Evidence of Evolution-Answers in gray

Background

When Charles Darwin first proposed the idea that all new species descend from an ancestor, he performed an exhaustive amount of research to provide as much evidence as possible. Today, the major pieces of evidence for this theory can be broken down into the fossil record, embryology, comparative anatomy, and molecular biology.

Fossils

This is a series of skulls and front leg fossils of organisms believed to be ancestors of the modern-day horse.

Source: http://www.iq.poquoson.org

1.Give two similarities between each of the skulls that might lead to the conclusion that these are all related species.

the pointy bone on top of the muzzle of the horse and the triangular shape of the head and the gap between front and rear teeth

2.What is the biggest change in skull anatomy that occurred from the dawn horse to the modern horse?

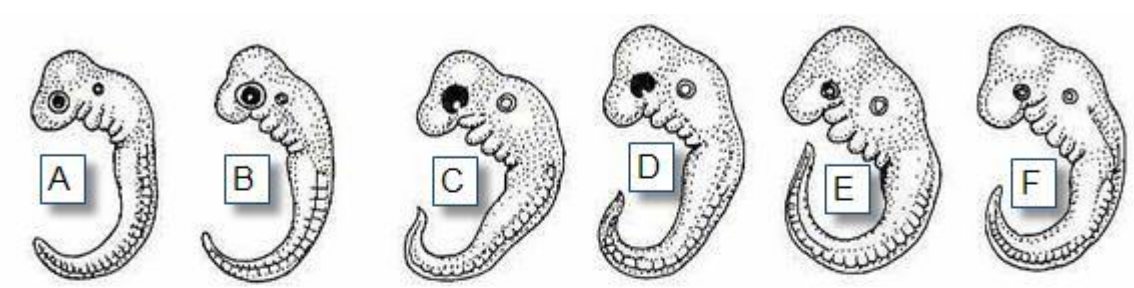
Increase in the size of the skull; a shift from cusps to complex ridges on the grinding surface of the premolars and molars, elongation of the face and of the space between the incisors and cheek teeth, an anterior shift of the cheek teeth so they lie forward of the eye; a deep lower jaw bone;

3. What is the biggest change in leg anatomy that occurred from the dawn horse to the modern horse?

Fifty five million years ago, there was an animal the size of a small dog, called *Hyracotherium* (sometimes called *Eohippus*). Its front feet had four toes, and its back feet had three. Modern horse feet have a single hoof. We see the reduction and loss of the side toes and enlargement of the terminal phalanx (hood) elongation and enlargement of the central metapodial (the longest bone in the foot)

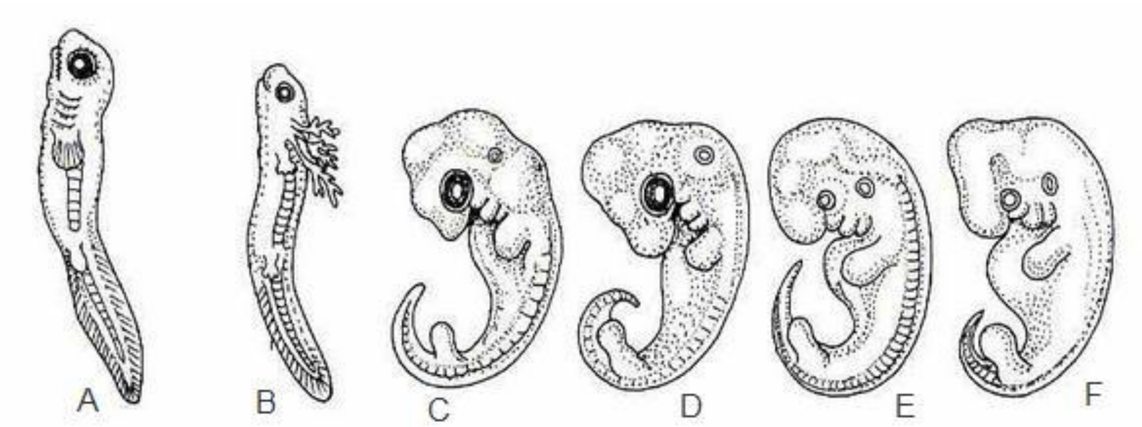
Embryology

Organisms that are closely related may also have physical similarities before they are even born! Take a look at the six different embryos below:



