Evolution

Evidence of Evolution

- Fossil Evidence
- Comparative Anatomy
  - ↳Homologous Structures
  - ↳Analogous Structures
  - ↳Vestigial Organs and Structures
- Embryology

Fossil Evidence

- Fossils are formed when organisms become buried in sediments, causing little decomposition of the organism.
- Over time the calcium in their bones and other hard tissues is replaced by minerals as the sediment itself is changed to rock.
- As time progresses various sedimentary layers get deposited, with the oldest on the bottom and the youngest on the top. By observing the appearance, abundance and types of fossils in each of these layers we can understand the progression of the species that lived in that location over time.
- Fossils are also formed through freezing, being embedded in amber, preserved in tar, or even footprints and imprints.

- Scientists can tell how old a fossil is by carbon or radioactive dating them.
- Once the fossil has been dated it can be used as an index with other fossils from the same period of time. This allows for a comparison of evolutionary evens at different locations by comparing the fossils that are in the time periods before and after them.
- It has been found that fossils of similar organisms show large or small differences with the ones that are in other time periods.
- In some cases fossil evidence allows scientist to trace animals alive today to early ancestors that may now be extremely different in appearance.

Figure 1

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Paleozoic Era	Permian (248-290 million years ago)	Disappearance of many marine animals, rapid spread and evolution of reptiles
	Carboniferous (290-354 million years ago)	First half: Sharks, stegocephalia (lizard-like amphibians) Second half: First reptiles, spider, advanced snail, advanced scorpion, early (huge) dragonflies, primitive gymnosperms, first true conifers
	Devonian (354-417 million years ago)	Sharks, lungfish, armored fish Lower life: Coral, starfish, sponge, earliest known insect, first woody plants, ferns, scouring rushes, scale trees
	Silurian (417-443 million years ago)	First air-breathing animal (scorpion), first vascular plants, first land plants with conducting tissue
	Ordovician (443-490 million years ago)	Graptolites (small colonial coelenterates), first vertebrates (primitive fishes), early corals
	Cambrian (490-543 million years ago)	First abundant fossils appear Trilobites, early snails, cephalopod mollusks, brachiopods, bryozoans, foraminiferans, seaweeds, lichens
Precambrian Time	Precambrian (>543 million years ago)	Algae (and probably many species of soft-bodied organisms which did not leave fossil traces), simple bacteria

Figure 2

- This stratigraphic column shows the order in which organisms appeared. Each layer represents a particular time frame and shows an organism which was found during that time.
- The oldest fossils appear in lower layers, and the most recent fossils at the top. This allows for placement of fossils to be used as an aid in dating the organism found.

Comparative Anatomy

- Comparative Anatomy includes Homologous and Analogous structures as well as vestigial features.
- Comparisons of anatomical features in different organisms often provides evidence to support the theory of evolution. As Organisms are often classed together according to similarities in their structures.
- It was through comparing the anatomy of organisms that scientist discovered phylogeny, meaning the evolutionary history of a group of organisms.

"What can be more curious than that the hand of a man, formed for grasping, that of a mole for digging, the leg of a horse, the paddle of the porpoise, and the wings of the bat, should all be constructed on the same pattern, and should include the same bones, in the same relative positions.

-Darwin.

Homologous Structures

- Homologous structure are structures that share a common origin but may serve different functions in modern species.
- These structures are evidence that organisms with similar structure evolved from a common ancestor.
- Examples include the forelimbs of a variety of mammals. For example, human, cat, whale and bat.
- These species show the same skeletal elements. Is in the humerus, radius and ulna.
- However these skeletal elements have been modified over time to suit the different functions suitable for the type of mammal.
- Homologous structures result from divergent evolution meaning their ancestral lines started out fairly similar, but evolved along different paths, becoming more different over time.

