

Ape



This is our Grandmother Ape.

She lived a **long, long** time ago.



She could **grab** branches to climb.

Can you grab?

And she could **hoot** when she was happy.

Can you hoot?



Grandmother Ape had many kinds of grandchildren.

They could **wiggle** and **chomp** and **crawl** and **breathe**
and **squeak** and **cuddle** and **grab** and **hoot**.

Can you find our Grandmother Human?



**Grandmother
Ape**



**Cousin
Gibbon**



**Grandmother
Human**

**Cousin
Orangutan**



**Cousin
Gorilla**



**Cousin
Chimpanzee**



Human



This is our Grandmother Human.

She lived a **long** time ago.



She could **walk** on two feet.

Can you walk?



And she could **talk** and tell stories.

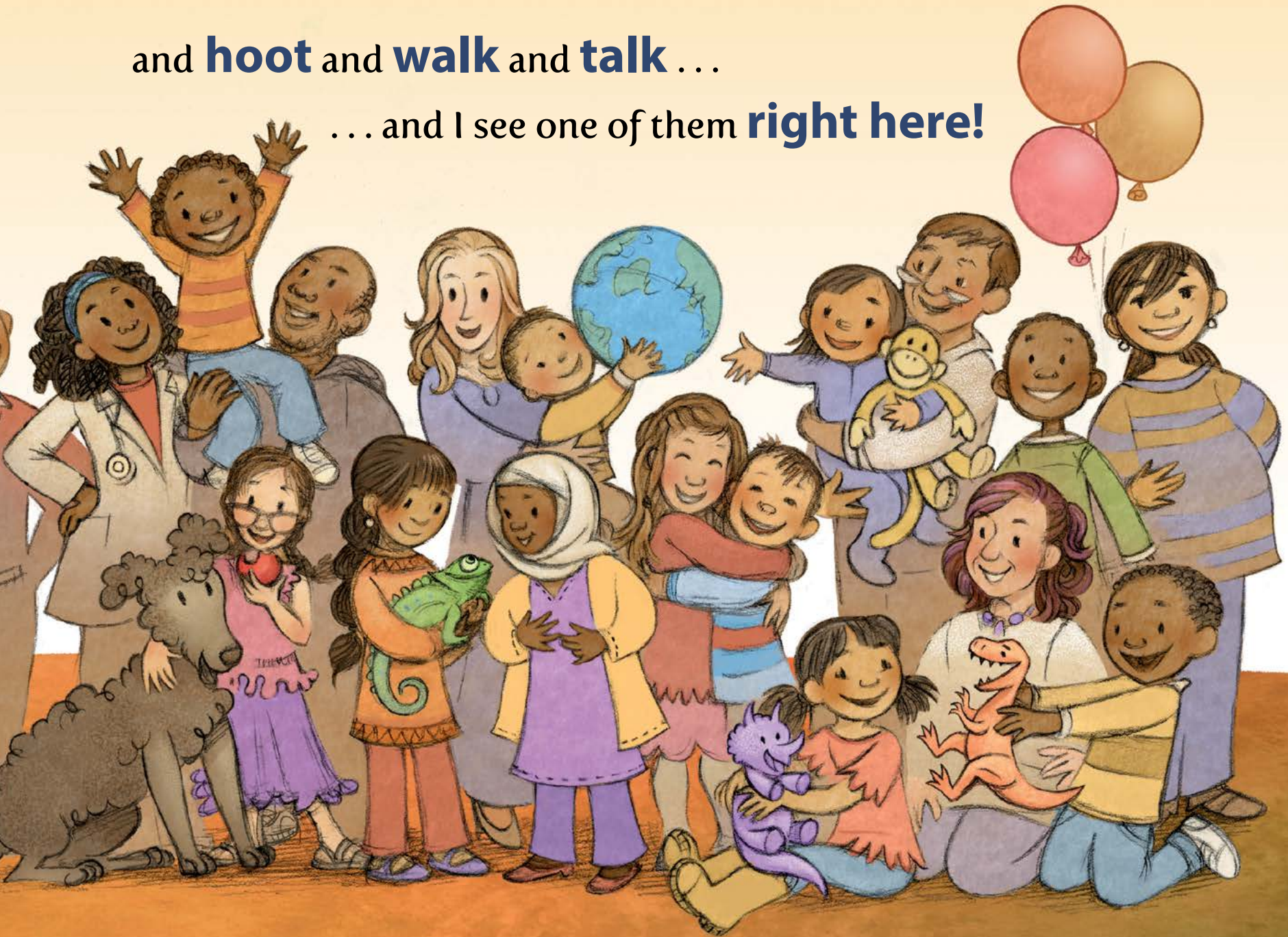
Can you talk?

