Sources of Evidence of Evolution

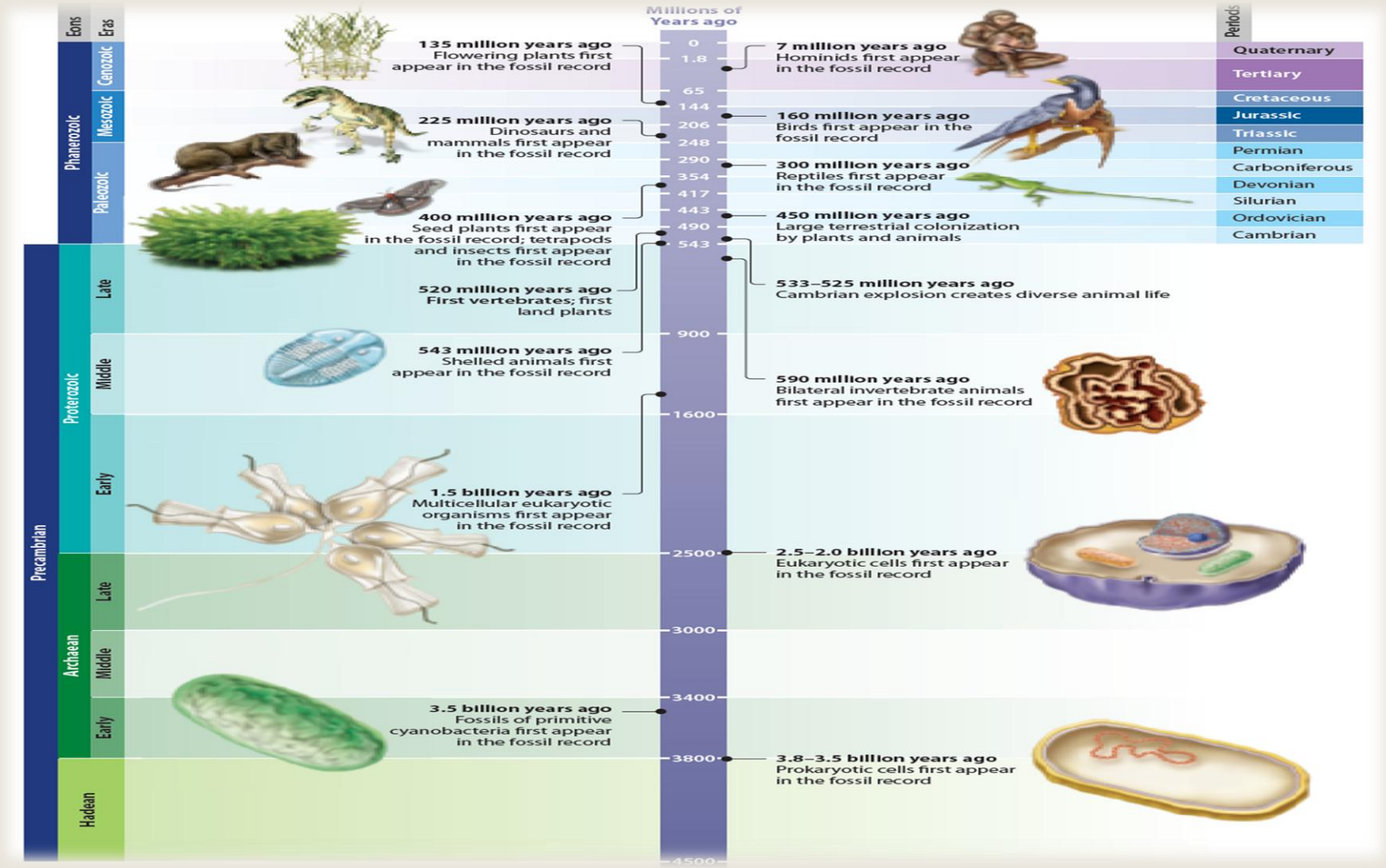
- In The Origin of Species, Darwin assembled a group of facts that had previously seemed unrelated.
- Darwin's ideas were developed, for the most part, by his observations of the distribution of organisms throughout the world (as outlined in Table 8.1 on p. 329).

Fossils: Evidence for the History of Life

- Sedimentary rock with fossils provides a ***fossil record*** of the history of life by showing the kinds of species that were alive in the past.
- For instance, when people examined the Burgess Shale fossil beds in British Columbia, they found fossils of animals that lived in an ancient ocean during the Cambrian period, over 500 million years ago.

