VII. Factsheets:

❖ Kiwi factsheet

**Species:** Recent genetic studies suggest that there are five species of kiwi. All share the genus name *Apteryx,* which means “no wing.”

**Appearance:** Species vary in size but most are the size of a chicken. They have big feet, tiny wings with a claw at the tip, fuzzy hair-like feathers, and a long beak.

**Habitat:** All species live on the islands of New Zealand. They live in forests and shrublands.

**Ecology:** Kiwis cannot fly. During the day, they rest in burrows in the ground. At night, they go out to forage, using their long beaks, sense of smell, and possibly also an ability to detect vibrations in the ground, to find insects, worms, and other small animals that live in the soil. Kiwis form mating pairs, and at least one species seems to mate for life. In some species, the males do most of the work of incubating and brooding the eggs and young chicks, but in other species, males and females share the work.

**Evolution:** Genetic studies suggest that the kiwi lineage split from other birds about 68 million years ago—around the time that non-avian dinosaurs went extinct. Modern kiwi lineages (the species alive today) seem to have begun to diverge from one another about 8 million years ago. Kiwis are closely related to rheas, emus, ostriches, cassowaries, the extinct moa, and the extinct elephant-bird from Madagascar. Early studies based on anatomy suggested that tiny kiwis and giant moas (another New Zealand native) were close cousins; however, scientists recently extracted DNA from 1400-year-old moa skeletons, and found that kiwis seem to be more closely related to Australian emus and cassowaries than they are to New Zealand moas.

**Conservation:** All kiwi species are threatened, and some species are critically endangered with less than 500 individuals. Kiwi numbers are in decline because of habitat loss, human activity, and, significantly, the invasion of predators like stoats, ferrets, cats, and dogs.
Hawaiian honeycreeper factsheet

Species: Hawaiian honeycreepers form a clade called Drepanidinae. There are around 25 species of honeycreeper alive today—but before humans moved to Hawaii and triggered a wave of extinctions, there were more than 50 species.

Appearance: The Hawaiian honeycreepers are small birds, often with brightly colored plumage in some striking combination of black, brown, red, yellow, and/or white. Different species display remarkable variation in bill shape and size, ranging from long, thin, curving bills to short, robust bills. These bill shapes are adapted to the feeding habits of the different species.

Habitat: The Hawaiian honeycreepers are native to and found only in the Hawaiian Islands. Different species occupy different habitats within the islands.

Ecology: Hawaiian honeycreepers make their livings in a variety of ways. Some species specialize on seeds, some on particular plants, some on fruits, some on insect larvae, some on snails, and some on nectar.

Evolution: Many lines of evidence suggest that Hawaiian honeycreepers evolved from a finch ancestor. Around five million years ago, the honeycreepers’ ancestors invaded the still-forming Hawaiian Islands and began diversifying into different species. Species of the evolving honeycreeper clade invaded new islands as they were formed by volcanic activity. The honeycreepers are notable as an extreme example of an adaptive radiation on islands. From just one ancestral species, the honeycreepers diversified into many species with different feeding adaptations, colors, and ecological niches. Some species may have even coevolved beak shapes with the flowers that they sip nectar from.

Conservation: The Hawaiian honeycreepers are imperiled. They have already suffered severe extinction. Many went extinct shortly after Polynesians arrived on Hawaii, and they are currently experiencing a second wave of extinction. Of the 25 or so species alive today, 18 are endangered because of habitat loss, human activity, the invasion of predators, and disease. The introduction of mosquitoes carrying avian malaria has been a particular challenge to honeycreeper survival.

adaptive radiation—an event in which a lineage rapidly diversifies with the newly formed lineages evolving different adaptations.

coevolution—a process in which two or more different species reciprocally affect each other’s evolution. For example, species A evolves, which causes species B to evolve, which causes species A to evolve, which causes species B to evolve, etc.
❖ Peppered moth factsheet

**Species:** *Biston betularia*

**Ecology:** The peppered moth is common in England. It often rests on tree trunks and tree branches where it may be caught by the birds that are able to spot it against the tree.