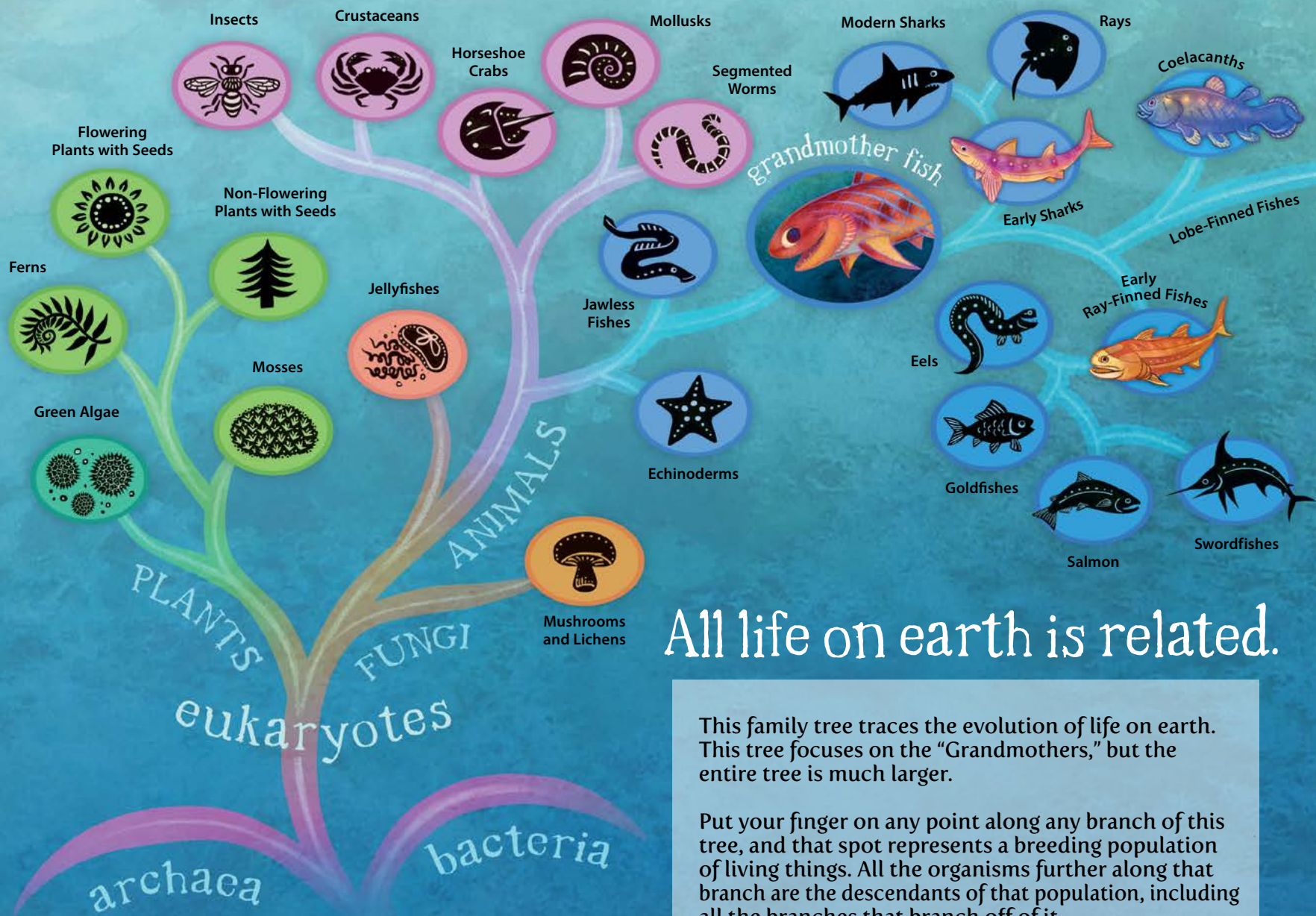
Grandmother Human had many kinds of grandchildren.
They could **wiggle** and **chomp** and **crawl** and
breathe and **squeak** and **cuddle** and **grab**



