

Previous Class

Why animal experiments ?

Model animals used

Phases in testing a new product for human

Regulations of animal research

Animal Cloning



Dolly and her surrogate mother.

Why Clone Animals?



Five genetically identical cloned pigs.

To answer questions of
basic biology

For herd improvement.

For pharmaceutical
production.

To satisfy our desires (e.g. pet
cloning).

Is Animal Cloning Ethical?



The first cloned horse and her surrogate mother/genetic twin.

As with many important questions, the answer is beyond the scope of science.

USU's Contribution – A Cloned Mule and the First Cloned Equine

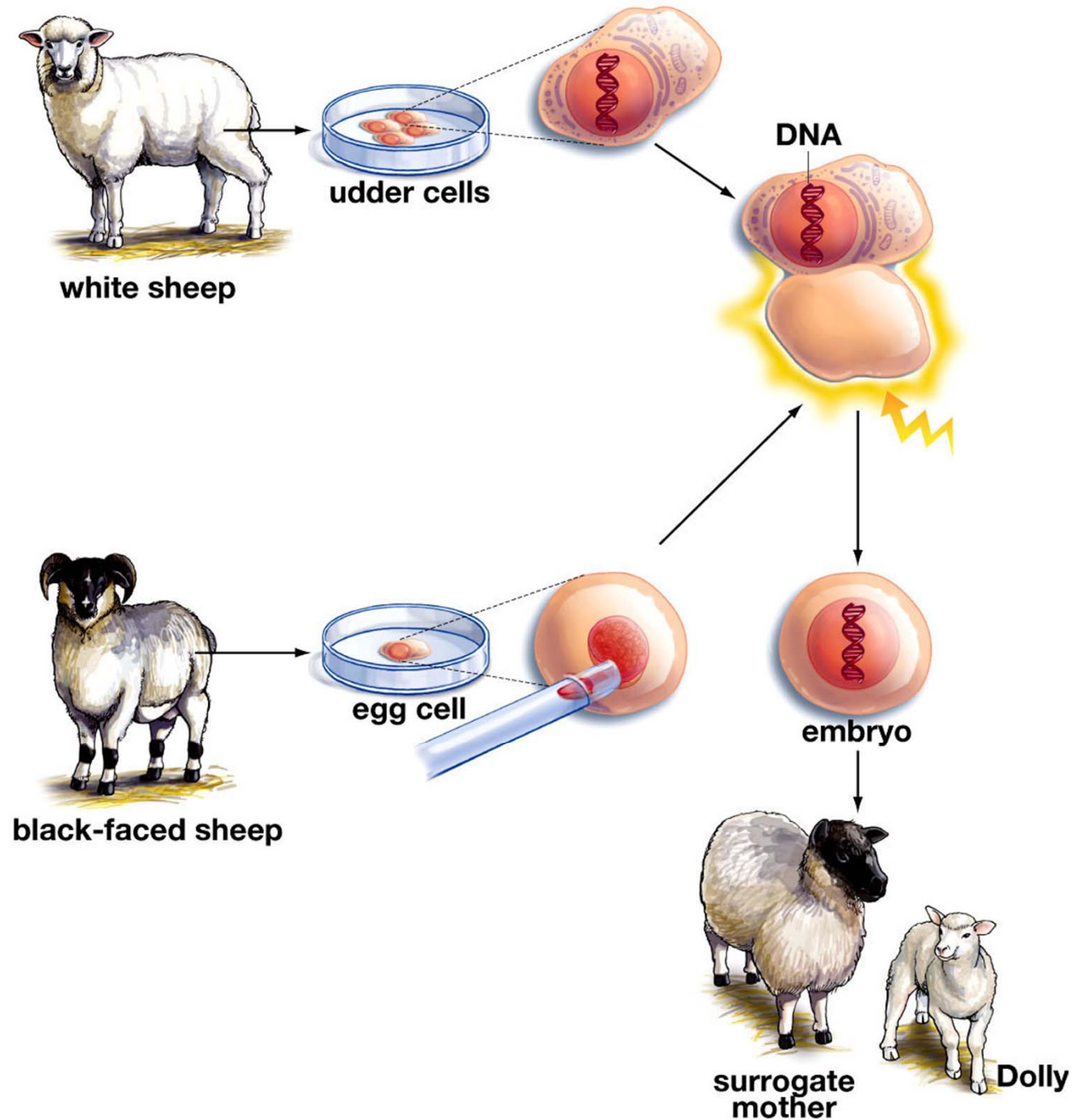
A **mule** is the offspring of a male [donkey](#) and a [female horse](#).^[1] Horses and donkeys are different species, with different numbers of [chromosomes](#).



The Biotechnology of Reproductive Cloning

Even under the best of circumstances, the current technology of cloning is very inefficient.

Cloning provides the most direct demonstration that all cells of an individual share a common genetic blueprint.



Saved by Cloning?

