first month, and 90 percent of these show evidence of developmental abnormalities. It is hardly surprising that traits that control major features of the organism are not susceptible to study through procedures of population genetics. If nearly all mutational changes in the genes that control these traits are lethal, they will not be expressed as alternative alleles in living organisms and thus will not provide the opportunity for positive selection leading to evolutionary change.

There are a few mutations among well-studied organisms that are responsible for the gain or loss of a finger or toe in otherwise normal individuals, but most of the changes that produce skeletal abnormalities are associated with grave disturbances of developmental processes leading to malformations in many organ systems (Lyon and Searle 1989; McKusick 1994). Thus, it is rarely possible to speak in terms of mutation rates and selection coefficients of genes that might lead to changes in basic patterns or processes of development. Most mutations known to cause changes in developmental processes are too damaging to provide a model for the manner in which evolutionary advances may have occurred. There must be many other mutations that result in minor changes to individual parts of the body, but few have been recognized as related to specific embryological processes.

Heterochrony

In addition to the origin of totally new structures or major reorganization of existing patterns, much of evolution can be seen as proceeding by incremental modification of the size and proportions of already existing structures. This can be broadly attributed to modification in the timing of developmental processes. The development of some parts of the body may be either accelerated or delayed compared with others, a process known by the general term **heterochrony**. For example, the skulls of apes and humans closely resemble one another early in development; subsequently the facial region develops more slowly in humans, retaining the proportions of juvenile apes, while the period of growth and expansion of the braincase is greatly prolonged, allowing for a brain size at least three times the volume of that in apes of comparable body size.

Among the most clearly documented examples of heterochrony are seen in the development of salamanders (Duellman and Trueb 1986). Although most groups of salamanders pass through an aquatic larval stage that matures into a terrestrial adult, all the members of four families – Sirenidae, Amphiumidae, Proteidae, and Cryptobranchidae – are permanently aquatic. In other families, particular species may be obligatorily aquatic, or have the capacity to metamorphose into terrestrial adults, depending on environmental conditions. In species that undergo metamorphosis, the reproductive organs complete development in the terrestrial stage. In contrast, the permanently aquatic forms exhibit a particular category of heterochrony, termed **neoteny,** in which the reproductive system matures while other aspects of the body retain a level of development comparable to that of the larval stage of other genera.

The most famous neotenic salamander is the axolotl, *Ambystoma mexicanum,* which does not metamorphose in its natural environment but can be induced to do so by injections of the hormone thyroxin. In obligatorily neotenic salamanders, the