**The story:** Before the industrial revolution, the light-colored form of the moth (called ‘typica’) was most common in England. They blended in well against light-colored tree trunks. Any dark-colored mutants (called ‘carbonaria’) that arose would have been selected against because they would have been easy for birds to spot and eat. However, during the industrial revolution, factories between London and Manchester began to spew out soot that darkened the trees. Consequently, in the 1850s, the dark-colored form became more common. The genes for dark color now had an advantage and the lighter form was selected against. By 1895, the dark form dominated the moth population in the areas affected by the pollution. Recently, pollution control laws have significantly improved air quality in the area. Consequently, the trees are lighter and the light-colored form is on the rise again. This is a classic example of natural selection in action. In just 150 years, we’ve directly observed the evolution of a population from one form to another and back again.

**The science:** Experiments and observations performed by Bernard Kettlewell in the 1950s suggested that the basic story described above was indeed an accurate picture of the moths’ evolution. Since then, other researchers (e.g., Michael Majerus) have studied the moths further. That research, again, backs up the basic story described above and additionally suggests that migration of the moths is an important factor in determining which moths are found where. However, Majerus also noticed that some of Kettlewell’s original experiments were not very well designed.

**Misinterpretation:** Some creationist publications have (probably willfully) misinterpreted criticisms of Kettlewell’s experimental technique as suggesting that the moth example is “wrong” or “faked.” This is not true. Scientists who have improved on Kettlewell’s experimental technique have studied the moths and found support for the basic explanation of moth evolution that Kettlewell put forth. In addition, they’ve elaborated on the explanation so that we now know even more about how the moths have evolved.
❖ *Archaeopteryx factsheet*

**Species:** *Archaeopteryx lithographica* (Archaeo = ancient, pteryx = wing)

**Discovery:** This fossil bird was first found in 1861 in a quarry in Germany. It was extremely well preserved—even its feathers. Since then several other *Archaeopteryx* fossils have been discovered.

**Appearance:** So far, specimens have been found that range from sparrow-sized to pigeon-sized. *Archaeopteryx* had a long tail, relatively long legs, teeth, and claws at the tips of its wings. Scientists don’t know what color it was.

**Significance:** Having lived about 150 million years ago, *Archaeopteryx* is the earliest bird yet discovered. Furthermore, it has features that clearly demonstrate that it evolved from dinosaurs. It shares over 100 anatomical features with dinosaurs. Thus, it is a great example of a transitional form—it has features of both dinosaurs and modern birds and helps us understand how and why different bird traits might have evolved. However, it is NOT the ancestor of all modern birds. It is a very early branch on the bird family tree, but is not the root of that tree.

**Flight:** Although it is currently thought that *Archaeopteryx* could sustain powered flight, it was probably not a strong flyer; it may well have run, leaped, glided, and flapped all in the same day.
❖ Bambiraptor factsheet

**Name:** The full name of this dinosaur is *Bambiraptor feinbergi*. It is named after Bambi from the Disney movie because of its small size. The root *rapt* means “to seize”—which is probably what *Bambiraptor* did to its prey.

**Discovery:** *Bambiraptor* was found in Montana in 1995 by a 14-year-old boy. So far, we’ve only found one example of *Bambiraptor*—but luckily the fossil was remarkably complete, so we have a good picture of what this animal looked like.

**Appearance:** With its tail, *Bambiraptor* was almost three feet long—but was just one foot tall and weighed 4.4 lbs. However, the fossil we have is likely from an animal that was not fully grown, so they may have gotten bigger than this. It was probably covered in feathers—though it couldn’t fly. It also appears to have had a pretty large brain for its size (almost as large as that of modern birds), and deadly claws.