Siberian “ibex”

Some are firm believers while many view these approaches to be more of a stunt.

Note the use of a closely related species, a domestic goat, as egg donor and surrogate mother.



FIGURE 15.8 Endangered and Cloned The animal on the right, a Siberian ibex, was cloned from an adult ibex, but the egg cell used in the procedure was donated by a common goat like the one at left. The goat in the picture served as the surrogate mother in the procedure, giving birth to the ibex in 2004.

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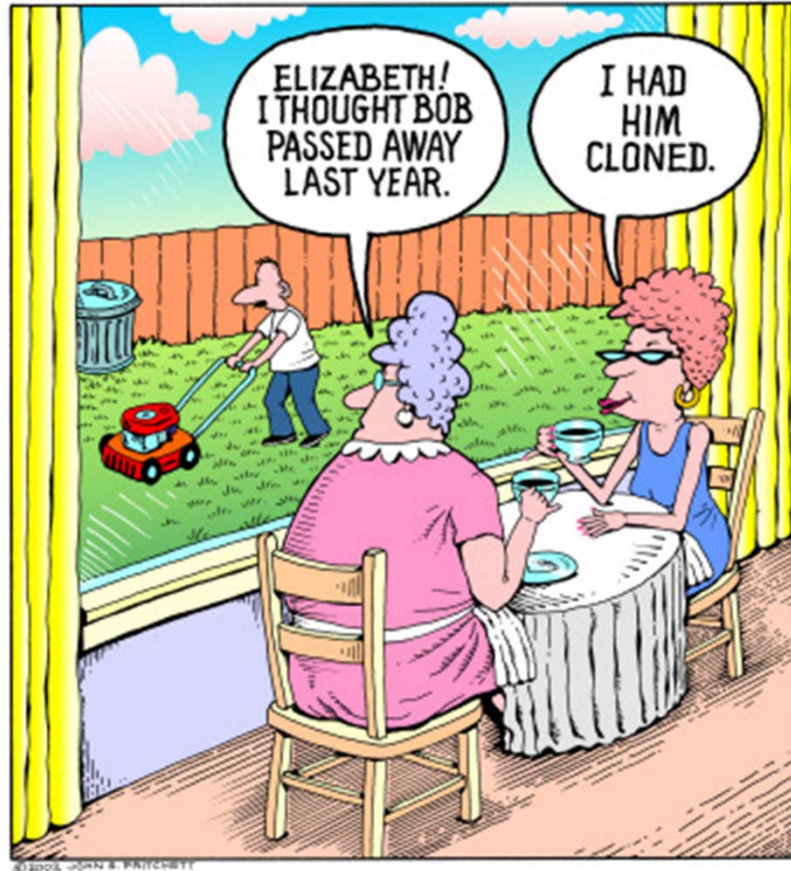
Carbon Copy– the First Cloned Pet



(Science (2002) 295:1443)

Significantly, Carbon Copy is not a phenotypic carbon copy of the animal she was cloned from.

The Next Step?



Highly unlikely.

Attempts at human cloning are viewed very unfavorably in the scientific community.

- Embryo twinning (conventional approach)
 - splitting embryos in half to produce artificially created twins
 - commonly practiced in cattle industry today
 - limitation is that organisms being copied is unknown
 - you may or may not end up with an animal that has the desired characteristics and you have to wait until the animals is full-grown to find out.
- Dolly was created from an adult cell-not an embryo
 - Dolly was an exact copy of an adult with known characteristics.
 - How is this done?

Creating a Clone from an Adult

- DNA from donor cell must be inserted into an egg
- Egg is prepared by enucleation
 - Pipette suctions out the nucleus
- DNA from donor cell put into egg cell
- Embryo is transferred to a surrogate mother for gestation
- Sheep, pigs, goats, cattle, and a gaur have been cloned

Cells collected from donor animal and put in a culture medium that keeps them alive but prevents their replication and stops gene expression.

