Marsupial embryo jumps ahead in development

November 29 2010

Any embryonic short-tailed opossum finishes its development outside the womb. | Anna Keyte

(PhysOrg.com) -- Long a staple of nature documentaries, the somewhat bizarre development of a grub-like pink marsupial embryo outside the mother's womb is curious in another way.

Duke University researchers have found that the developmental program executed by the marsupial embryo runs in a different order than the program executed by virtually every other vertebrate animal.

"The limbs are at a different place in the entire timeline," said Anna Keyte, a postdoctoral biology researcher at Duke who did this work as

part of her doctoral dissertation. "They begin development before almost any other structure in the body."

Biologists have been pursuing the notion that limb development is triggered by other organ systems coming on line first, but this study shows the marsupial's limbs begin development without such triggers.

"Development is probably more flexible than we might have known otherwise," said biology professor Kathleen Smith. Their study animals were gray short-tailed opossums (*Monodelphis domestica*) native to Brazil and Bolivia, but the same should hold true for any marsupial, Smith said.

For the undeveloped embryo to be able to drag itself across the mother's belly from the birth canal to the teat, it needs a formidable pair of forelimbs. To get them, its developmental program has been rearranged to start building the forelimbs much sooner.

"A lot of these genes were turned on earlier than you'd see in a mouse or a chick," Keyte said. The researchers were also able to show that the forelimbs received cells from a much larger part of the developing embryo than is normally seen in other vertebrates. What surprised the researchers was that the genetic program to establish the hind limbs also appeared to be turned on early.

Gene expression sets up the pattern of where each of the four limbs will be, but the marsupial's forelimbs grow much faster than the hind limbs because the embryo devotes more of its scarce number of early cells to building those structures, Smith said. The plans are in place for the hind limbs, but not the bricks to build them.

The embryo emerges from the mother with burly forearms that include bones and well developed muscles, while the hind limbs are small and rubbery.

Blind, hairless and with an incomplete brain, a marsupial embryo is shockingly underdeveloped to be living outside the womb. But the system obviously works for marsupials.

"There are probably 50 explanations for why marsupials develop outside the womb, and none of them are very good," Smith said. It's pretty clear however that the external development gives the female a lot more control over her reproduction. If conditions change or she runs out of food, the marsupial mother can easily terminate an external pregnancy.

More information: "Developmental origins of precocial forelimbs in marsupial neonates," Anna L. Keyte and Kathleen K. Smith. *Development* 137, 4283-4294 (2010) doi:10.1242/dev.049445

Provided by Duke University