Source: http://www.starlarvae.org

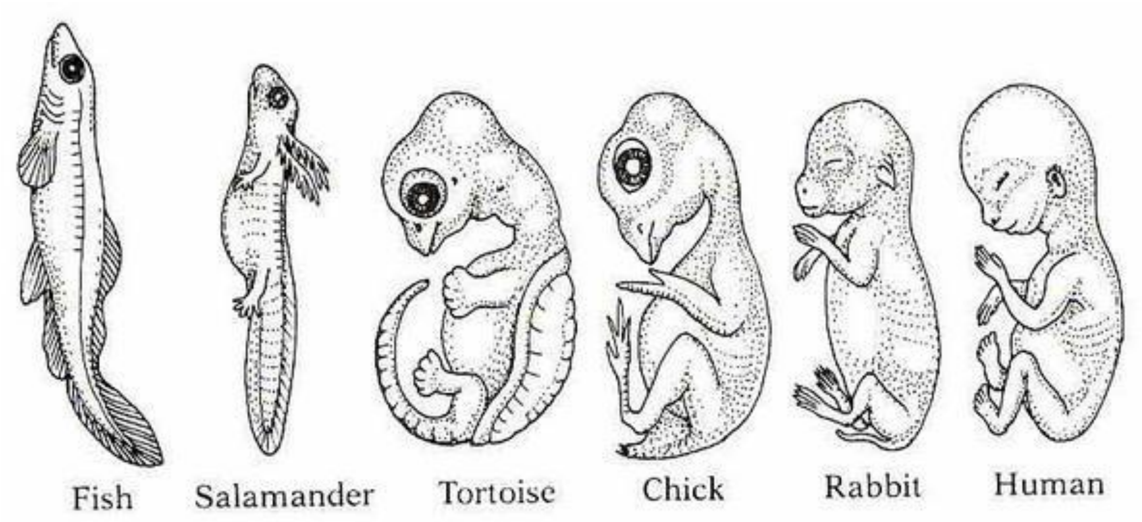
These are older, more developed embryos from the same organisms.



Hypothesize which embryo is from each of the following organisms:

These are embryos at their most advanced stage, shortly before birth.

Describe how the embryos changed for each of these organisms from their earliest to latest stages.



Species	**Anatomical Changes From Early to Late Stages**
Human	Developed limbs, defined features in face, neck, ears, loss of tail, tiny fingers present

Developed beak, tail shorter, wings and legs developed, head quite large

Chicken

Tail gone, developed limbs, detailed features in ears and mouth

Rabbit

Shell developed, limbs have developed, tail is thinner, large belly, long tail, beak

Tortoise

Salamander

Has gills, tail and large underbelly

Fish

fins developed, gills, tail and scales

1.Look again at the six embryos in their earliest stages. Describe the patterns you see. What physical similarities exist between each of the embryos?

Same basic shape, circular spots (eyes) and underbelly, all have tails, tiny bumps on underside, hole for ear