and **hoot** and **walk** and **talk** . . .

. . . and I see one of them **right here!**



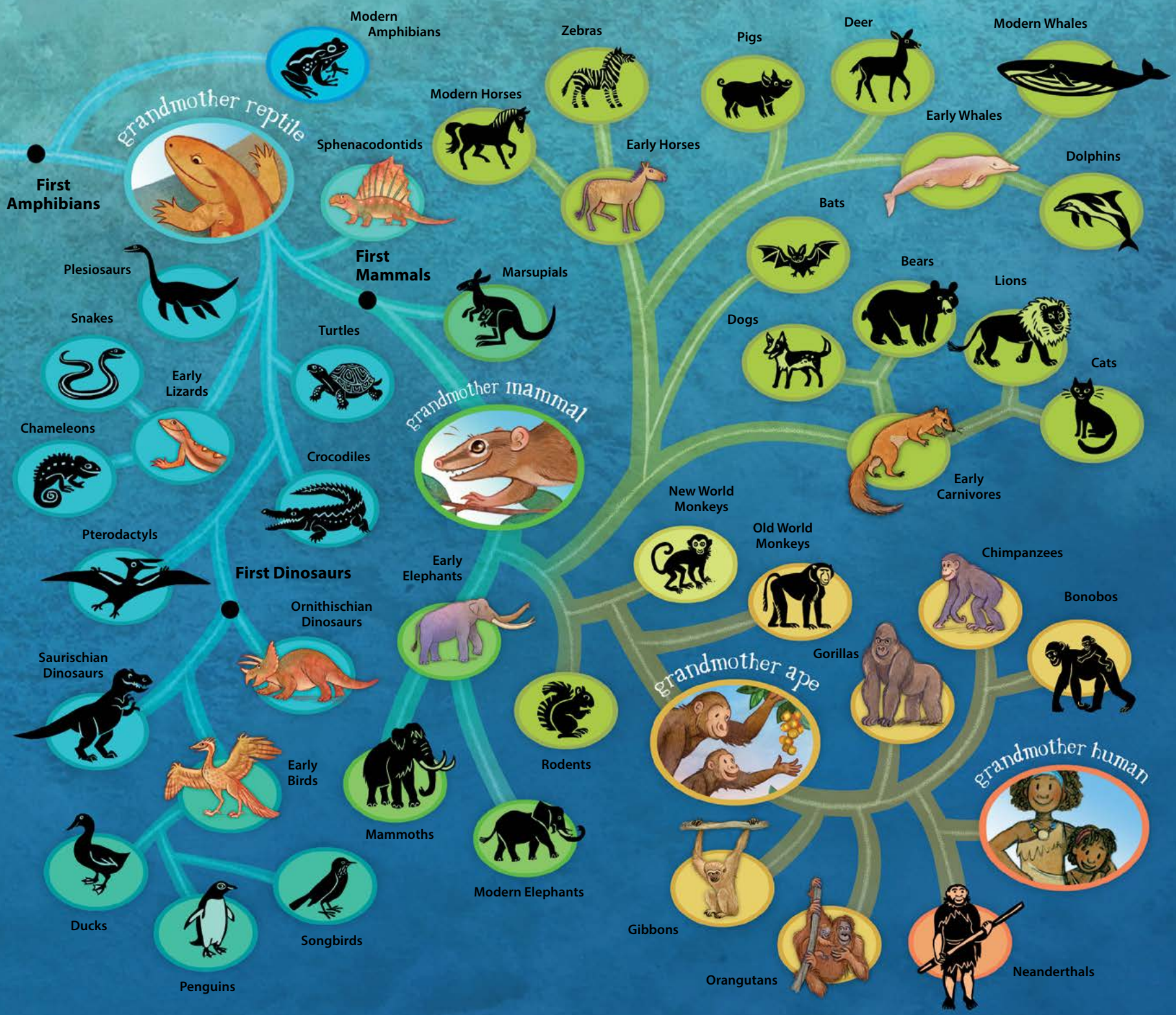


All life on earth is related.

This family tree traces the evolution of life on earth. This tree focuses on the "Grandmothers," but the entire tree is much larger.

Put your finger on any point along any branch of this tree, and that spot represents a breeding population of living things. All the organisms further along that branch are the descendants of that population, including all the branches that branch off of it.

Our evolutionary family tree



Dear Parents, Teachers, Babysitters, and Other Readers:

The story of *Grandmother Fish* gets children to see how evolution relates to them personally, but only you can really explain to them how evolution works. *Grandmother Fish* uses my words, but you can reach your children where they are, with your own words.

Evolution by natural selection is very difficult to understand because it doesn't make intuitive sense. Many adults have misconceptions about evolution, and to a lot of people it just doesn't make any sense at all. These last pages are for you to share with your children. They are written for you, but they are in simple terms to help you find the right words to use with your children. The simple writing also makes the material accessible to older children reading on their own.

The end notes are a resource for you to draw on when you need it. Let your children guide you in what they need to know and can understand. Skim over these back pages to see what's here, and then read whatever sections interest you or your children.

Jonathan Tweet
Seattle 2015



Explaining Concepts of Evolution

Here is a list of simple points to help you explain evolution and natural selection to children. Elaborate each point at your children's level, and explain it a little at a time.

Descent with Modification

You might also be able to point out examples of heredity and diversity in your family.

Baby animals grow up to be a lot like their moms and dads. A puppy grows up to be a dog, not a cat or a fish.

Babies grow up to be a little different from their parents. Some differences make life easier, some make life harder, and some don't matter. Differences just happen.