**Ecology:** *Bambiraptor* probably made its living as a hunter of small mammals and reptiles.

**Significance:** *Bambiraptor* is a Dromaeosaur dinosaur—a type of Maniraptoran dinosaur that is thought to be the closest relative of birds. It lived about 75 million years ago.

**Feathers:** Scientists think that *Bambiraptor* was covered in feathers, even though these weren’t preserved in the single specimen we have. Why would we think this? The principle of *parsimony*. We know that birds have feathers. And we know that some Maniraptoran dinosaurs not so closely related to birds had feathers because the feathers were preserved as fossils. The simplest explanation for this is that feathers evolved early in the history of the Maniraptorans and were inherited by all these different groups. Since *Bambiraptor* is so closely related to birds, it is very likely that it too inherited feathers. Some scientists even think that *T. rex* may have had feathers!

* parsimony—a principle stating that the simplest explanation accounting for the observations is the preferred explanation. 
Feathered (but non-avian!) dinosaur factsheet

Since birds are dinosaurs, it should be obvious that plenty of dinosaurs have feathers—but did you know that many non-avian dinosaurs had feathers as well? Dinosaurs evolved feathers long before any dinosaurs evolved into birds. For example, Bambiraptor (see previous factsheet) probably had feathers—though these were not preserved in the fossils we’ve found so far. In the past 20 years, however, paleontologists have found many remarkable fossils of non-avian dinosaurs that do preserve evidence of their delicate feathers. Most of these fossils have been found in South America and Asia (especially China). Here, we’ll review just a few of the dinosaurs known from their fossils to have had feathers.

Dilong paradoxus, a 125 million year old Tyrannosaurid from China. This five foot long dinosaur would have walked around on two legs. It was shaped a bit like T. rex, but had a longer neck, longer arms, and shorter legs relative to its body. It had filamentous, branched feathers found on fossils of its tail and jawbone. Dilong’s feathers suggest that T. rex (another Tyrannosaurid) might have also had feathers—but perhaps only as a baby and juvenile.

Sinornithosaurus millenii, a 125 million year old dromaeosaur dinosaur from China. Sinornithosaurus was a small bipedal dinosaur with a skull about five inches long. It was completely covered with downy feathers, some of which were branched and some of which were single filaments.

Velociraptor mongoliensis, a 75 million year old dromaeosaur dinosaur from Mongolia. This animal was about five feet long and would have weighted about 33 lbs (Jurassic Park got this wrong—and also failed to showcase their feathers!). Velociraptor has not yet been found in rocks that would have preserved its feathers, but we know that it had fairly modern feathers (with a quill and everything) from its bones. Its forearms had “quill knobs”—structures to which feathers attach. The pictures at right show a Velociraptor forearm (A and B) above a turkey vulture forearm (C and D) for comparison.
Tree of life factsheet

Biologists represent evolutionary relationships on family trees called phylogenies. This factsheet reviews the basics of understanding phylogenies.

Reading trees: The root of the tree represents the ancestral lineage, and the tips of the branches represent the descendents of that ancestor. Depending on how many branches the tree depicts, the descendents at the tips might represent different populations of a species, different species, or different clades, each composed of many species. As you move from the root to the tips of the tree, you are moving forward in time. When a lineage splits (speciation), it is represented as a branching point.

Phylogenies trace patterns of shared ancestry among lineages. Each lineage has a part of its history that is unique to it alone and parts that are shared with other lineages. Similarly, each lineage has ancestors that are unique to that lineage and ancestors that are shared with other lineages—common ancestors.

Understanding clades: Evolutionary trees depict clades. A clade is a group of organisms that includes an ancestor and all descendents of that ancestor. Clades are nested within one another—they form a nested hierarchy. A clade may include many thousands of species or just a few.
Misinterpreting phylogenies: When reading a phylogeny, it is important to keep three things in mind:

- Evolution produces a pattern of relationships among lineages that is tree-like, not ladder-like.

