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By Philip Cohen

IN THE closest thing to a human virgin birth that modern science has ever recorded, British geneticists last week described the remarkable case of a young boy whose body is derived in part from an unfertilised egg. The discovery has provided a rare glimpse into the control of human development and the evolutionary changes that made sex essential for mammalian reproduction.

Parthenogenesis – development of an unfertilised female sex cell without any male contribution – is a normal way of life for some plants, insects and even lizards. Sometimes, an unfertilised mammalian egg will begin dividing, but this growth usually does not get far. The self-activated “embryo” will create rudimentary bone and nerve, but there are some tissues, such as skeletal muscle, that it cannot make, preventing further development. Instead, it becomes a type of benign tumour called an ovarian teratoma.

Why mammals should have evolved these blocks to parthenogenesis is hotly debated (see “Why genes have a gender”, New Scientist, 22 May 1993), but the blocks mean that sex is necessary for mammalian reproduction and development.

Now David Bonthron and his colleagues at the University of Edinburgh have shown that this is only partly true. In this month’s issue of Nature Genetics (vol 11, p 164), they describe the case of a three-year-old boy they call FD, who has mild learning difficulties and asymmetric face features, but otherwise seems healthy.

The geneticists first realised that FD was unusual when they looked at his white blood cells. Because FD is a boy, his cells should all have a Y chromosome, which contains the gene for “maleness”. But his cells contain two Xs, the chromosomal signature of a female.

Occasionally, chromosomal females carry one X chromosome bearing a chunk of the Y chromosome which includes the maleness gene. Bonthron and his colleagues initially assumed that FD was an example of this syndrome. But even when they used extremely sensitive DNA technology, they were unable to detect any Y chromosome material in FD’s white blood cells.

The real surprise came when the researchers discovered that the boy’s skin is genetically different from his blood, with the skin containing the normal X and Y chromosomes of a typical male. This clue prompted them to look more closely at FD’s X chromosomes. In a normal female, each cell contains two different Xs, one from the father and one from the mother.

The researchers examined DNA sequences all along the X chromosomes in FD’s skin and blood, and discovered that the X chromosomes in all his cells were identical to each other and derived entirely from his mother. Similarly, both members of each of the 22 other chromosome pairs in his blood were identical and derived entirely from the mother.

What could explain this unusual mixture of genetics in one person? The researchers believe that FD's development started when an unfertilised egg self-activated and began to divide. A sperm cell then fertilised one of the cells, and the mixture of cells began to develop as a normal embryo. This fusion with a sperm must have occurred very early on, because self-activated eggs quickly lose the ability to be fertilised. At some point, the unfertilised cells must have duplicated their DNA, boosting their chromosome number back up to 46. Where the unfertilised cells hit a developmental block, the researchers believe, the fertilised cells compensated and filled in that tissue.

The researchers say that FD's case demonstrates that whatever blocks there are to successful human parthenogenesis, unfertilised cells are clearly not always disabled. For example, these cells were able to create a seemingly normal blood system for FD.

FD's case also fits in with research in mice, where researchers have been able to create partially parthenogenetic animals by in vitro fertilisation. Azim Surani, a geneticist at the University of Cambridge, says that his experiments have also identified skin as a tissue in which parthenogenetic cells are usually excluded, presumably because they have trouble developing. He says that these similarities suggest that the barriers to development without a father were set early in mammalian evolution.

Experiments with mice have also shown that parthenogenetic cells grow more slowly than normal cells and that the two can co-exist in the same tissue. The proportion of parthenogenetic cells in a given tissue type can also vary throughout the body. The researchers believe this could explain why FD's face is slightly asymmetric, with features smaller on the left-hand side. Bonthron notes that one in every few hundred people has slight asymmetry, and it is possible that some of these people could also be partially parthenogenetic.

Nevertheless, Bonthron believes that similar cases are incredibly rare. Many different types of disturbance in early development can cause body asymmetry, and FD's remarkable genetics depended upon a highly unusual combination of circumstances occurring within a very short time window. “I don't expect we'll ever see another one,” says Bonthron. (see Diagram)