Animal Biotechnology

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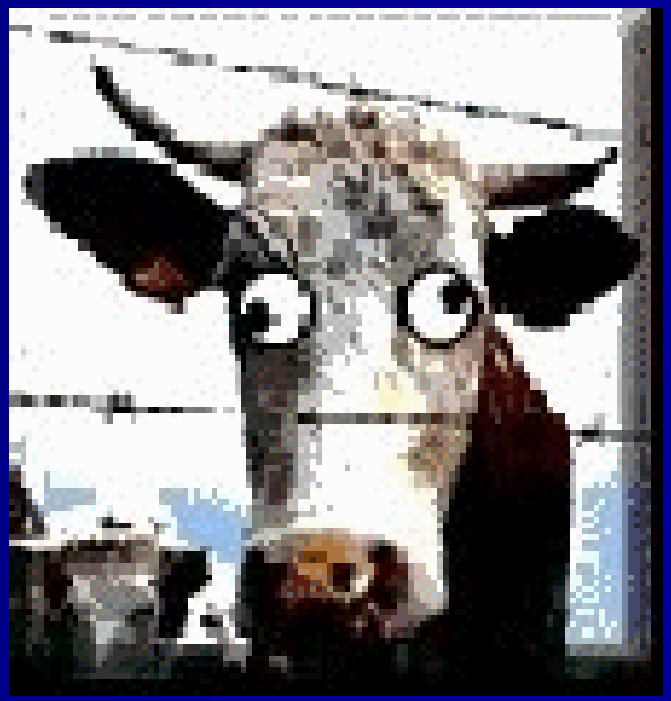
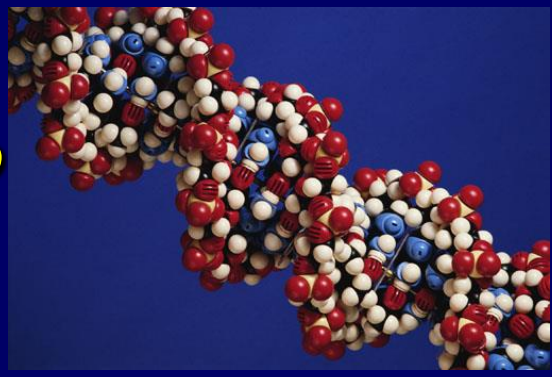


http://animalscience.ucdavis.edu/animalbiotech/

What is Biotechnology ?



Biotechnology - The application of science and engineering to living organisms.

Animal biotechnology

- Artificial selection (breeding programs)
- Artificial Insemination
- Embryo transfer
- Using DNA information for the marker-assisted selection of superior animals
- Cloning
- Genetic engineering

"The public opposes animal biotechnology.."

- The majority (56%) of Americans oppose scientific research into genetic modifications of animals.