- Just because we tend to read phylogenies from left to right, there is no correlation with level of “advancement.”

- For any speciation event on a phylogeny, the choice of which lineage goes to the right and which goes to the left is arbitrary. The following phylogenies are equivalent:

Building phylogenies: Biologists reconstruct the evolutionary history of a group of organisms by collecting and analyzing evidence. This evidence takes the form of characters—heritable traits that can be compared across organisms, such as physical characteristics (morphology), genetic sequences, and behavioral traits. To build a phylogenetic tree, biologists collect data about the characters of each organism they are interested in and then analyze those data to figure out the pattern of evolutionary relationships most consistent with the data.

Phylogenies are essentially hypotheses about the relationships among groups of organisms. That means that phylogenies may change if we discover new evidence (i.e., learn more about the characters of a group of organisms) or if we interpret existing evidence in new ways.
Timeline of evolution factsheet

If you wanted to squeeze the 3.5 billion years of the history of life on Earth into a single minute, you would have to wait about 50 seconds for multicellular life to evolve, another four seconds for vertebrates to invade the land, and another four seconds for flowers to evolve — and only in the last 0.002 seconds would “modern” humans arise. Evolutionary time is deep!

The timeline below shows some of the major events in life’s history—but keep in mind that most of that history occurred before the first multi-cellular organisms evolved 555 million years ago.

<table>
<thead>
<tr>
<th>Years ago</th>
<th>Event</th>
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<tbody>
<tr>
<td>130,000</td>
<td>Anatomically modern humans evolve. Seventy thousand years later, their descendents create cave paintings — early expressions of consciousness.</td>
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<tr>
<td>4 million</td>
<td>In Africa, an early hominid, affectionately named “Lucy” by scientists, lives. The ice ages begin, and many large mammals go extinct.</td>
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<tr>
<td>65 million</td>
<td>A massive asteroid hits the Yucatan Peninsula, and ammonites and non-avian dinosaurs go extinct. Birds and mammals are among the survivors.</td>
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<tr>
<td>130 million</td>
<td>As the continents drift toward their present positions, the earliest flowers evolve, and dinosaurs dominate the landscape. In the sea, bony fish diversify.</td>
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<tr>
<td>225 million</td>
<td>Dinosaurs and mammals evolve. Pangaea has begun to break apart.</td>
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<tr>
<td>248 million</td>
<td>Over 90% of marine life and 70% of terrestrial life go extinct during the Earth’s largest mass extinction. Ammonites are among the survivors.</td>
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<tr>
<td>250 million</td>
<td>The supercontinent called Pangaea forms. Conifer-like forests, reptiles, and synapsids (the ancestors of mammals) are common.</td>
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<tr>
<td>360 million</td>
<td>Four-limbed vertebrates move onto the land as seed plants and large forests appear. The Earth’s oceans support vast reef systems.</td>
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<tr>
<td>420 million</td>
<td>Land plants evolve, drastically changing Earth’s landscape and creating new habitats.</td>
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<tr>
<td>450 million</td>
<td>Arthropods move onto the land. Their descendents evolve into scorpions, spiders, mites, and millipedes.</td>
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<tr>
<td>500 million</td>
<td>Fish-like vertebrates evolve. Invertebrates, such as trilobites, crinoids, brachiopids, and cephalopods, are common in the oceans.</td>
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<tr>
<td>555 million</td>
<td>Multi-cellular marine organisms are common. The diverse assortment of life includes bizarre-looking animals like Wiwaxia.</td>
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<tr>
<td>3.5 billion</td>
<td>Unicellular life evolves. Photosynthetic bacteria begin to release oxygen into the atmosphere.</td>
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<tr>
<td>3.8 billion</td>
<td>Replicating molecules (the precursors of DNA) form.</td>
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<tr>
<td>4.6 billion</td>
<td>The Earth forms and is bombarded by meteorites and comets.</td>
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