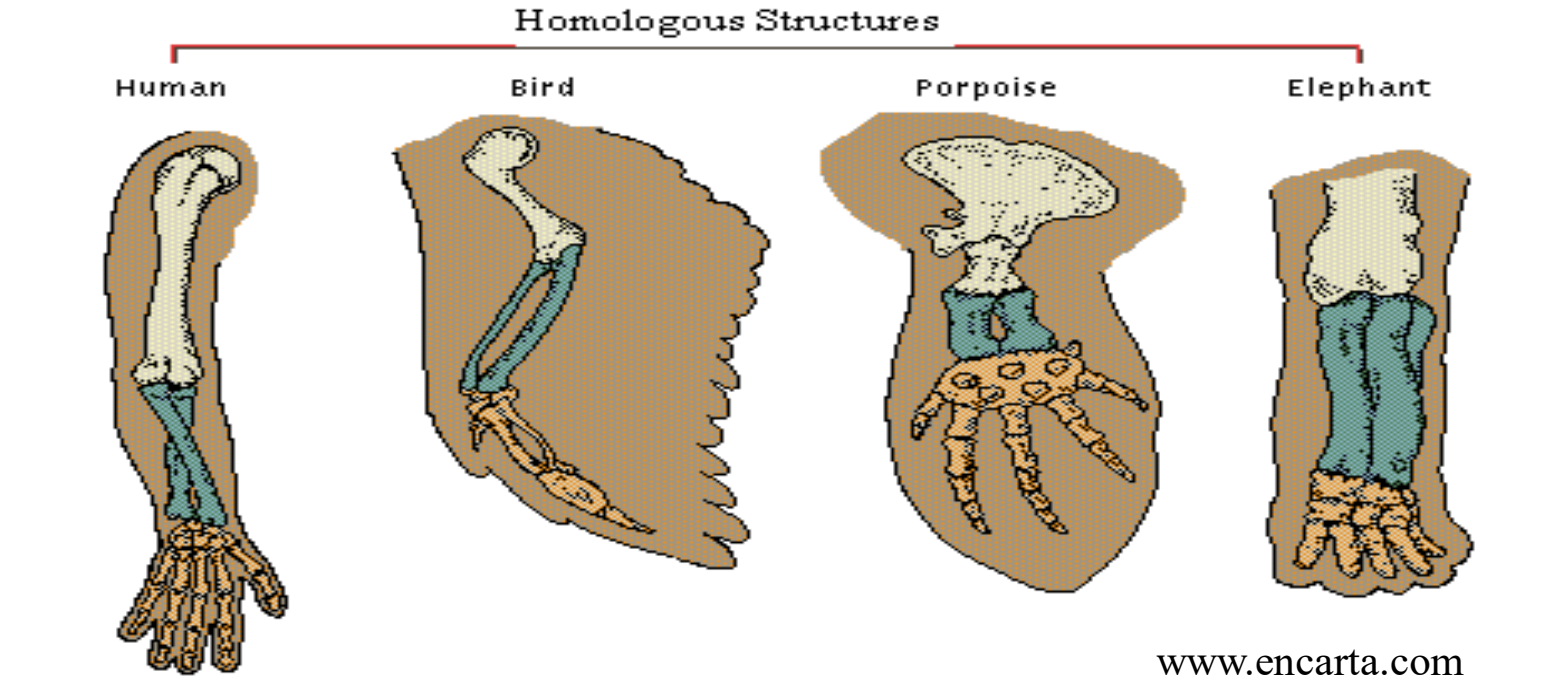

Figure 3

- Structures that are similar due to evolutionary origin, such as the forearm bones of humans, birds, porpoises, and elephants, are called homologous. However, structures that evolve separately to perform a similar function are called analogous. The wings of birds, bats, and insects, for example, have different embryological origins but are all designed for flight.

Analogous Structures

- Analogous structures are a contrast to homologous structures.
- They serve the same function between organisms but are different in internal anatomy.
  - ↳ Such as the wings of birds and butterflies or the eyes of lobsters and fish.
- These structures are of no use in classifying organisms or in working out their evolutionary relationships with each other.