Over time, the differences add up, so animals today look very different from the moms and dads from a long time ago.

Artificial Selection

You can also use other examples besides dogs.

Dogs look different from how dogs used to look a long time ago.

People who wanted big dogs picked big dogs to have puppies. After a long time, their dogs were bigger than before.

Other people got different kinds of dogs, like small dogs or fluffy dogs.

All the different kinds of dogs come from one kind of dog that lived a long time ago.

Natural Selection

Natural selection works because some individuals leave many more surviving offspring than others do. Some die before reproducing, and others have few descendants for other reasons. These guidelines hint at death but don't mention it. Address the topic in ways suitable to your children.

Living in nature is dangerous for animals.

Animals have ways to keep themselves safe.

Baby animals are born with differences, and some differences make them safer. Animals that keep themselves safer have more babies.

A long time ago, one group of Grandmother Reptile's children climbed trees to be safer, and the best climbers were the safest.

The best climbers had the most babies. Those babies were also different from their parents.

After a long time, they had evolved into a kind of animal that was really good at climbing, which is Grandmother Mammal.

In different parts of the world, animals found different ways to be safe, so they evolved differently.

All the different mammals today come from one kind of mammal that lived a long time ago: Grandmother Mammal.

Guide to the Grandmothers, Their Actions, and Their Grandchildren

Grandmother Fish



Gnathostome

Our ancestors evolved into **gnathostomes** about 400 million years ago. The one pictured represents our branch of the gnathostome family tree, separate from the extinct placoderm branch.

Wiggle

They swung their tails from side to side to push themselves through the water. To wiggle like a fish, wiggle side to side.

Chomp

Jaws helped them catch and eat other animals. The other fish didn't have hinged jaws. Our ancestors could bite, but they couldn't chew.