The Burgess Shale

A Geological Time Scale

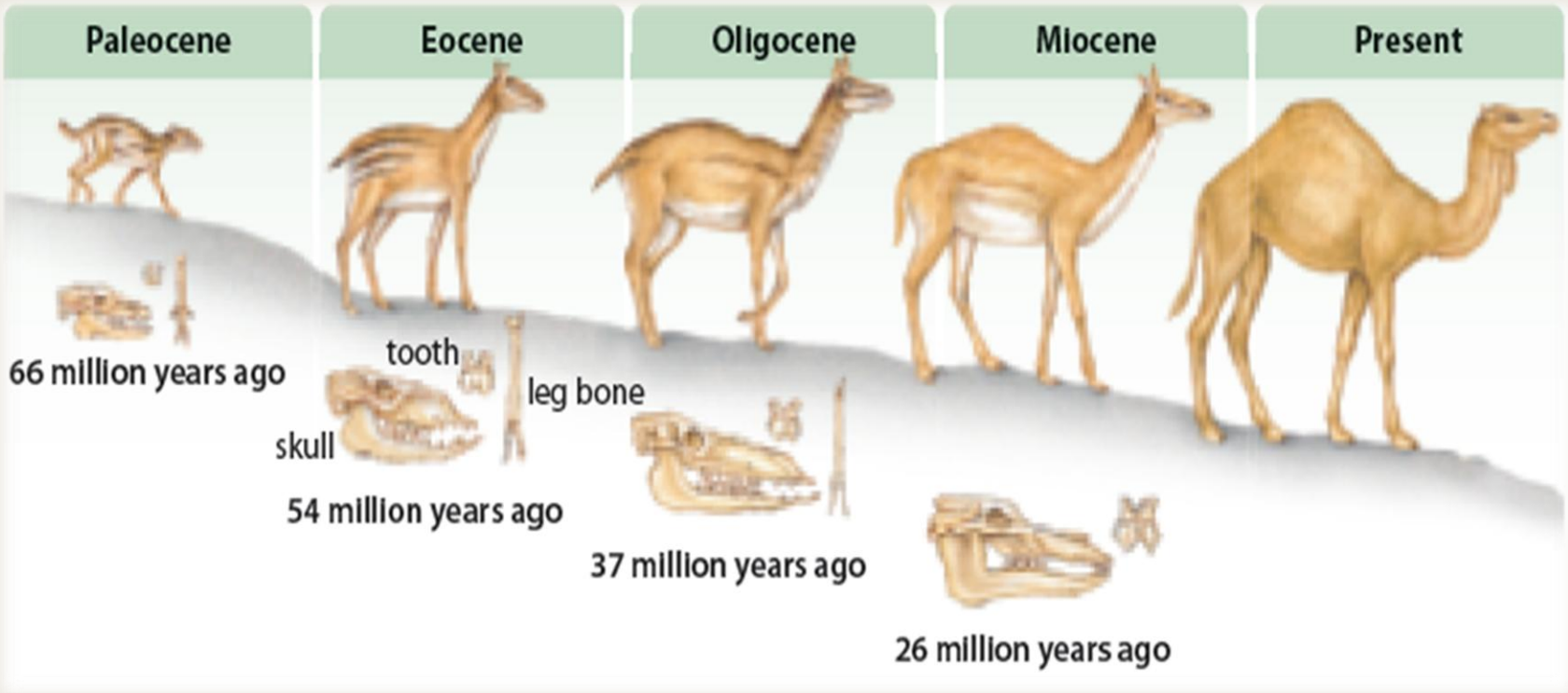


Evidence from Fossil Records

1. Fossils found in young layers of rock are much more similar to species alive today than fossils found in older, deeper layers of rock.
2. Fossils appear in chronological order in the rock layers. So, probable ancestors for a species are found in older rocks, which usually lie beneath the rock in which the later species is found.
3. Not all organisms appear in the fossil record at the same time.

The Modern Camel

- Paleontologists have used fossils to trace the evolution of the modern camel.



