GENERATIONGENIUS
ALWAYS QUESTION. ALWAYS WONDER.

LESSON PLAN

CLASSIFICATION OF LIVING THINGS
GRADES 6-8

SUMMARY

Students analyze and interpret data from charts and images to identify patterns in order to classify a fossil. Students compare their classifications of this fossil to determine similarities and differences in findings.

NEXT GENERATION SCIENCE STANDARDS CORRELATION

MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.

Science & Engineering Practices	Connections to Classroom Activity
Analyzing and Interpreting Data	• Students analyze and interpret data for five different vertebrates to determine in what class the Seymouria fossil belongs. • Students compare their classifications and note similarities and differences in the evidence from data used to support their claims.

Disciplinary Core Ideas	Connections to Classroom Activity
LS4.A: Evidence of Common Ancestry and Diversity The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth.	• Students classify a fossil by comparing its characteristics to those of modern organisms.

Cross Cutting Concepts	Connections to Classroom Activity
Patterns	• Students use charts and images to identify patterns in characteristics of a fossil compared to modern organisms.

DURATION

45 minutes

MATERIALS

- Images and Information for Six Different Organisms (including Seymouria)
- Flow Charts of Vertebrate Traits (PowerPoint slides)
- Paper
- Pen or pencil

ENGAGE

Show students an image of the Seymouria fossil.
Ask students if they can identify the animal. Give students about 1 minute of independent thinking time, and then ask them to turn to a partner to share their ideas.

Ask the speaker to use the sentence stem, "I think___ because___." Ask the responder to reply using the stems, "I heard you say ___. I agree/disagree because _____."

Encourage students to support their ideas with evidence from their observations of the fossil. Make sure students have the opportunity to switch roles.

Tell students you will take three shares to the class. Tell students they can share their own idea or their partner's idea.

The Seymouria has many features similar to other animals that make it difficult to classify. Students will work in groups to classify Seymouria by comparing its features with the features of some other similar animals The question we are trying to answer is, **How should the Seymouria fossil be classified?**

EXPLORE

WATCH THE GENERATION GENIUS CLASSIFICATION OF LIVING THINGS VIDEO AS A GROUP

Tell students that to get a better understanding of how scientists classify organisms, we are going to watch the *Generation Genius* video "Classification of Living Things." To gauge students' prior knowledge and to prime them for the video, engage students in the **Before Discussion Questions**. After the video, you may want to use some of the **After Discussion Questions** to reinforce the main ideas presented.

Have each group examine the pictures of the Seymouria fossil and use what they learned from the video to classify the Seymouria as best as they can. Ask students to discuss the following questions in their groups:

1. Which kingdom does Seymouria belong to? Why do you say so?
2. Which phylum does Seymouria belong to? Why do you say so?
3. Which class does Seymouria belong to? Why do you say so?

Because only skeletal remains exist for the Seymouria, ask students what other information might be useful to help them determine to which class it belongs.

EXPLAIN

Hand out a set of the animal information cards for the five different organisms (frog, lizard, pigeon, bat, and rat) to each group. Tell students to compare and contrast the features of the five modern vertebrate skeletons with the Seymouria fossil.

As you move from group to group, ask questions such as the following: How might comparing the Seymouria with known animals help us classify it? Which characteristics of the specimens will you examine (leg bones, skull, position of eyes, etc.)? How many different characteristics of the specimens will you need to examine? How will you organize the data you collect to identify patterns? Tell the groups that they need to include their claim, the evidence to support their claim, and their reasoning (which science ideas tie their evidence to the claim).

Have each group share its classification of the fossil.

Have the class discuss these questions: What seems to be true about our claims? Did everyone use the same evidence to arrive at their claim? How confident are we that we have the correct classification? What additional information might be useful? What other questions do we have?

Key takeaways for students:

- Organisms, including fossils, can be classified and identified based on similar characteristics.
- Data need to be organized so that patterns can be identified, analyzed, interpreted.

ELABORATE

Compare student claims with those of paleontologists (scientists who study fossils) for the Seymouria. Show slide 1 and ask students if this information is helpful. Students should conclude that this information is not helpful because it contains traits that a fossil doesn't show. Share slide 2, which compares skeletal features. Working in their small groups, ask students to compare the traits they used. Show slide 3 and ask, "Is the Seymouria a reptile or an amphibian?" Slide 3 has a side view of the Seymouria skeleton, which provides students with a different view than their information card. Students should suggest that the Seymouria has some features like a reptile (teeth, heel, belly ribs) and some features like an amphibian (flat head, less flexible skull, small belly ribs). Show slide 4 and ask students if they agree that the Seymouria could be considered a missing link between amphibians and reptiles!