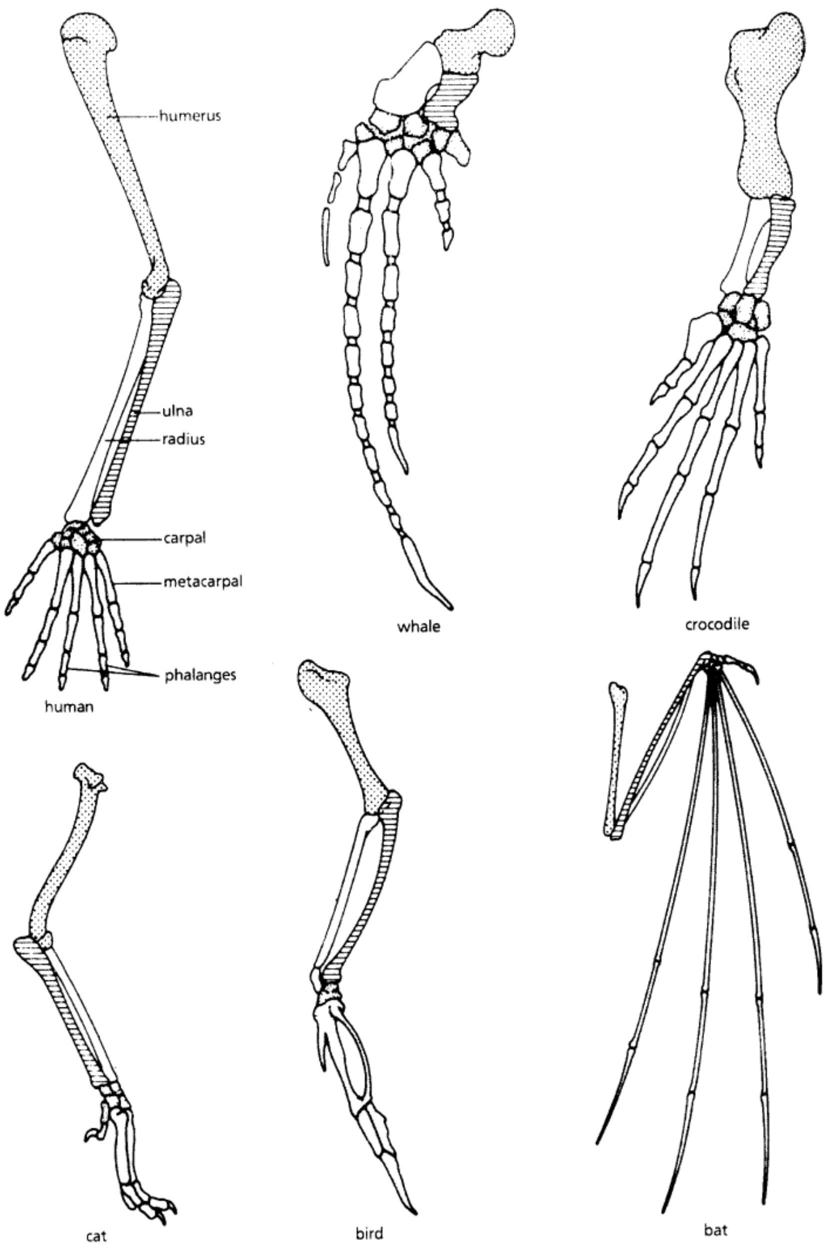
2. Does this suggest an evolutionary relationship? Explain how these embryos can be used as evidence of a common ancestor between each of these six organisms.
Examination of vertebrate embryos reveals that during corresponding stages of early development, the embryos appear to be very similar. For example, all vertebrate embryos pass through stages in which they have gill pouches. The pouches eventually develop into the gill apparatus in fish; in later-evolving vertebrates that do not have gills, the gill pouches undergo further refinement and develop into structures associated with the head and neck. Similarly, all early vertebrate embryos have tails, which persist in some animals but regress during the later stages of development of humans. Thus,

the individual development of an animal occurs through a series of stages that paint a broad picture of the evolutionary stages (phylogeny) of the species to which it belongs.
"Ontogeny recapitulates Phylogeny", Haeckel

Read more: http://www.biologyreference.com/Co-Dn/Development.html#b#ixzz2stPBHWw9

Comparative Anatomy

Shown below are images of the skeletal structure of the front limbs of 6 animals: human, crocodile, whale, cat, bird, and bat. Each animal has a similar set of bones. Color code each of the bones according to this key:



For each animal, indicate what type of movement each limb is responsible for.

