12.7: Vertebrate Evolution

What type of fish is a simple perch?

Does it have a partial of complete vertebral column? What about a jaw? Do you think the endoskeleton is made of cartilage or bone? Why are these important evolutionary steps? A bony skeletal could support a larger body. Early bony fish evolved into modern ray-finned and lobe-finned fish, which then evolved into species that could move out of the water.

Vertebrate Evolution

The earliest vertebrates were jawless fish, similar to living hagfish. They lived between 500 and 600 million years ago. They had a cranium but no vertebral column. The phylogenetic tree in Figure below gives an overview of vertebrate
evolution. As more data become available, new ideas about vertebrate evolution emerge.

Phylogenetic Tree of Vertebrate Evolution. The earliest vertebrates evolved almost 550 million years ago. Which class of vertebrates evolved last?

**Evolution of Fish**

Not too long after hagfish first appeared, fish similar to lampreys evolved a partial vertebral column. The first fish with a complete vertebral column evolved about 450 million years ago. These fish also had jaws and may have been similar to living sharks. Up to this point, all early vertebrates had an endoskeleton made of cartilage rather than bone. About 400 million years ago, the first bony fish appeared. A bony skeleton could support a larger body. Early bony fish evolved into modern ray-finned and lobe-finned fish.

**Evolution of Other Vertebrate Classes**

Amphibians, reptiles, mammals, and birds evolved after fish.

- The first amphibians evolved from a lobe-finned fish ancestor about 365 million years ago. They were the first vertebrates to live on land, but they had to return to water to reproduce. This meant they had to live near bodies of water.
- The first reptiles evolved from an amphibian ancestor at least 300 million years ago. They laid amniotic eggs and had internal fertilization. They were the first vertebrates that no longer had to return to water to reproduce. They could live just about anywhere.
- Mammals and birds both evolved from reptile-like ancestors. The first mammals appeared about 200 million years ago and the earliest birds about 150 million years ago.

**Evolution of Endothermy**

Until mammals and birds evolved, all vertebrates were ectothermic. Ectothermy means regulating body temperature.
from the outside through behavioral changes. For example, an ectotherm might stay under a rock in the shade in order
to keep cool on a hot, sunny day. Almost all living fish, amphibians, and reptiles are ectothermic. Their metabolic rate
and level of activity depend mainly on the outside temperature. They can raise or lower their own temperature only
slightly through behavior alone.

Both mammals and birds evolved endothermy. Endothermy means regulating body temperature from the inside through
metabolic or other physical changes. On a cold day, for example, an endotherm may produce more heat by raising its
metabolic rate. On a hot day, it may give off more heat by increasing blood flow to the surface of the body. Keeping body
temperature stable allows cells to function at peak efficiency at all times. The metabolic rate and activity level can also
remain high regardless of the outside temperature. On the other hand, maintaining a stable body temperature requires
more energy—and more food.

Summary

• The earliest vertebrates resembled hagfish and lived more than 500 million years ago.
• As other classes of fish appeared, they evolved traits such as a complete vertebral column, jaws, and a bony
  endoskeleton.
• Amphibians were the first tetrapod vertebrates as well as the first vertebrates to live on land.
• Reptiles were the first amniotic vertebrates.
• Mammals and birds, which both descended from reptile-like ancestors, evolved endothermy, or the ability to
  regulate body temperature from the inside.

Review

1. In what order did vertebrates evolve?
2. Birds evolved from what other type of vertebrate?
3. What were the first vertebrates to lay amniotic eggs?
4. Compare and contrast ectothermy and endothermy, including their pros and cons.