Sharks have skeletons made of cartilage, which is lighter than bone. Ray-finned fish are almost all the fish you can think of, from sea horses to swordfish. Not many lobe-finned fish are left, unless you count the animals that descended from them: amniotes and the closely related amphibians.

Grandmother Reptile



Amniote

Our ancestors evolved into **amniotes** about 300 million years ago. They laid eggs with amniotic sacs, allowing them to survive on land. Mammal children still develop in amniotic sacs.

Crawl

They crawled on their bellies, with their legs splayed out to either side, like salamanders do today.

Breathe

When they were still fish, our ancestors evolved lungs and nostrils to get more oxygen. Lungs allowed our ancestors to evolve into land animals.

Dinosaurs went extinct 65 million years ago, except for the lines that had evolved into birds. Crocodiles are closely related to dinosaurs. There are many types of lizard, some of which evolved into snakes. Before the dinosaurs evolved, Dimetrodon and related animals were top predators. We mammals are their close relatives.

Grandmother Mammal



Eutherian

Our ancestors evolved into **mammals** about 200 million years ago. The mammal pictured is a eutherian, bearing live young and nursing them like we do today.

Cuddle

They evolved cuddling as part of nursing young. Both of these behaviors are governed by the "cuddle hormone," oxytocin.

Squeak

They squeaked with the backs of their throats. We still use the throat for emotional sounds, such as laughing and crying.

After the dinosaurs died out, mammals evolved into many new forms. Elephants evolved in Africa. Like the first eutherian, the first apes and carnivores lived in the trees. Deer lived on the ground and whales in the sea. Many other types of mammals are not shown. Marsupials and monotremes are on separate lines.

for your own information or to help you explain evolution to your child

Grandmother Ape



Our ancestors evolved into **primates** about 60 million years ago, just after the dinosaurs were wiped out. They evolved into apes about 30 million years ago.

Hominoid

Grab

Our early primate ancestors' paws evolved into four "hands" that helped them climb and live in trees. In humans, our rear "hands" have evolved into stable feet specialized for walking and running on the ground. They are a new kind of foot, unlike the feet of any other animal.

Hoot

Apes use their mouths as well as their throats to hoot and coo. Hooting and cooing are social activities, like squeaking. It's hard to be sure just when our ancestors started hooting.

Gibbons and orangutans live in the trees, like the first apes. Our line took to the ground, evolving into gorillas, chimpanzees, and humans. Other close relatives include bonobos and various extinct human and prehuman lines. We split from the chimpanzee line about 7 million years ago.

Grandmother Human



Our ancestors evolved into **Homo habilis** or a closely related species about 2 million years ago. "Homo" is Latin for "human," and individuals in this genus are considered human. Various other human lines evolved, and our ancestors evolved into *Homo sapiens* about 200,000 years ago in Africa. There were several other human species at that time, but we're the only ones left.

Homo sapiens

Walk

Our ancestors started walking on four legs over 200 million years ago. They evolved a fully bipedal stance after we split from the chimpanzee line, but millions of years before we were human.

Talk

Our whole society is based on communication and thought. Researchers disagree over when our ancestors started speaking, but probably it was between 100,000 and 500,000 years ago. Talking is an inherently social activity that would evolve only in a highly social species.

We *Homo sapiens* are a recent species. It has been a lot longer since the first ape than since the first *Homo sapiens*—150 times longer. We spent most of our time in Africa, spreading across the globe only in the last 50,000 years. We are all closely related, and we are one human race.

Correcting Common Errors

Use these notes to look for and correct any misunderstandings that your child may have.