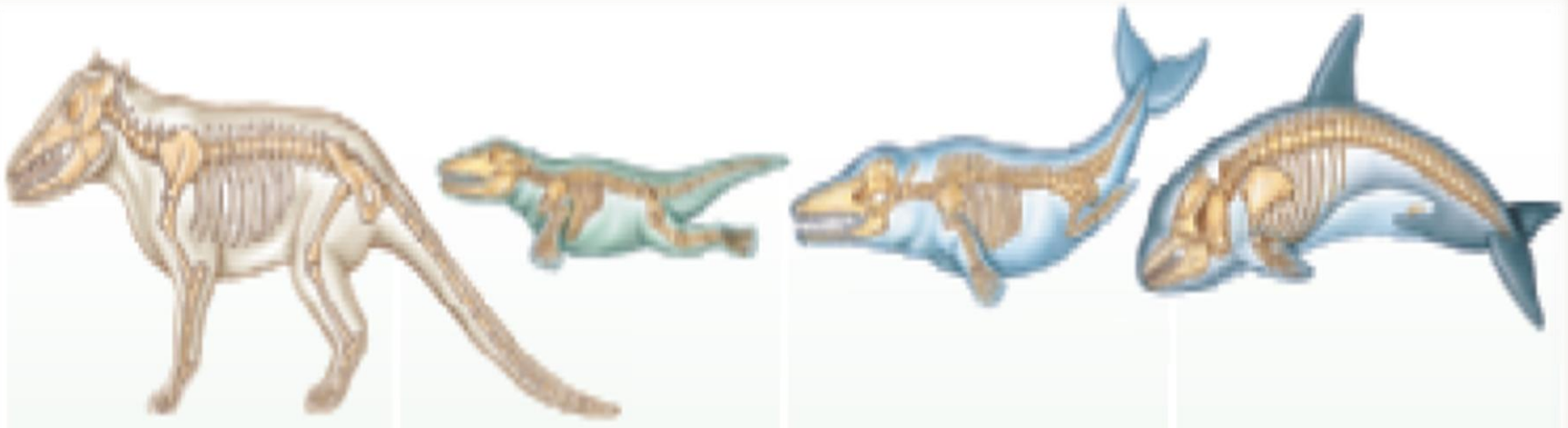
Evidence from Transitional Fossils

- The original fossil record gave only scattered "snapshots" of ancestral forms.
- Scientists wondered about the gaps between these snapshots.
- The ongoing discovery of hundreds of **transitional fossils** - fossils that show intermediary links between groups of organisms - has helped scientists better understand the evolutionary process and relationships between groups of organisms.
- Transitional fossils link the past with the present.

Transitional Fossils and Vestigial Structures

- For example, scientists have found fossilized whales that lived 36 to 55 million years ago. These fossils link present-day whales to terrestrial ancestors. Basilosaurus and Dorudon were ancient whales that had tiny hind limbs but led an entirely aquatic life. Dorudon was about the size of a large dolphin, about 5 m long. It had a tiny pelvis (located near the end of its tail) and legs about 10 cm long. These characteristics would have been useless to an animal that lived an aquatic life. Structures that are the reduced forms of structures that were functional in the organism's ancestors are called **vestigial structures**. The pelvic bone in the Dorudon whale - and in some modern whales, such as baleen whales - is called a vestigial pelvic bone.

The Modern Toothed Whale



Pakicetus attocki lived on land, but its skull had already evolved features characteristic of whales.

Ambulocetus natans likely walked on land (as modern sea lions do) and swam by flexing its backbone and paddling with its hind limbs (as modern otters do).