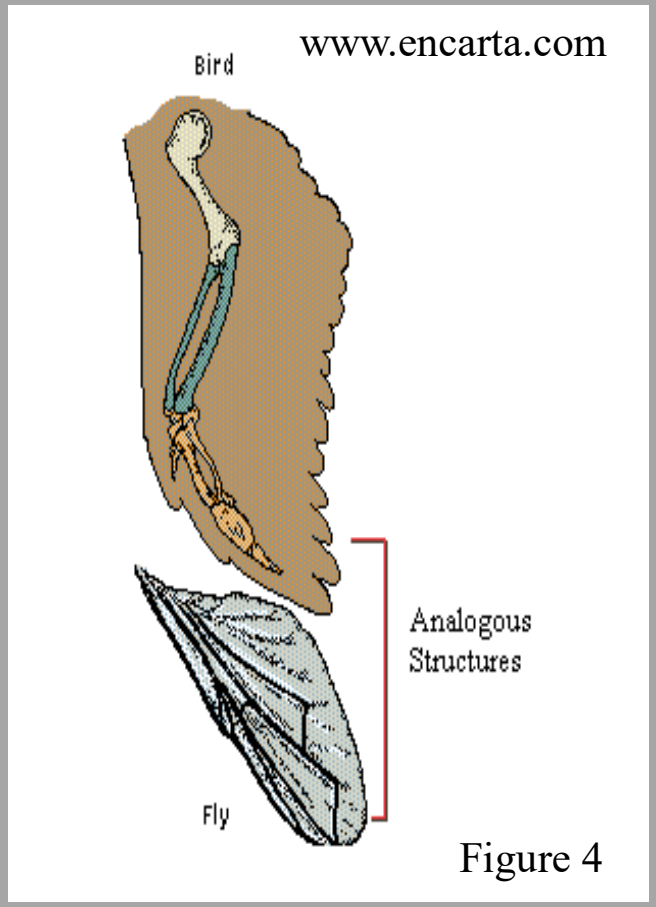

Figure 4

Vestigial Organs

- Vestigial organs provide further evidence for evolutionary change.
- These organs are usually dwarfed and useless to the organism.
- Examples of these include:
    - The human appendix which is useless in humans, but in other mammals it is necessary for digestion of high cellulose diet.
    - The human external ear muscles.
    - The tail bone.
    - Wisdom teeth.
    - Some snakes have skeletal limbs.
- Sometimes vestigial organs may be adapted for new uses
  e.g. penguin winds can't be used for flight , yet they are adapted for swimming.
- Even though organisms have these organs there is no significant disadvantage to the organism.