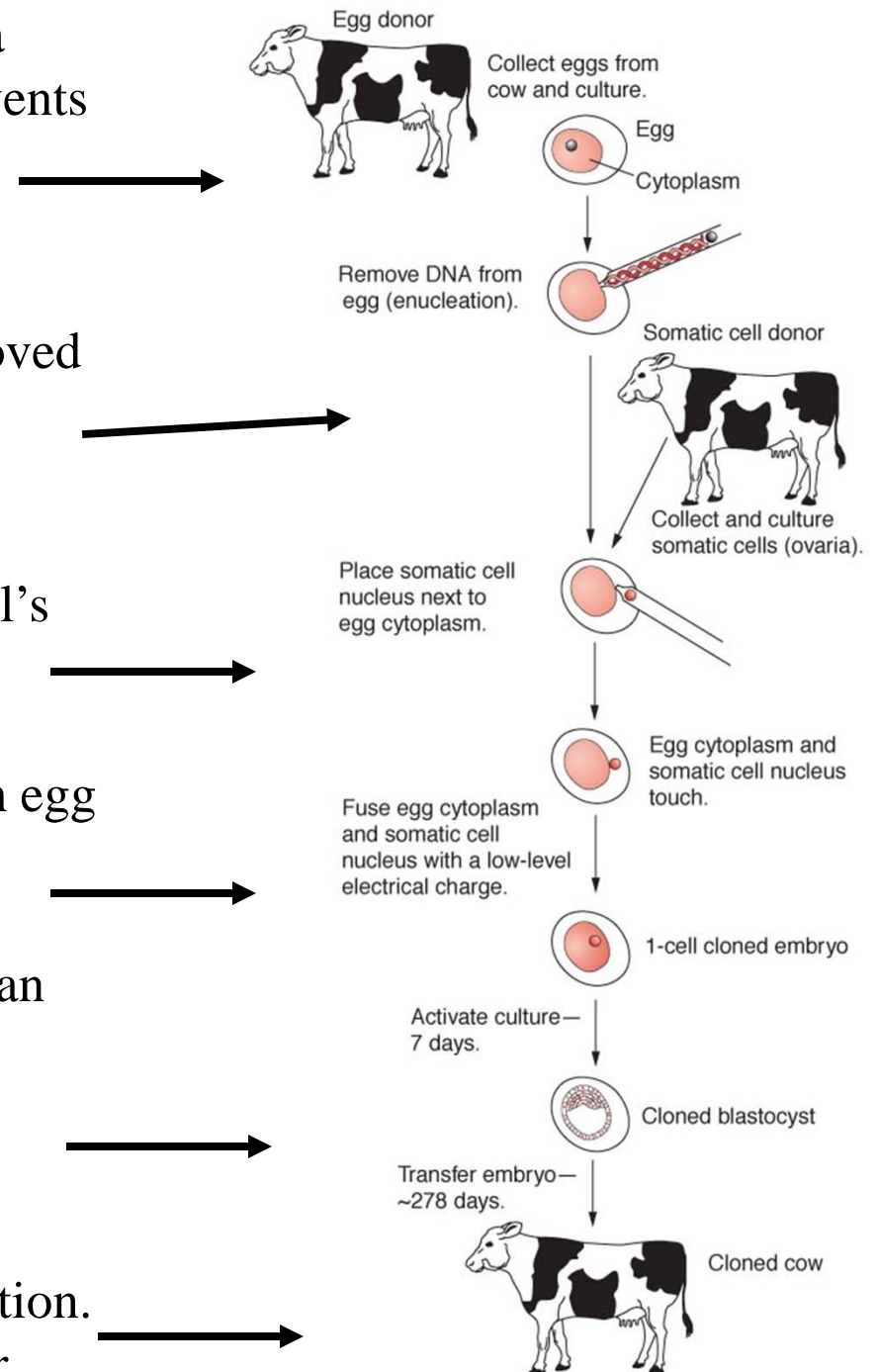
Egg of an animal has its nucleus (DNA) removed (enucleation)

Nucleus of cultured somatic cells from donor animal are then inserted into a recipient animal's egg next to its cytoplasm.

Apply low-level electric charge and fuses with egg cytoplasm to produce a 1-cell cloned embryo.

New cell containing egg behaves as if it were an embryonic cell rather than an adult cell. Cell division occurs just as it would in an ordinary fertilized egg.

Transfer embryo to surrogate mother for gestation. Newborn will be genetically identical to donor



Successfully cloned species

- Sheep
- goat
- pig
- cow
- endangered cow (gaur)
- house cat

Limits of cloning

- Donor cell must come from a living cell
- Success rate is still low
 - Dolly was successful only after 277 failed attempts
 - only 29 implanted embryos lived longer than 6 days
 - Many clones are born with defects
 - kidney problems
 - diabetes
 - crippling disabilities
 - old before their time-telomere length
 - Dolly was diagnosed with arthritis -premature aging?
 - Clones are not exactly identical
 - Shaped by experiences and environments

Cloning as a means of producing replacement body parts?

- Idea is to reduce chance of cloned tissue from being rejected by original “parent”.
- It would take years for clone to produce the organs to be used for transplant

Benefits of Cloning

- Reduce variability of responses of a population being used to test new drugs, etc.
 - avoids confounding factor of different genetic predispositions
- Preservation of endangered species
 - cloning pandas using common black bear as surrogate host.
- Reduce time to produce new breeds of farm animals
 - from 6-9 years → 3 years

The Future of Cloning

- Still a young science and subject to much experimentation
- Not a practical solution to transplant organ shortages
 - Profound ethical questions
 - Would take years for clone to be mature enough to donate organs

The Future of Cloning

- Clones can be used in medical research where their identical genetics makes it easier to sort out results of treatments
- Clones may provide a unique window on the cellular and molecular secrets of development, aging, and diseases
- Clones could sustain breeding population of endangered species
- Cloning can be used to directly improve agricultural production