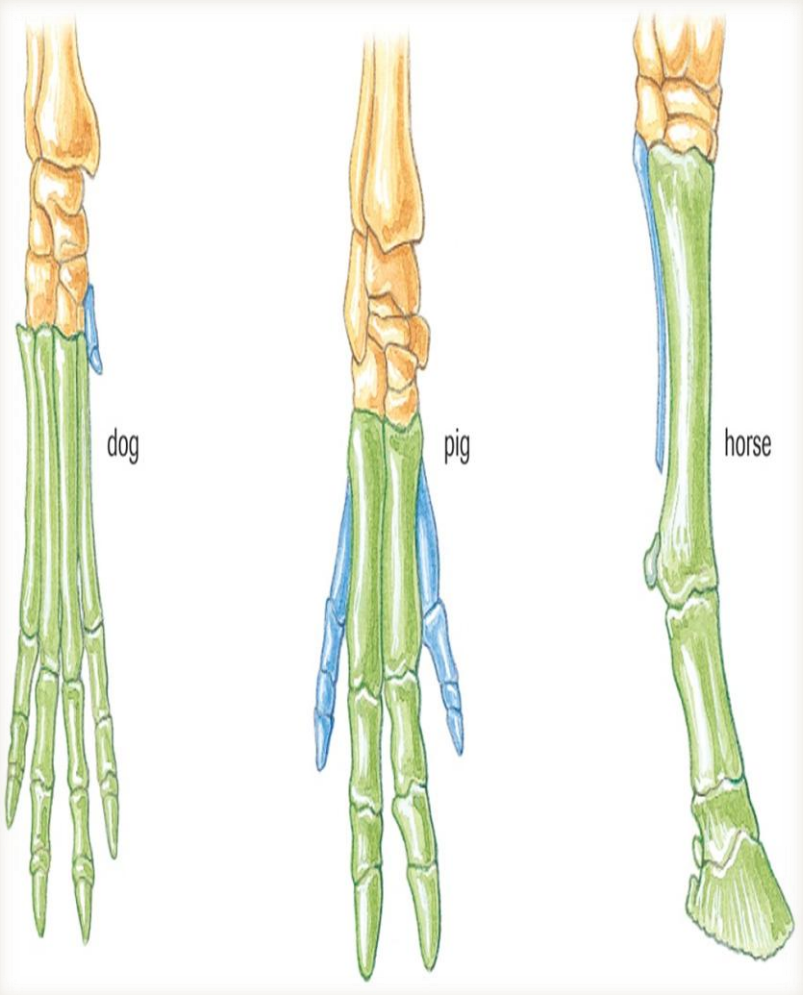
Rodhocetus kasrani's small hind limbs would not have helped it swim, much less walk.

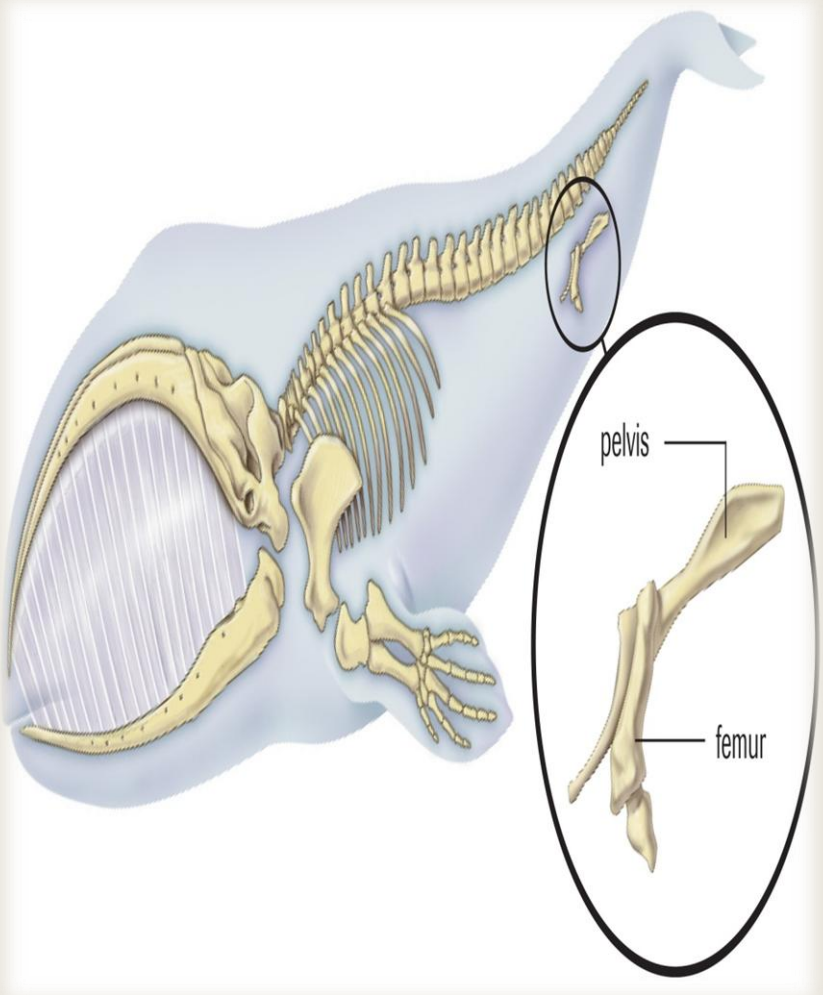
Modern toothed whale

Examples of Vestigial Features

- Pelvic bones and leg bones in some pythons and boas.
- Toes and digits in dogs, pigs, cattle, and deer.
- The human appendix.
- Rudimentary wings in flightless insects.