http://pewagbiotech.org/research/2005update/2005summary.pdf

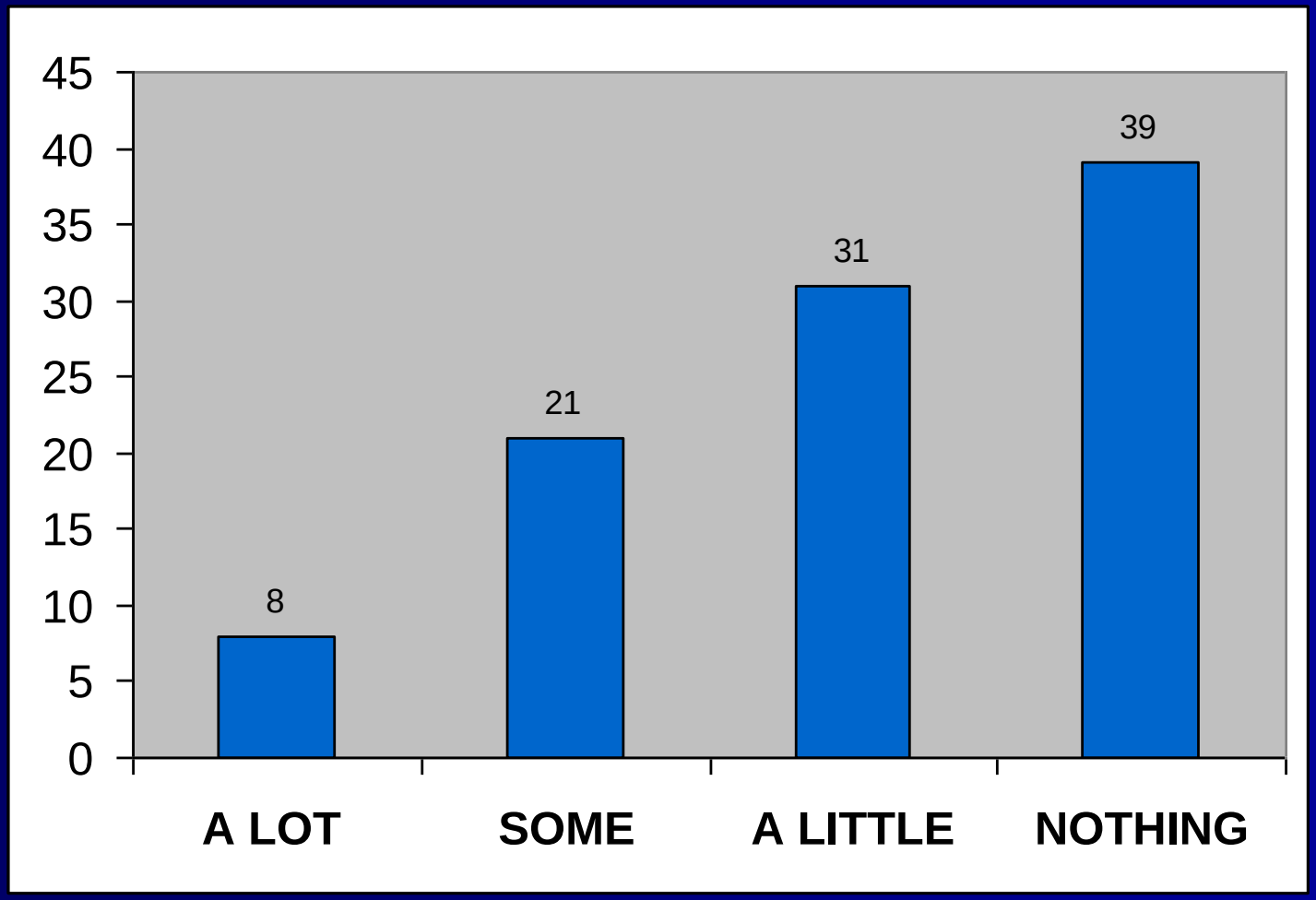
- In a survey of New Jersey consumers, Hallman found that two-thirds of respondents disapproved of traditional animal crossbreeding techniques and half found them "morally wrong".

Schilling, B. J., Hallman, W. K., Adelaja, A. O., and Marxen, L. J.2002. *Consumer Knowledge of Food Biotechnology: A Descriptive Study of U. S. Residents*. Food Policy Institute, Cook College, Rutgers - The State University of New Jersey. 25p. http://www.foodpolicyinstitute.org/

Genetically-modified pet animals

Public Attitude Towards Biotechnology

How much have you heard about animal biotechnology ? (IFIC, 2004)