EVALUATE

There are multiple ways to assess your students' understanding of this topic. The exit ticket is an opportunity for students to use the science ideas they built in the lesson in a new context. Alternatively, you can use the Kahoot! quiz (which provides downloadable scores at the end of the game) and/or the paper quiz. All these resources are located right below the video in the assessment section.

EXTENSION

Working in pairs, more advanced students can read this short article and use the pictures of the invertebrate fossils and the descriptions provided to develop a dichotomous key for the fossils. Pairs can swap keys and provide feedback on choices that are unclear or lead to incorrect classification. WikiHow has a nice, illustrated process for making a dichotomous key that students could use to help them set theirs up.

IMAGES AND INFORMATION FOR DIFFERENT ORGANISMS

Frog Skeleton—dorsal view showing specialized morphology for jumping

Frog Skeleton—dorsal view showing urostyle (long bone formed from fused vertebrae) and short, stiff vertebral column

Features:

- A skeleton that is highly modified for jumping (although many forms have altered these features to specialize in other lifestyles, such as an aquatic or burrowing one):
  - Elongated hind limbs, including the ankle bones (tarsals) and foot bones (metatarsals and phalanges).
  - A **urostyle**: a rod-like fusion of the sacral vertebrae running in parallel with the extended iliac blades of the pelvis, resulting in a strong shock-absorbing pelvic basket.
  - Short, stiff vertebral column (nine or fewer vertebrae proper) and no ribs. This helps to stiffen the trunk, providing a solid path for the transmission of thrust from the limbs when jumping, as well as maintaining posture.
- Short and flat head.
- No teeth on the dentary.
- Fused radius and ulna to form a **compound radio-ulna**.

Source: www.ucl.ac.uk/museums-static/obl4he/vertebratediversity/frogs_and_toads.html#

Lizard Skeleton—dorsolateral view

Lizard Skeleton—dorsal view

Features:

- Cranial kinesis—a high degree of flexibility between the bones of the back of the skull, allowing relative movements between them.
- Paired hemipenes (male reproductive organs) are fully eversible (can be turned inside out).
- Pleurodont dentition—teeth set into the side of the inner surfaces of the jaws and periodically replaced.
- Loss of gastralia (ventral belly ribs).
- Double-hooked fifth metatarsal, functionally analogous to the mammalian heel.
- Further complexity to the mesotarsal joint (in comparison to nonsquamate lepidosaurs).

Image source: www.skullsunlimited.com/products/real-lizard-skeleton-ok-16308
Information source: www.ucl.ac.uk/museums-static/obl4he/vertebratediversity/squamata.html

Pigeon Skeleton – lateral view

Pigeon Skeleton - posterio-dorsal view

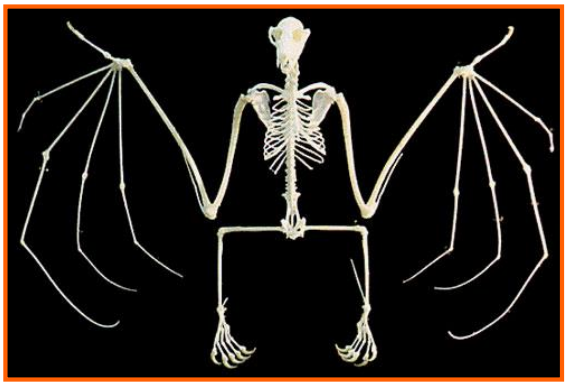
Features:

- Wings, formed of the humerus, radius, ulna, wrist, and three digits (of these, the first and third are greatly reduced).
- Fused **clavicles**, forming the furcula (wishbone).
- Large keeled **sternum** (breastbone) for the attachment of powerful flight muscles.
- No teeth; replaced by a horny beak.
- **Caudal** vertebrae are reduced and fused to form the **pygostyle**, which supports the tail feathers.
- Reversed **hallux** (big toe) on feet, specialized for **perching**.

