DEEP DIVE for “Crows”

Lesson 4: Flight

1
Watch some VIDEOS

And enjoy!

“You are a fish”
MinuteEarth, https://youtu.be/yyeDgBm1Du8
OH MY GOSH WE’RE NOT THE ONLY PEOPLE SAYING THIS!!!
(3 minutes)

“Scientists discover secret to bird flight”
The Telegraph, https://youtu.be/WRH4_jLCxQs
How do feathers hold together? You can *hear* the answer!
(1 minute)

“What’s a feather look like under a microscope?”
Science Up with the Singing Biologist,
https://youtu.be/BoYe3sd8qdE
Oh, this is a clear view of what a feather looks like, and a clear explanation of *why* it looks like that! (3 minutes)

How do feathers grow?

BioBush, https://youtu.be/P7JMdO1mQZw
In class, we said that the skin *squeezes* them out like toothpaste... but is that all there is to it? (6 minutes)

2

SEE a feather (for the first time)

Feathers are the secret of flight: they're incredibly strong yet incredibly light. How do they do it? You're a giant: you can't understand a feather unless you get small. We drew a picture in class, but if you have a microscope, you can do it for yourself.

Does it have to be an expensive microscope? Nope! *Even a magnifying glass will do.*

If you live in the United States, maybe you want to read the text of the Migratory Bird Treaty Act of 1918. Then again, maybe you don't!

1. Find a feather

Take a trip to a park, or to your special, year-long place. Bring a Frisbee — that way, even if you don't find a feather, it'll have been time well spent!

2. Don't be worried, but don't be stupid!

When I was a kid, people warned me not to touch feathers — they could have disease! Looking into this now, that seems pretty unlikely. But: *don't touch it if it has poop on it.* (Though were you going to do that anyway?) And after you touch it, don't touch your face until you've washed your hands.

3. Draw the feather

Just draw the feather as it appears to your eyes. Use pencil, markers, charcoal, crayons — whatever's most fun!

4. Draw what you *think* you'll see, up close

Before you magnify it, draw what you *think* it'll look like up-close. THIS IS VERY USEFUL.

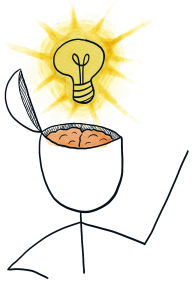
5. Look under a magnifying glass or microscope

Take your time; maybe have some music on. Just poke around, and see what you can see. Imagine you've been shrunk to only 1 millimeter tall — how would you be experiencing this feather?

6. Draw it

Keep asking yourself, *how is this feather so strong?* Draw what you actually see. (If you'd like to show off your art on our Facebook page, feel free — people would love to see it!)

3



Try to learn the TRIVIA by heart

Print these out and read them aloud.

Part A: Fish

question	answer
Why can crows fly, but you can't? (Hint: You're a ___ whose skin squirts ___; a crow is a ___ whose skin squirts ___.)	You're a fish whose skin squirts horn; a crow is a fish whose skin squirts steel.
Is a crow a dinosaur?	Yes — their grandmothers were raptors
Are dinosaurs fish?	Yes — their grandmothers were fish
Is a crow a fish?	Logically, it seems we have to say yes!
What do all fish have in common? (Hint: bones, seeing, smelling, eating, moving)	Fish have bones and spines, two eyes, two nostrils, a mouth that opens *down*, either two or four limbs, and a tail
What's the official scientific word for "fish and their grandchildren"?	Vertebrates (VER-teh-bretz)
Is this how scientists define "fish"?	Yes, some do!
What's going on here, with how we're defining "fish"?	You can use "fish" as (1) a "clade" (a literal family) or as (2) a "type" (a bunch of things that look the same); we're going with family!
What's unfortunate about using "fish" as a "type"?	It's still thinking like Linnaeus, and not like Darwin — it forgets that all life is one family!

Part B: Flying vs. Swimming

question	answer
Are you a fish?	Yes!
Are you a dinosaur?	No — you're more closely related to Dimetrodon than dinosaurs
What's a crow's wing?	A flipper
What's your arm?	A flipper!
Do fish go really fast through water?	Oh yes — maybe up to 70 mph, which is *faster* than a crow flies
Can we say that crows *swim* through the air?	Not… no, not really; swimming and flying are different
How does a crow push itself through the air?	By flapping its flippers
How does a goldfish steer?	By shaking its butt
How does a goldfish push itself through the water?	By shaking its butt
How does a goldfish steer?	By moving its arms

Part C: Feathers

question	answer
How does your skin make a hair?	It squirts it out, like a tube of toothpaste
How does a crow's skin make a feather?	It squirts it out, like a tube of toothpaste
What's a hair made of?	Molecules called "keratin" (technically, "alpha-keratin")
What else is made of alpha-keratin? (Hint: finger, horse, cat, rhino)	Fingernails, hooves, claws, horns
How strong is alpha-keratin?	Quite strong!
Is alpha-keratin strong enough to work as a feather?	Oh, no no no
What does a feather really look like?	A tree, with its branches locked together
Why do a crow's flight feathers need to be strong?	They need to push *so much air*
Feathers seem weak to us — why?	We're giants, and we don't know our own strength
How strong is the stuff feathers are made of?	Imagine it's as strong as steel
What are feathers made of?	A special kind of keratin — beta-keratin
Are we able to squirt out beta-keratin?	Ha, no! (We *wish*)
What kinds of animals are able to squirt beta-keratin?	Dinosaurs (including birds!) and their reptile relatives
Why are snake and lizard and alligator scales so strong?	They're made of beta-keratin

4

Something FUN (but optional)

So you'd like to understand what a fish (*cough cough* "vertebrate") really is?

In class, I mentioned the book *Your Inner Fish*, by Neil Shubin (discoverer of Tiktaalik), but a better way to imbibe this is through a few other ways.

First is the *very* short series that PBS made from the book, also called *Your Inner Fish*. The three episodes are titled "Your Inner Fish", "Your Inner Reptile", and "Your Inner Monkey".

People get their TV in all sorts of different ways, but if it helps, here's the show on PBS.org, and here it is on Amazon.

Second is the book *Grandmother Fish*, written by Jonathan Tweet and illustrated by Karen Lewis. Like I said in class, it's designed for preschoolers, but it's full of scientific insights that few adults know!

And third is a delightful (and punchy!) essay by a professor of evolutionary biology.

In all of this, remember: Linnaeus's mistake was to put animals in boxes. Darwin's insight was to put animals in trees.

Enjoy!