Common Error	Instead . . .
We descended from one fish or pair of fish, or one early human or pair of early humans.	We descended from a large number of early jawed fish, and a large number of early humans. Evolution means a change in a population, not in individuals. All those early jawed fish and early humans who survived and passed their traits down to us are our ancestors.
Individual animals changed into new forms.	No individual animal changed form, such as from a fish to a reptile. Instead, children were a little different from their parents. After many generations, these differences added up, and the newer animals were different from the older ones.
Humans appeared when an ape gave birth to a human.	The differences between a parent and a child are small. Only after many generations when all the differences add up do the descendants represent a new kind of animal (or species). This book uses the friendly term “grandmother” to mean “ancestor” and “grandchild” to mean “descendant.” In between “Grandmother Ape” and “Grandmother Human,” there were millions of generations of intermediate “grandmothers.”
Evolution progresses toward the human form.	If elephants were writing this book, it would end with Grandmother Elephant, and the elephants would think that evolution progresses toward the elephant form. Animals evolve into all sorts of new animals, and we just happen to be one of them.
Fish evolve into reptiles, reptiles evolve into mammals, and so on.	People used to think of evolution following a sequence in an upward direction, like a ladder, but that’s wrong. Only one line of fish evolved into reptiles. Mostly fish have evolved into different kinds of fish. The family tree branches, so different species alive today have common ancestors in the past. Animals are still evolving today, but they are evolving in new ways, never repeating the evolution that happened long ago.
Evolution only adds traits.	Evolution also takes traits away. Whales can’t crawl even though they’re descended from mammals that could.
We started as fish.	We had many more ancestors before fish. This book starts with fish because very young children can relate to fish. Before our ancestors evolved into fish, they were underwater wormlike animals. The wormlike animals are also the ancestors of insects, shellfish, octopuses, and other invertebrates. When life started, it wasn’t much more than organic chemicals that could make copies of themselves, and the earth was very different.
Reptiles lay eggs. Mammals give live birth.	Some reptiles give birth, and some mammals lay eggs. Children (and adults) intuitively expect simple, one-to-one relationships. But evolution makes lots of different animals, so reptiles are different from each other, and so are mammals.

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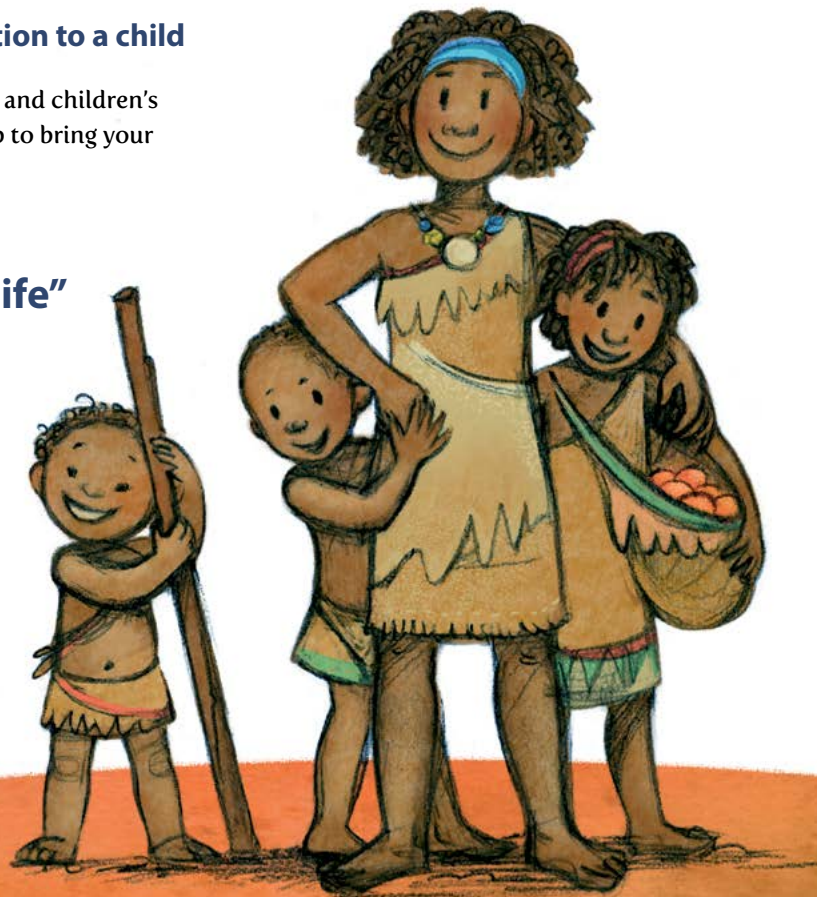
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