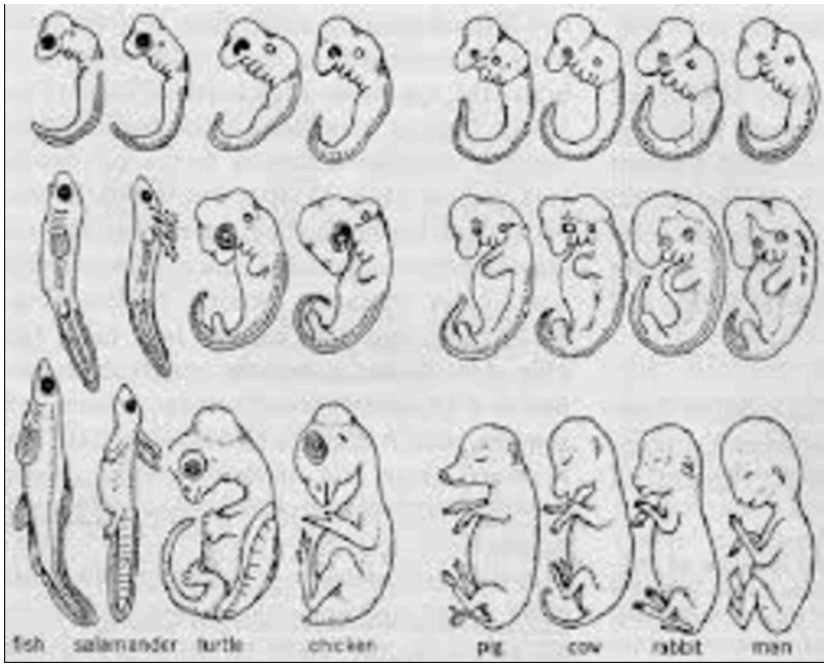
Embryological Development

Similarities in Embryology are a key piece of evidence used in supporting the theory of evolution. Early embryonic developments of many vertebrates are similar providing evidence that they share a common ancestry.

COMPARATIVE EMBRYOLOGY: THE VERTEBRATE BODY Even before Darwin proposed the theory of evolution through natural selection, Ernst von Baer claimed that the more closely related any two species are, the more similar their development. His treatise (1828) set the stage for linking the study of ontogeny, the development of the individual through a single life cycle, to phylogeny, the relatedness of species through descent from a common ancestor. When Darwin brought together the diverse lines of evidence to demonstrate that new species arose from previous species, he included the findings from studies on embryos. Von Baer, who discovered the mammalian egg as part of his detailed studies on animal development, observed that vertebrate animals, during the early stages of their embryological development, seem to have a common design, whereas the adult forms show differences. Arm buds from different species, for example, are virtually indistinguishable when they first form on the embryo, yet they may develop into a wing, an arm, or a flipper. In the early stages of growth when vital organs originate, the developmental sequences, or ontogeny, of all vertebrates are very similar. As the fertilized egg transforms into an



adult, the general vertebrate plan is modified during growth as each species acquires its adult species pattern. This plate illustrates six developmental stages (from left to right) of five species of vertebrates - one amphibian (the salamander), one bird (the chicken), and three mammals (the pig, monkey, and human). As you color, note the similarities of body shapes among the five species in the early developmental stages. The late fetal/newborn/adult stages reflect the emergence of species-specific body plans as a result of differential growth. Color the vertical arrow representing phylogeny gray. Color the title Fertilized Egg and the illustrated eggs beginning with salamander and moving up to human. Then, at the bottom of the plate, color the horizontal arrow representing ontogeny gray. Continue coloring the forms (b) through (f) and their titles, left to right, beginning each stage at the bottom of the plate and working up. Use contrasting colors for the different stages. The fertilized eggs (a), or zygotes, are very similar, though they differ slightly in the size of the cell nucleus. The orderly division of the single-celled zygote into a multicelled blastocyst is referred to as cleavage. By the late cleavage stage (b), the embryos look very similar and differ only in their cleavage patterns, which vary due to the presence of differing amounts of yolk in the egg. As the body segments form (c), all three mammals remain almost identical. Notice the ancestral gill slits, which in mammals will later develop into parts of the ear and pharynx. The mammals possess an umbilical cord that leads to the placenta. In contrast, the salamander and the chicken are nourished by yolk. The early forelimbs begin as buds (d). By the late fetal stage (e), limbs take on their adult shapes. The striking similarities in the late fetal stage between monkeys and humans reflect their close phylogenetic relationship. The main difference lies in the absence of a tail in the human fetus. (If an ape fetus were substituted for this monkey, it too would lack a tail). The chicken has developed its specialized shell breaker. The salamander has just hatched into its larval stage (e). It spends the first part of its life in the water, taking in life-giving oxygen through its feathery gill slits and using its limbs as paddles. Later, the

salamander undergoes metamorphosis and acquires its adult form with terrestrial limbs and lungs for breathing air. Only then, as an adult, can it leave the water to live, but not reproduce, on dry land. The newborns of each species receive quite different treatment The salamander abandons the eggs after she lays them, and the larvae receive no parental care at all. The hen incubates her eggs with body heat while sitting on them in a nest. The newly hatched chicks receive some protection from the mother hen but begin immediately to find their own food. After gestation times of four (pig), six (monkey), and nine months (human), newborn mammals are nourished by their mother's milk and require extended care before they become independent adults. A comparison of developmental stages among vertebrates led Ernst Haeckel (1834-1919) to propose his famous principle "ontogeny recapitulates phylogeny." A supporter of the idea of evolution, Haeckel claimed that the development of an individual (ontogeny) reflects the stages through which the individual's species has passed during its evolution (phylogeny). However, the phrase "ontogeny recapitulates phylogeny" oversimplifies and misleads by implying that evolution has goals or is directed. Instead, early developmental sequences of all vertebrates are similar due to common ancestry. All vertebrate embryos follow a common developmental plan due to having a set of genes that give the same instructions for development. As each organism grows, it diverges according to its species' way of life. Human embryonic development is similar to that of other vertebrates, more like that of other mammals than nonmammals, and most similar to that of other primates. From the study of ontogeny, we discover clues about the transformation of species through evolutionary change. – adapted from The Human Evolution Coloring Book, 2d ed., by Adrienne L. Zihlman. Produced by Coloring Concepts Inc. New York: HarperCollins, 2001.