6.2 Animal cloning

Artificial clones in animals, and a comparison of reproductive and non-reproductive cloning

In animals, only embryonic **totipotent** stem cells are capable of differentiating into any cell and producing a new individual. They are capable of specialising into any type of adult cell from the organism, and can switch on or switch off certain genes present in the *genome* (as no body cell requires the entire gene set to be switched on).

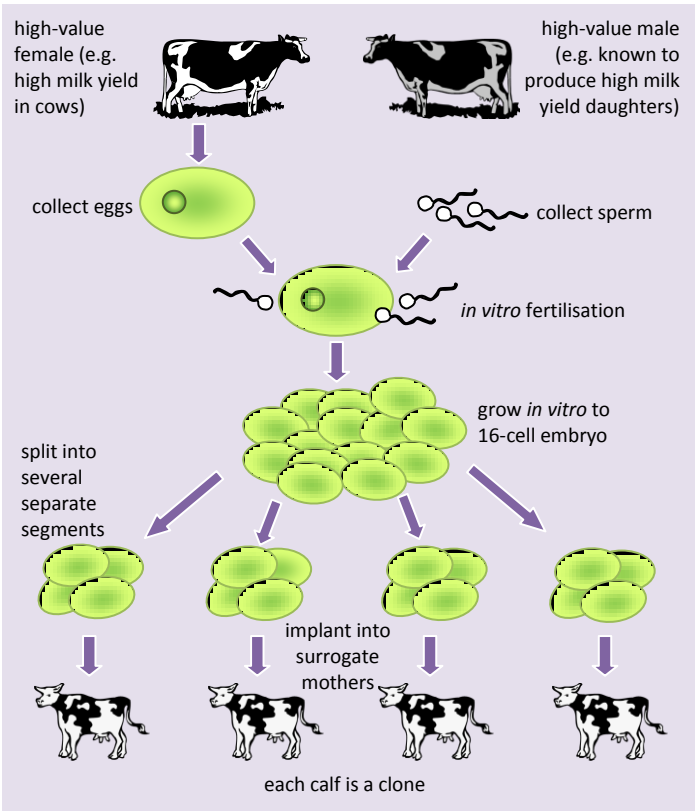
There are two methods of artificially cloning animals, as discussed below. A **cloned** animal is one that has been produced using the same genetic material as another animal. Such an animal shares the same *genotype* as the donor organism.

Embryonic division

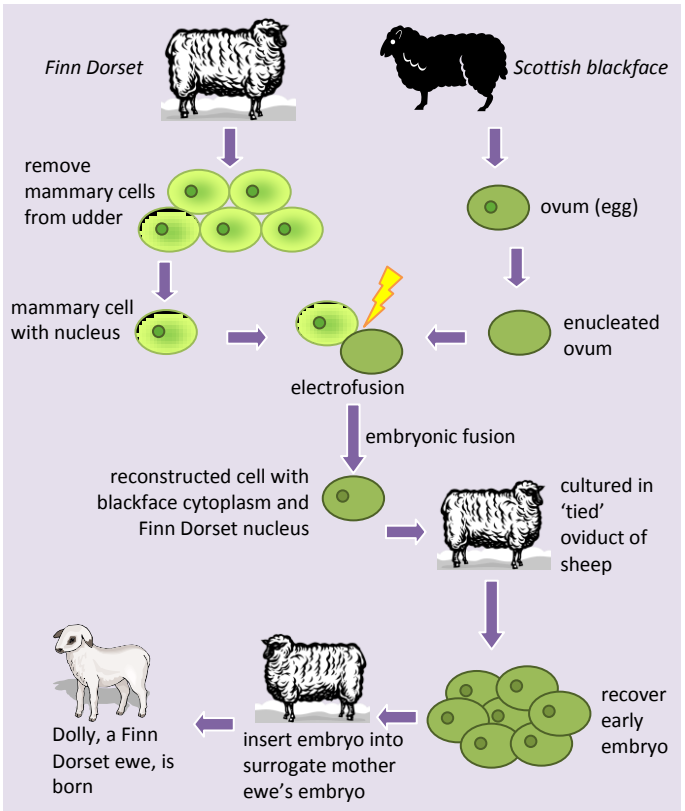
The first method involves the splitting of the embryo to create 'artificial identical twins'. Cells from a developing embryo can be separated out, with each one then going onto produce a separate (but genetically identical) embryo itself. This method was developed some 40 years ago, and has been successful in cloning sheep, cattle, rabbits and toads, and in 2000 the first primate (Tetra, a rhesus monkey) was cloned in this way.

Somatic nuclear transfer

By transferring a nucleus from a cell into an egg cell which has had its own nucleus removed (**enucleated**), an egg can go on through the stages of development using genetic information from the inserted nucleus. The first animal to be cloned in this way, rather famously, was Dolly the sheep in 1996. The cell was taken from the **mammary gland** from the udder of one sheep and its nucleus removed and transferred into the enucleated cell of another sheep, and then inserted into the uterus of a third sheep, and then finally a fourth to fully develop. Dolly was the one and only success of 277 attempts.



▲ Cloning by embryonic division



▲ Cloning by somatic nuclear transfer

Reasons for cloning animals

Advantages of animal cloning are obvious: the reproduction rate of genetically superior animals increases; the number of animals with a wanted trait rise; the cloned embryo can be sexed or tested for certain diseases before implantation into a surrogate mother; and a fertile female of an endangered species is not needed for somatic nuclear transfer.

Of course, the major drawback is the ethical issues concerned with the cloning of animals (discussed later on in the unit).

Non-reproductive cloning

What you have read so far of animal, and plant, cloning has all been '**reproductive**' **cloning** which involves generating new organisms. However, **non-reproductive cloning** involves using cloned cells to produce new cells, organs and tissues, and this is a field of research which is very recent and shows promising signs of contributing to society when techniques have been developed. This would be able to help repair damaged tissues and organs, such as:

- regenerating heart muscle cells following a heart attack
- repairing nervous tissue destroyed by diseases such as multiple sclerosis
- repairing the spinal cords of those paralysed by an accident that resulted in a broken back or neck

There are numerous advantages of using cloned cells for non-reproductive cloning:

- ✓ cells are taken from the same organism as they are donated too – genetically identical and so no chance of rejection
- ✓ could mean an end to the long donor organ waiting lists that exist currently
- ✓ cloned cells are totipotent and so could be used to generate any adult organism's cell type
- ✓ using cloned cells is likely to be less dangerous than major surgery