Source: www.ucl.ac.uk/museums-static/obl4he/vertebratediversity/birds.html#

Bat Skeleton—dorsal view

Bat Skeleton—ventral view



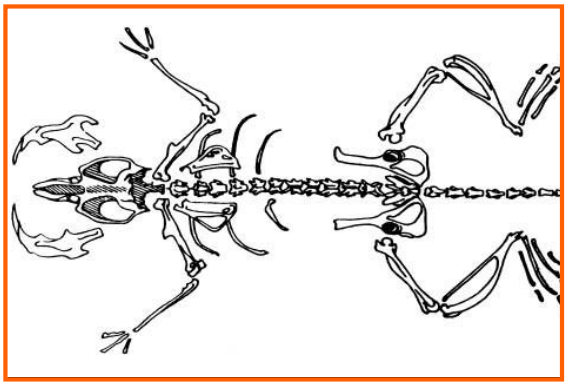
Features:

- The **ulna** and **fibula** are shortened and thin.
- Bats, like birds, also have fused cranial bones for additional lightness.
- Like most birds, bats have a keel on the **sternum** (breastbone) to which the large flight muscles attach.
- Unlike birds, whose wings are supported by the bones of the arm and one finger, a bat's wing membrane, or **patagium**, is supported by the arm and by four highly elongated fingers.

Image sources: https://www.skullsunlimited.com/products/real-bat-skeleton-sk-300; https://ucmp.berkeley.edu/mammal/eutheria/chiromm.html

Rat Skeleton—lateral view

Rat Skeleton—dorsal view



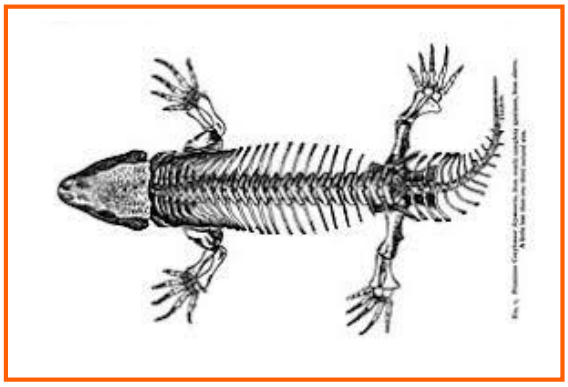
Features:

- The presence of a malleolus at the bottom of the fibula (the smaller of the two shin bones).
- The complete mortise and tenon upper ankle joint, where the rearmost bones of the foot fit into a socket formed by the ends of the tibia and fibula.
- A wide opening at the bottom of the pelvis, which allows the birth of large, well-developed offspring.