A Look at Vestigial Features





Evidence from Biogeography

- **Biogeography** is the study of the past and present geographical distribution of organisms.

- Darwin and Wallace hypothesized that species evolve in one location and then spread out to other regions.

Evidence from Biogeography

- Biogeography supports this hypothesis with examples such as the following:

1. Geographically close environments are more likely to be populated by related species than are locations that are geographically separate but environmentally similar.

Evidence from Biogeography

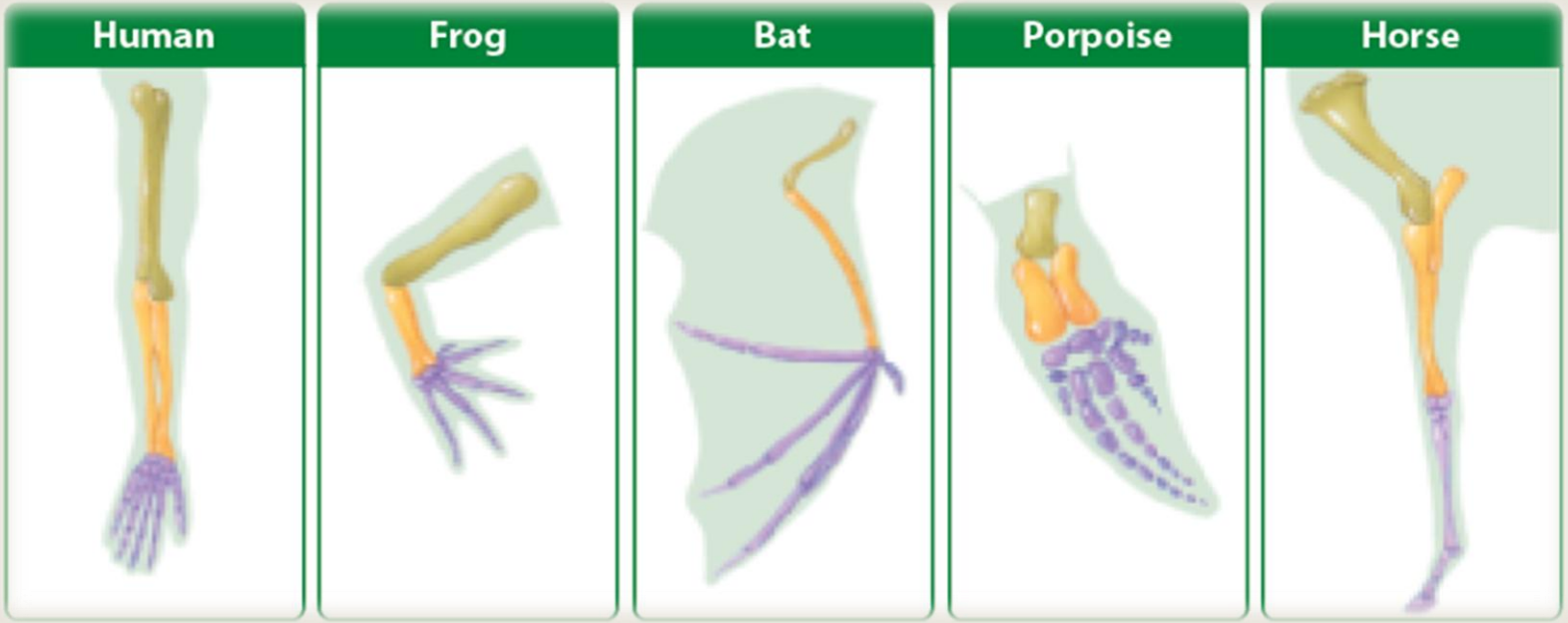
2. Animals found on islands often closely resemble animals found on the closest continent. This suggests that animals on islands have evolved from mainland migrants, with populations becoming adapted over time as they adjust to the environmental conditions of their new home.
3. Fossils of the same species can be found on the coastline of neighbouring continents.
4. Closely related species are almost never found in exactly the same location or habitat.

Evidence from Anatomy

- Vertebrate forelimbs can be used for various functions, such as flying (birds and bats), running (horses and dogs), and swimming (whales and seals).
- Despite their different functions, however, all vertebrate forelimbs contain the same set of bones, organized in similar ways.
- How is this possible?
- The most plausible explanation is that the basic vertebrate forelimb originated with a common ancestor.

Homologous Structures

- **Homologous structures** are those that have similar structural elements and origin but may have a different function.



