SEXUAL AND ASEXUAL REPRODUCTION AND CLONES.
By
William Reville, University College, Cork.

When the news broke about Dolly, the cloned sheep, I thought of the summer's day when I called to see my mother. I found her cloning plants in the back garden. Had I been wearing my Superman spectacles, that allow me to see incredibly tiny things, I would have seen that the whole garden was a hive of cloning activity. Bacteria were cloning themselves all over the place. I would have seen aphids busily cloning themselves over by the hedge, and, down in the far corner, the bees and the wasps were also at it. Cloning is 'old-hat' to Mother Nature.

Biological organisms reproduce themselves either by sexual or asexual methods, and some organisms can employ both methods. In asexual reproduction, the new individual (offspring) is produced by a single parent and derives genetic material from that single parent only. In sexual reproduction the new individual has two parents and usually derives half its genetic complement from one parent and half from the other parent. The recent cloning of the sheep Dolly, in Scotland, is a special example of artificially contrived reproduction, where all the genetic content of the offspring comes from the mother.

The genetic content of an organism resides in its chromosomes. A biological clone is defined as an individual that is genetically identical to its single parent. For example when simple single-celled organisms wish to reproduce they do so by dividing in two. The chromosomes of the 'parent' cell duplicate prior to the cell dividing, and each daughter cell receives an identical copy of the parent's chromosomes. Both daughters are genetically identical to the parent and are therefore clones of the original.

The asexual production of clones is also common in horticulture. The type of cloning my mother was doing simply involves sticking twigs ('cuttings'), cut from plants she fancied when out for a stroll, into the ground. The cutting takes root and grows into a new plant identical to the plant of which it was once but a twig.

Asexual reproduction can also take place in multicellular animals. The more primitive the animal, the more likely it is to be capable of asexual reproduction. For example you could cut a sponge or a flatworm into small parts, and each part, if kept in its usual environment, will grow into a complete organism. These new organisms can be considered to be clones of the original.

Many insects, including bees, wasps and aphids, also commonly produce clones of themselves. Technically this is classified as a form of sexual reproduction, because a sex cell, the egg, is involved. However, the process differs radically from the usual form of sexual reproduction seen in higher animals.

This special process in insects is called parthenogenesis. In aphids, an unfertilised egg cell containing only a half-set of chromosomes develops into an embryo, and subsequently into an adult insect, without the assistance of any sperm cell. The egg's half set of chromosomes duplicates itself to produce a full set, the egg divides and continues to divide to become a fully developed organism. All of the chromosomes in the new organism come from the female parent. Again we are dealing with a form of cloning.

I once heard a well-known Irish feminist declare at a public meeting - 'we (women) don't need men; we can have children by parthenogenesis'. She may have been joking, but she sounded serious. If she was serious, she could scarcely have made a nastier statement.

Could a woman conceive by parthenogenesis? I don't know the answer to this question. In most forms of life an egg requires activation by a sperm in order to start dividing and to develop into an embryo. However, in several cases it has been shown that it is possible to spark this activation experimentally and to obtain parthenogenetic reproduction. For example, sea-urchin eggs can be stimulated to divide by placing them in strong salt water. Frog eggs have been stimulated similarly by pricking them with needles. There is a report that rabbit eggs were also successfully stimulated in this manner. A certain breed of white turkeys produce eggs (unfertilised) that sometimes develop into embryos when incubated. Some of these embryos eventually hatch and go on to produce adults - turkeys without fathers.

Conventional sexual reproduction is the norm for human beings and for most organisms that are at our generally level of complexity. Sexual reproduction is effected by the union of a sperm cell from the father with an egg cell from the mother. The new individual receives an equal amount of genetic material from each parent.

The genetic material, genes, resides on the chromosomes, located in the nucleus of the cell. Our bodies are composed of cells of 2 types - somatic cells and germ cells. The somatic cells make up our tissues - muscle, kidneys, liver, etc. The germ cells are involved in procreation - sperm cells in the male, and egg cells in the female. Somatic cells contain 23 pairs of chromosomes, one set coming originally from the father and the other set from the mother. Somatic cells increase in numbers by each dividing into two and, in this way, tissues grow and maintain themselves. Prior to somatic cell division (mitosis) the chromosomes duplicate themselves and each daughter cell receives the full complement of 23 pairs of chromosomes. On the other hand when germ cells are formed, each cell receives, not 23 pairs, but 23 individual chromosomes. Union of the sperm with the egg restores the somatic situation of 23 pairs of chromosomes in the fertilised egg. The subsequent development into an adult consisting of billions of cells is effected by countless cell divisions beginning with the first division of the fertilised egg cell. Each somatic cell in the body contains the same 23 pairs of chromosomes which constitute the entire genetic blueprint of the organism.

Cells of different tissues in the body look different from each other and perform different tasks, even though every cell contains identical genetic information. The explanation is that these differentiated cells use only part of the entire genetic blueprint information. Parts of the blueprint not in use in a particular tissue are switched off.

Since an ordinary somatic cell has identical genetic information to that in the original fertilised egg, biologists have long wondered if it is possible to trigger a somatic cell to develop into a whole new organism - into a clone of the parent cell? Many attempts have been made over the years to achieve such cloning, and with some success.

The phenomenon of parthenogenesis shows that the environment within the egg can trigger a programme of development in the chromosomes that results in the eventual formation of an adult organism. In attempting to clone an organism from a differentiated somatic cell, the approach has been to extract the nucleus from such a cell, remove the nucleus from an egg cell and replace it with the nucleus from the differentiated somatic cell, and hope that the egg cell environment would trigger the developmental programme. Success has been achieved in this manner in cloning tadpoles. However, not until Dolly was there ever a success in triggering the chromosomes from a somatic cell from an adult mammal into a full developmental programme. Dolly was cloned from an udder cell taken from an adult sheep.

Although the cloning of Dolly was a landmark achievement in the history of biology, we do not yet know how successful the process is. In the meantime Dolly the clone successfully mated in the normal manner with a ram and gave birth in the normal manner to her own lamb Bonnie. However we must still wait to see if Dolly will live out a normal lifespan in a normal manner. She was 'born' of adult somatic DNA that bore the normal 'wear and tear' characteristic of such material. Analysis of Dolly's DNA has recently shown that in terms of 'wear and tear' it is several years older than Dolly's chronological age.

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