Source: https://ucmp.berkeley.edu/mammal/eutheria/placental.html

Fossilized Seymouria Skeleton—dorsal view

Line Drawing of Seymouria Skeleton—dorsal view

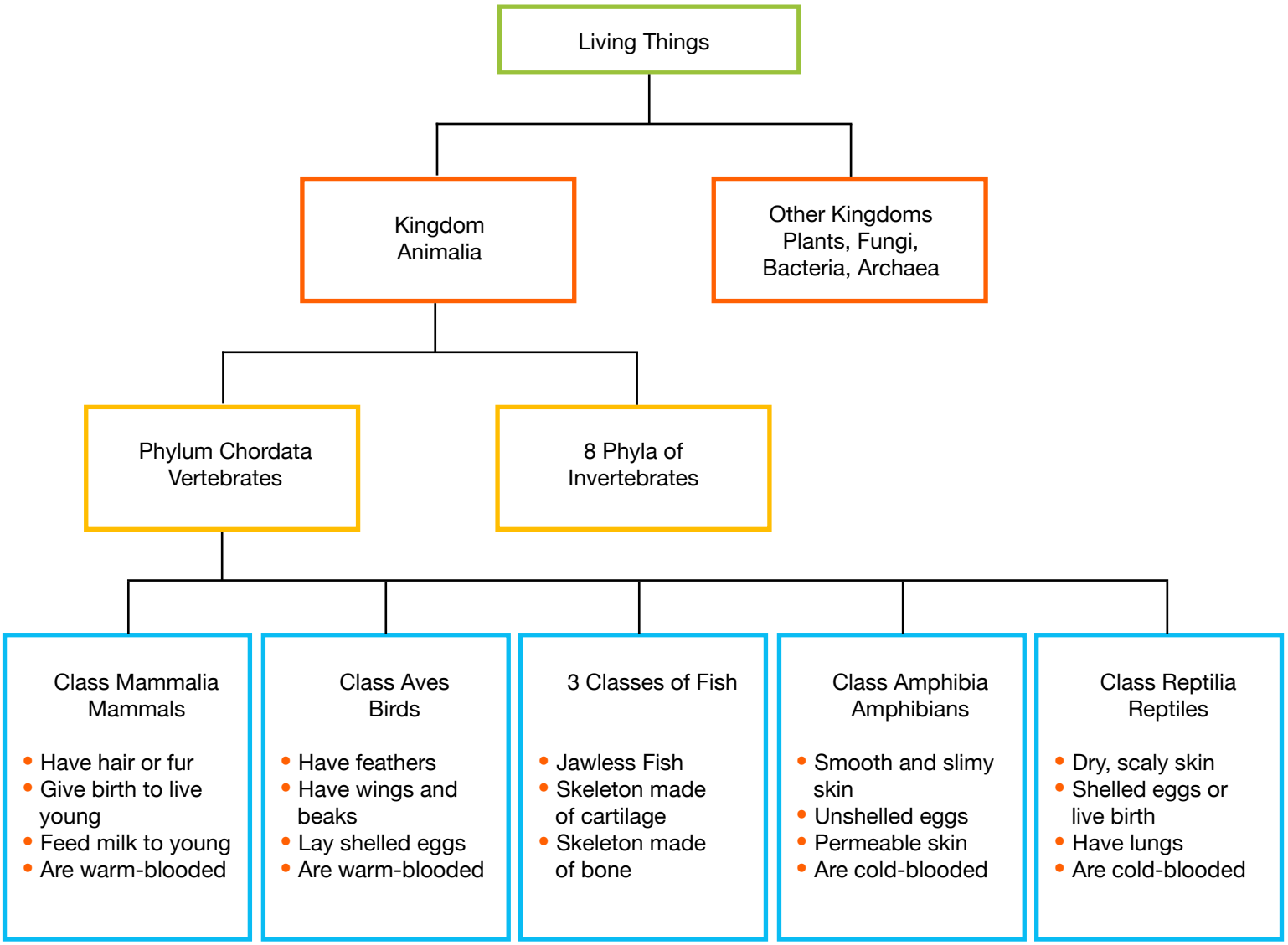


The Seymouria is a tetrapod that lived approximately 280–270 million years ago during the early Permian period. In the late 19th century, fossilized bones of this animal were found in a cave in Seymore, Texas, by Charles H. Sternberg. These bones were packed away and sent to Harvard University for further study. In 1939, out of boxes containing nine different animals, Harvard's Dr. T. E. White rediscovered Seymouria and went to Texas to look for more fossils. He then went on to describe the fossils, and named them after the town it was found in. Since its original discovery, more fossils of Seymouria have been found all over the world. They have been found in other parts of Texas, in Utah, and even in Germany.