Animal Primary Functions

Human Using tools, picking up and holding objects

Whale swimming

Cat running, walking, jumping

Bat flying, flapping wings

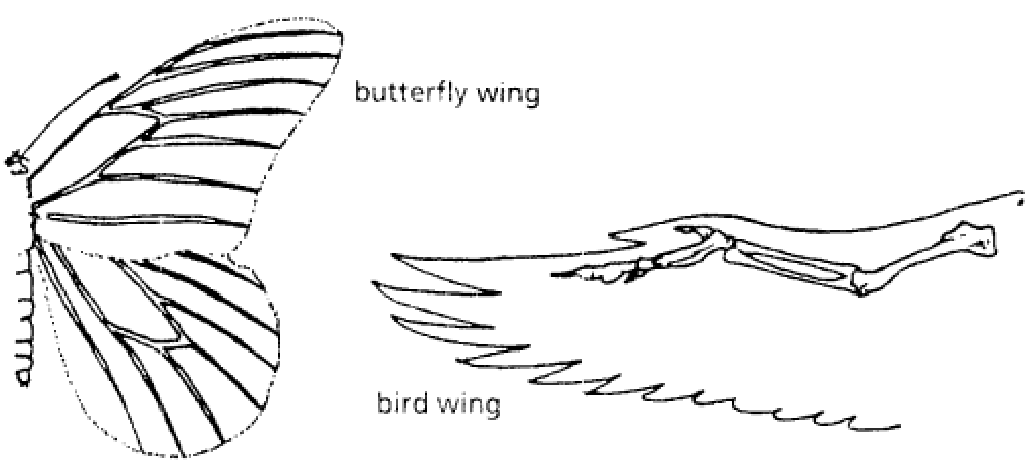
Bird walking, hopping,

Crocodile swimming, walking/crawling

Comparison to Human Arm in Function

Animal	Comparison to human arm in form	Comparison to Human Arm in function
whale	Whale has a much shorter and thicker humerus, radius, and ulna. Much longer metacarpals.	Whale fin needs to be longer to help in movement through water. Thumbs are not necessary, as they don't need to pick up and grasp things.
cat	Curved humerus, shorter thinner humerus and ulna and radius, smaller metacarpals and phalanges	Movement of cat involves jumping and running, smaller for agility and balancing on small ledges, no thumbs for grasping since they use claws and teeth for this.
bat	Thinner humerus, ulna, radius, smaller carpals, longer and thinner metacarpals and phalanges	Bones are smaller so that there is less weight in flight, long metacarpals and phalanges to extend wings
bird	Slightly shorter humerus, ulna, radius; metacarpals fused together, fewer but pointy phalanges	Bones are thinner for flight, more aerodynamic and light
crocodile	Shorter, thicker humerus, ulna and radius, larger carpals, pointy phalanges	Thicker legs to support heavy weight and long metacarpals for swimming

Compare the anatomy of the butterfly and bird wing below.

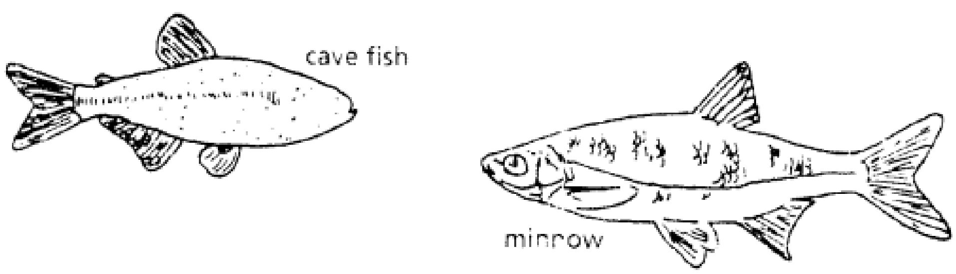


1. What is the function of each of these structures?

flying and gliding

2. How are they different in form? Give specific differences.
   2 pieces of the wing in butterfly whereas amny feathers in a bird's wing. There are bones in a bird's wing and non in the butterfly.

Compare the overall body structure of the cave fish and the minnow below.