Examples of Vestigial Structures

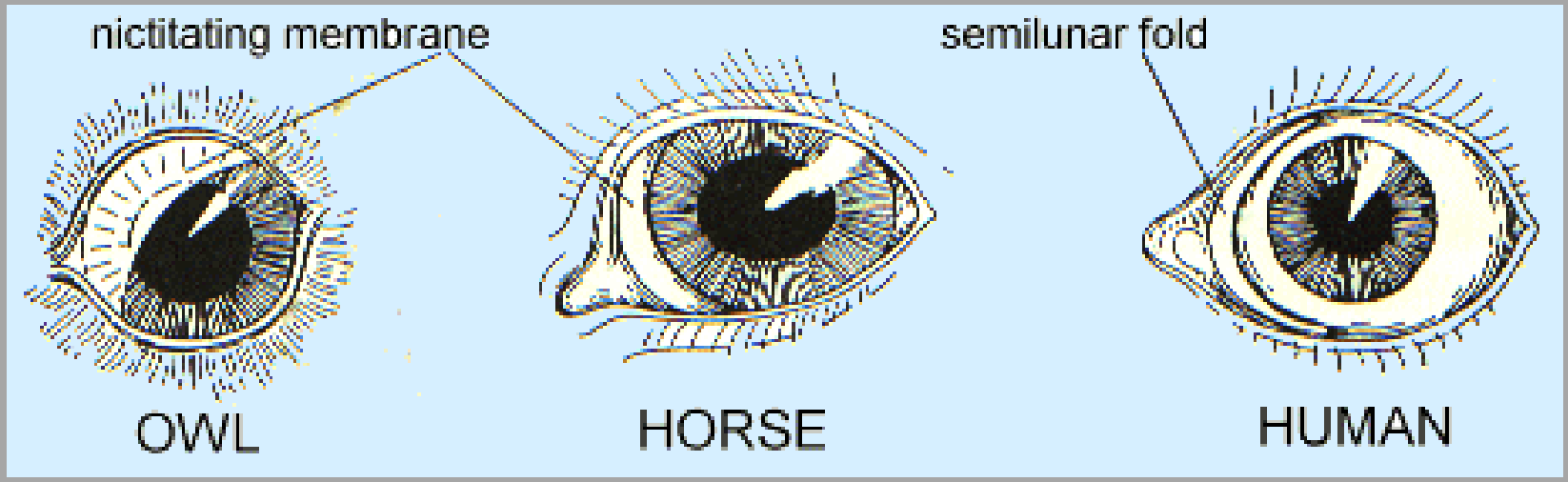

Figure 5

Vestigial organs associated with eye structures

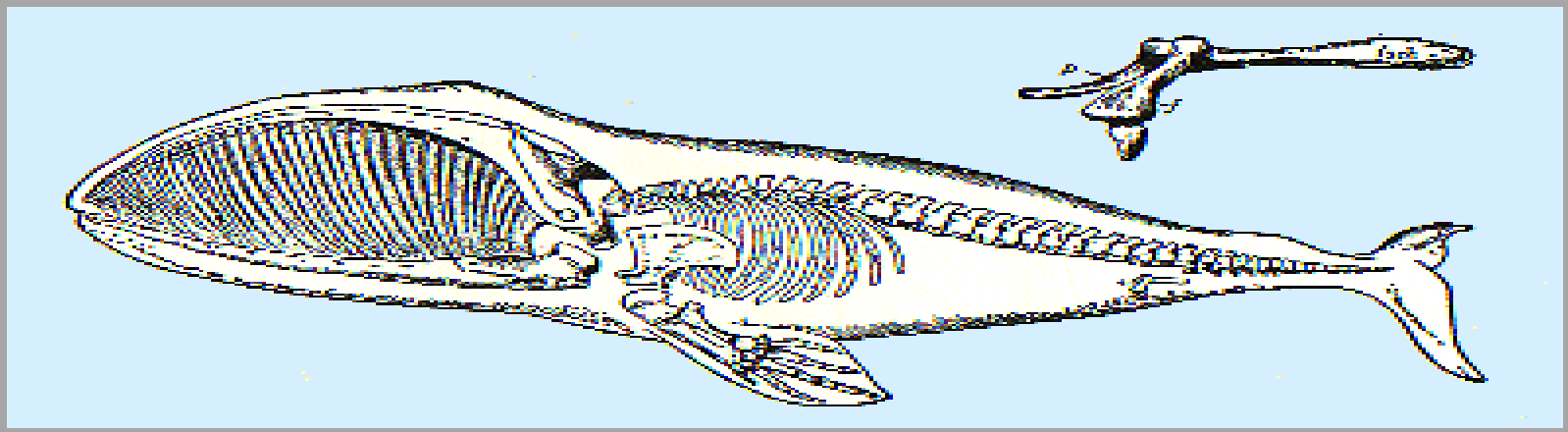

Figure 6

Vestigial remains of a pelvic girdle in a whale

Embryology

- Embryology of organisms can be used to demonstrate the existence and even degree of relatedness of organisms.
- In the early stages of development embryos of many organisms look extremely similar.
- Embryos in mammals, birds, reptiles and fish have many body similarities in common
  e.g. Gill slits, two chambered heart, and tail.
- As the embryos develop further, the similarities gradually disappear.
- This embryonic resemblances indicated that organisms are related by their common ancestors.