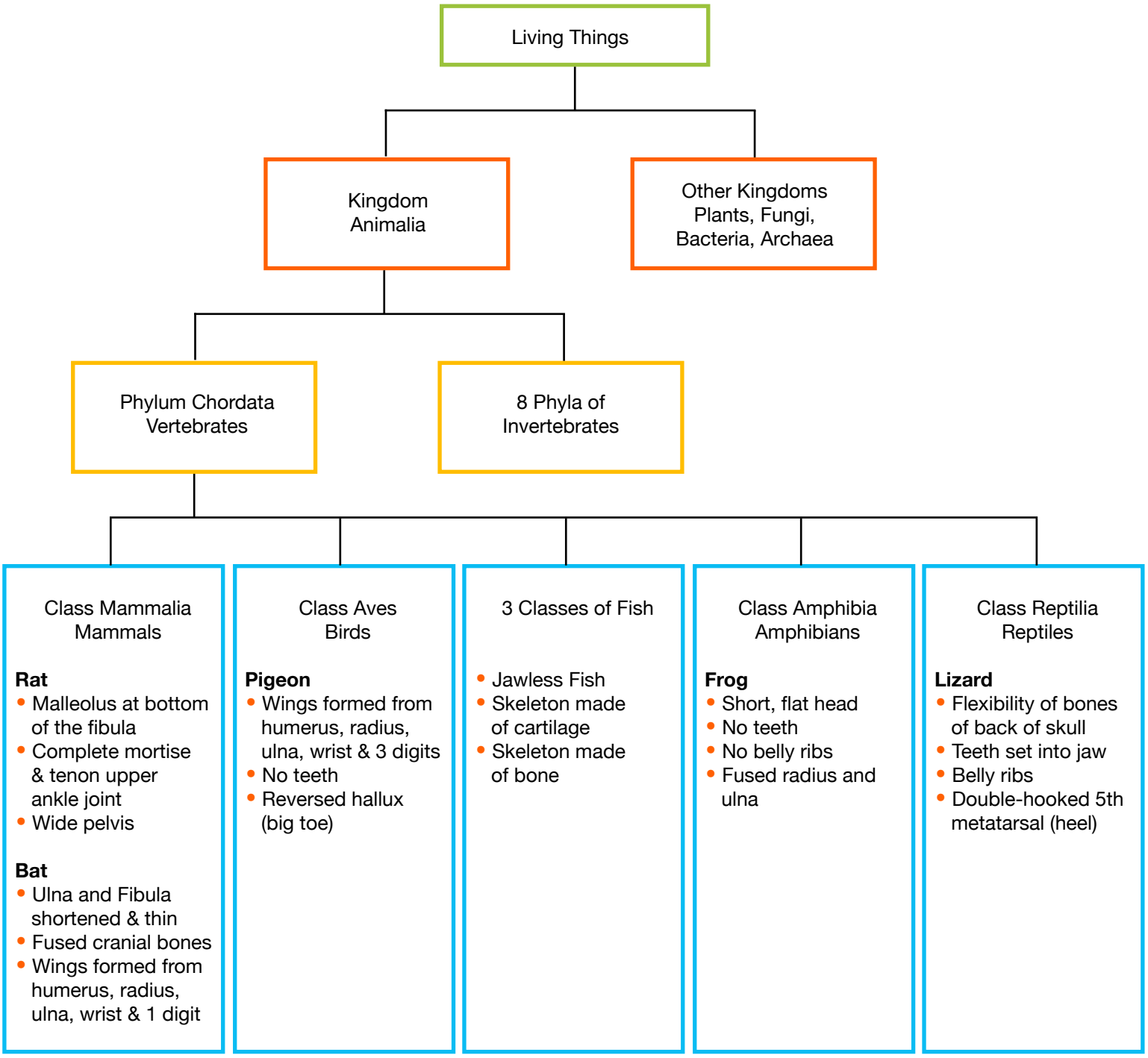
Source: www.newdinosaurs.com/seymouria

FLOW CHARTS OF VERTEBRATE TRAITS

Flow Chart 1. Traits of Vertebrates



Flow Chart 2. Skeletal Traits of Vertebrates



Skeletal Diagram of the Reptiliomorph *Seymouria*

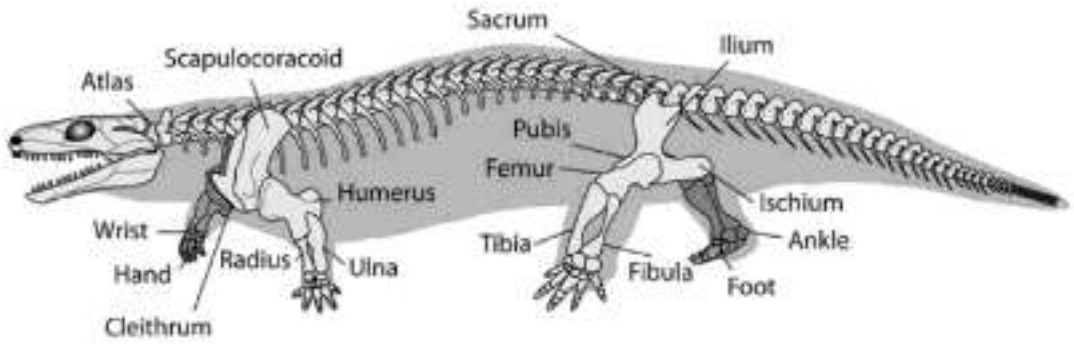
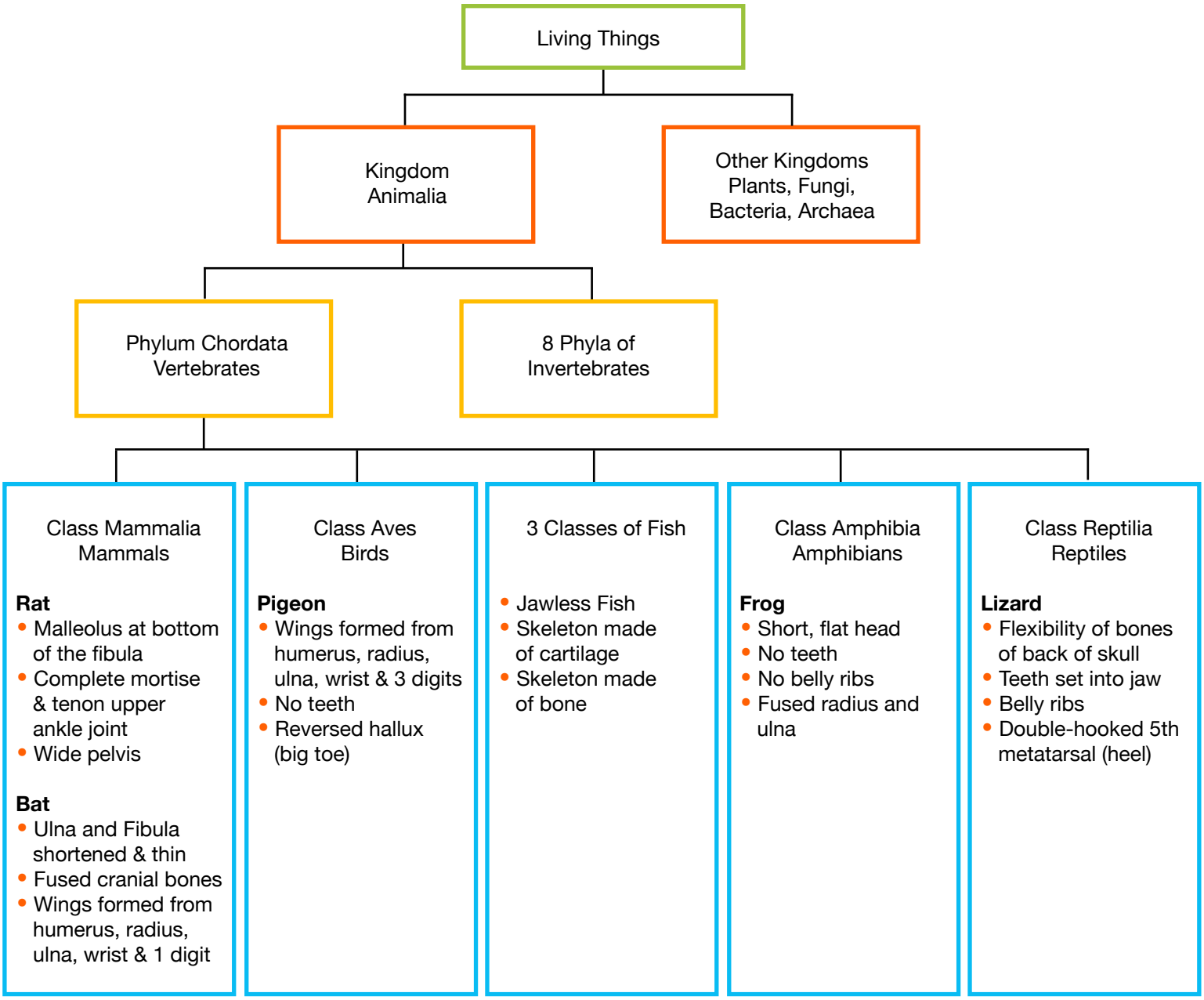


Image Source
https://books.google.com/books?id=sENNCwAAQBAJ&pg=PA240&lpg=PA240&dq=seymouria+limb+function&source=bl&ots=WKwM0mnQ6q&sig=ACfU3U0CRR2mbNhnmEwbjNAGlHKvOUc2OA&hl=en&sa=X&ved=2ahUKEwibspW5zq3qAhXpc98KHYkkCqoQ6AEwCXoECAwQAQ#v=onepage&q=seymouria%20limb%20function&f=false



Missing Link?

The Seymouria was initially classified as a reptile in the early 1940s because of its dry scaly skin. After a fossil was found with gill impressions, it was then classified as an amphibian, although that might not even be the whole story. Some scientists believe that this animal is actually a missing link between amphibians and reptiles.

Text and image source: https://www.newdinosaurs.com/seymouria/