1. What is the biggest, most obvious difference between the body structure of these two fish?
   Cave fish lack eyes and scales
2. Assume the two fish came from the same original ancestor. Why might the cave fish have evolved without eyesight?
   It's in a dark environment all of the time and so no need for sight. This adaptation would not have given it an advantage and therefore was not selected for.

3. What kind of sensory adaptation would you hypothesize the cave fish has to allow it to navigate in a cave, including catching and eating food?

Sensitivity to motion/vibration/electrical impulses/sound/smell/taste

You have now studied three different types of anatomical structures:

 Homologous structures show individual variations on a common anatomical theme. These are seen in organisms that are closely related.

1. Give an example of a homologous structure from this activity:
   Crocodile leg, human arm
   Human and cat front legs

 Analogous structures have very different anatomies but similar functions. These are seen in organisms that are not necessarily closely related, but live in similar environments and have similar adaptations.

2. Give an example of an analogous structure from this activity:
   Butterfly and bird wing or bat wing

□ **Vestigial structures**
are anatomical remnants that were important in the organism's ancestors, but are no longer used in the same way.

3. Give an example of a vestigial structure from this activity:
   Thumb of a whale fin

4. Below are some vestigial structures found in humans. For each, hypothesize what its function may have been.

Structure	Possible function
Wisdom teeth	Extra grinding ability for vegetation
Appendix	Store "good" bacteria to fight infections or digest cellulose like the caecum in rabbits
Muscles for moving the ear	Better hearing by changing direction of ears
Body hair	Keeping warm Stop pathogens from getting to mucous membranes Trap pheromones/oil on body
Little toe	Balance/clinging on rocks/trees
Tailbone	Rear stabilizing limb, balance

5. How are vestigial structures an example of evidence of evolution?
   Vestigial organs are often homologous to organs that are useful in other species. The vestigial tailbone in humans is homologous to the functional tail of other primates. Thus vestigial structures can be viewed as evidence for evolution: organisms having vestigial structures probably share a common ancestry with organisms in with organisms in which the homologous structure is functional.

Molecular Biology

Cytochrome c is a protein found in mitochondria. It is used in the study of evolutionary relationships because most animals have this protein. Cytochrome c is made of 104 amino acids joined together. Below is a list of the amino acids in part of a cytochrome protein molecule for 9 different animals. Any sequences exactly the same for all animals have been skipped.

For each non-human animal, take a highlighter and mark any amino acids that are different than the human sequence. When you finish, record how many differences you found in the table on the next page.

Animal	Number of Amino Acid Differences Compared to Human Cytochrome C	Animal	Number of Amino Acid Differences Compared to Human Cytochrome C
Horse	**5**	**Shark**	**14**
Picture	**7**	**Turtle**	**8**
Tuna	**11**	**Monkey**	**1**
Frog	**9**	**Rabbit**	**4**

Molecular Biology – Summary Questions

1. Based on the Cytochrome C data, which organism is most closely related to humans?

Monkey

2.Do any of the organisms have the same number of differences from human Cytochrome C? In situations like this, how would you decide which is more closely related to humans?

None of the organisms have the same number of difference from the human Cytochrome C. In situations like this, we can decide which is more closely related to humans by comparing anatomy structures, evolutionary tree or comparing them to the human genes by using another protein.

Conclusion

1.Charles Darwin published his book *On the Origin of Species* in 1859. Of the different types of evidence that you have examined, which do you think he relied upon the most, and why?

Darwin relied on the similar anatomies of species to link them. He also had some fossil evidence that showed slight changes in the body structure of the species over time, often leading to vestigial structures.

2. Given the amount of research and evidence available on evolution, why is it classified as a theory?

The scientific definition of the word "theory" is different from the colloquial sense of the word. Colloquially, or in everyday language, "theory" can mean a hypothesis, a conjecture, an opinion, or a speculation that does not have to be based on facts or make testable predictions. However, in science, the meaning of theory is more rigorous. A theory is a hypothesis corroborated by observation of facts, which makes testable predictions. In science, a current theory is a theory that has no equally acceptable or more acceptable alternative theory.