- Homeobox (Hox) genes that regulate the expression of hundreds of other genes appear to determine the path that embryo development follows.
- Depending on the Hox genes control the expression of other genes, parts of organisms develop differently. Similarities in Hox genes give strong indications of the presence of a relatively recent common ancestor.
- Also, homologous features can appear during embryonic development. These features serve no function as the organism grows
- In the early weeks of development, human embryos posses a tail similar to that in chicken and fish embryos.

Similarities in Embryos

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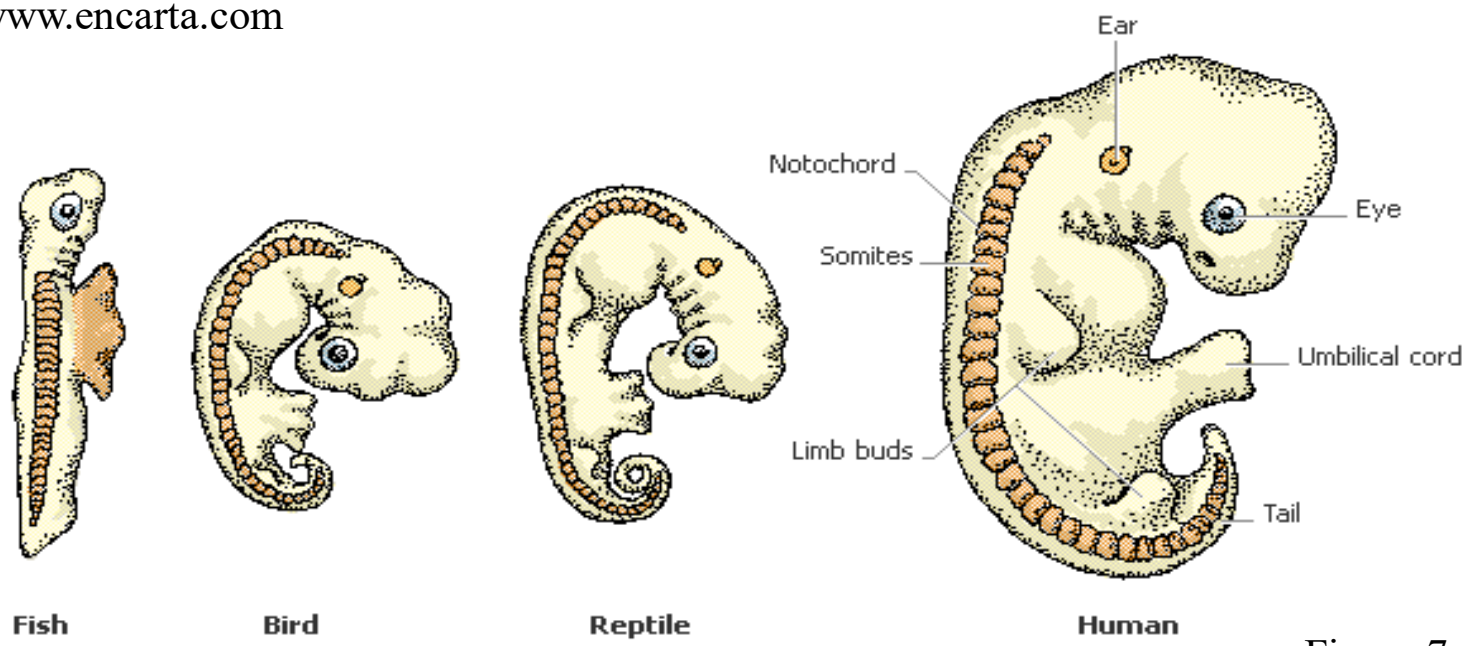

Figure 7