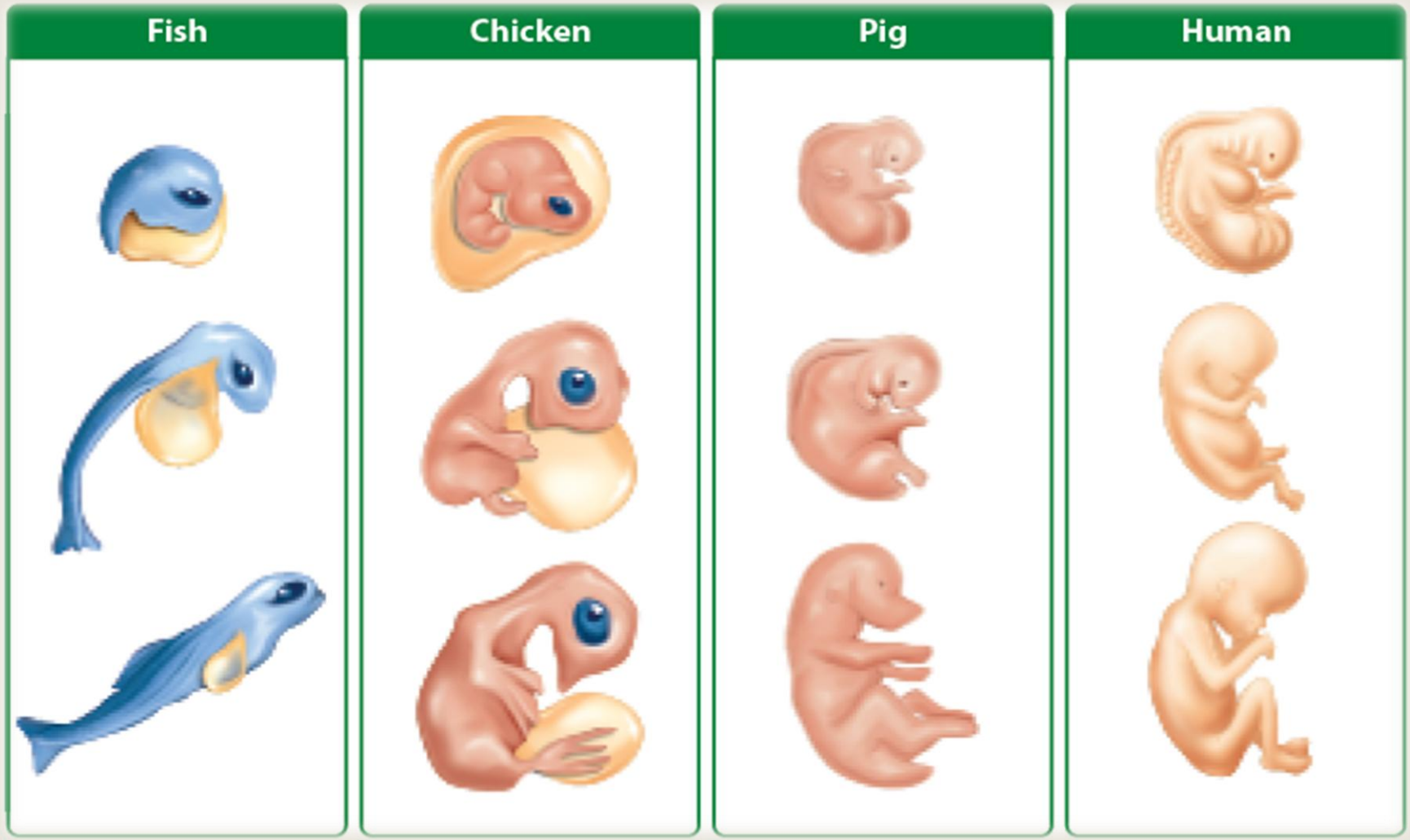
Analogous Structures

- Some organisms have **analogous structures** which are structures similar in function, but not in origin or anatomical structure.
- Example: the wings of a bird and that of a bee – both serve a similar function (flight) but are anatomically different in structure.

Evidence from Embryology

- Embryology is the study of early, pre-birth stages of an organism's development.
- The similarities between embryos in related groups (such as vertebrates) point to a common ancestral origin.

Evidence from Embryology



Evidence from DNA

- Since DNA carries genetic information, scientists can determine how closely related two organisms are by comparing their DNA.
- If two species have similar patterns in their DNA, this indicates that these DNA sequences must have been inherited from a common ancestor.