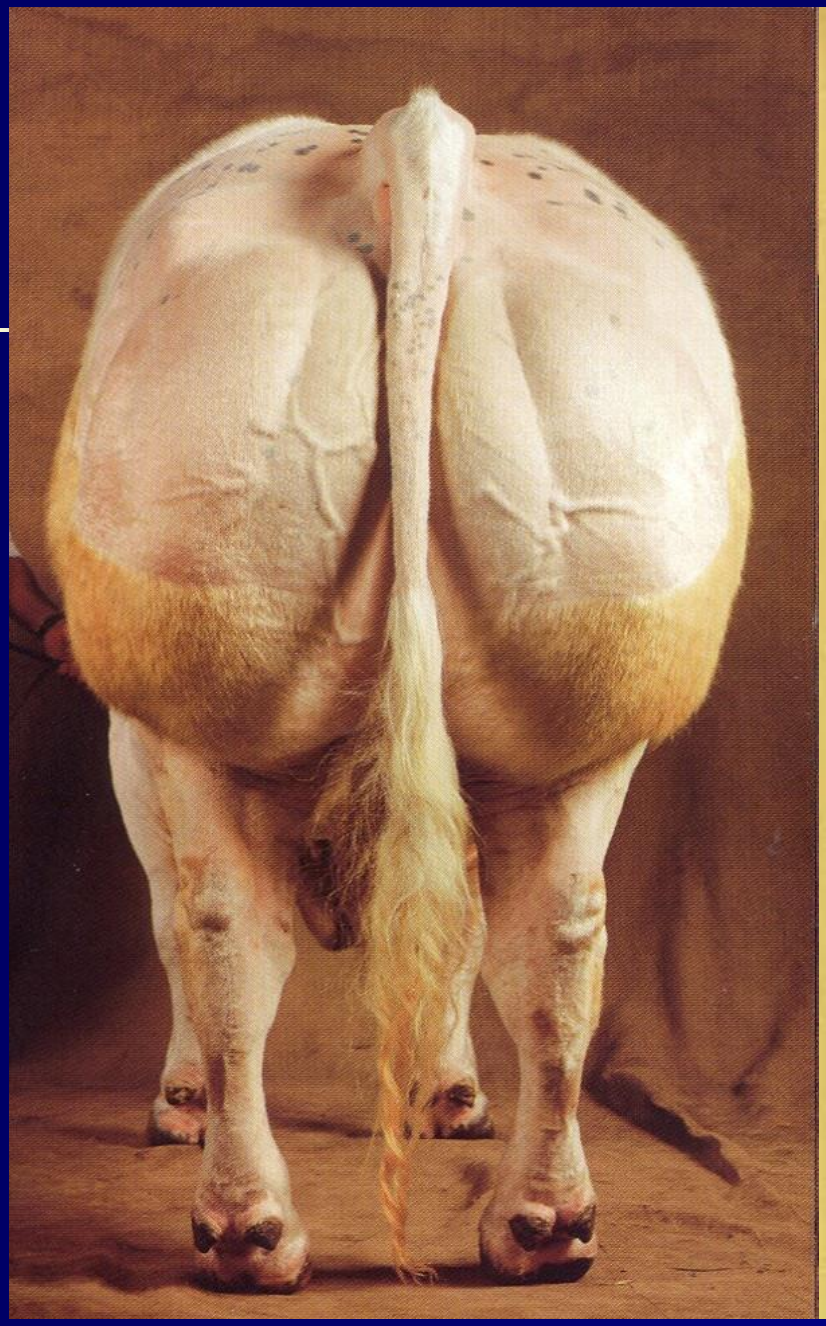


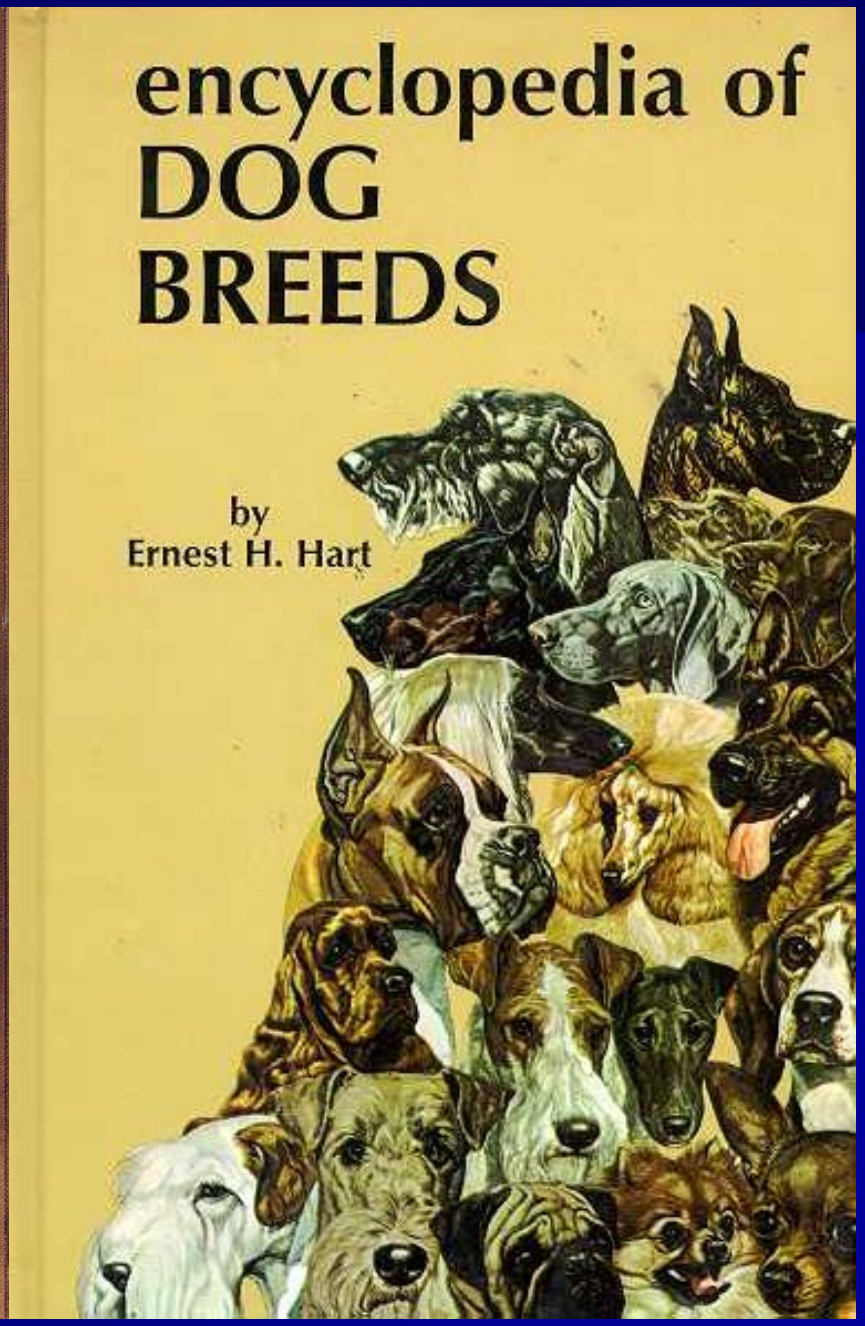
http://ific.org/research/upload/2004-Biotech-Consumer-Research.pdf

"I know it when I see it"

Of the 22% of people who say they know nothing about biotechnology, genetic engineering or genetic modification; almost half (46%) disapprove of the use of genetic modification to create plant-based foods, and 66% disapprove of animal-based genetic modification.

Hallman, W. K., Hebden, W. C., Aquino, H.L., Cuite, C.L. and Lang, J.T. 2003. *Public Perceptions of Genetically Modified Foods: A National Study of American Knowledge and Opinion.* Rutgers - The State University of New Jersey.




encyclopedia of
DOG
BREEDS
by
Ernest H. Hart

Animal biotechnology

- Artificial selection (breeding programs)
- Artificial Insemination
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OUTLINE

- What is a clone ?
  - Embryo splitting
  - Nuclear transfer
    - Embryo
    - Adult
- What are the concerns ?
  - Food Safety
  - Animal Welfare and Ethical Issues
- Public Opinion

What is a clone ?

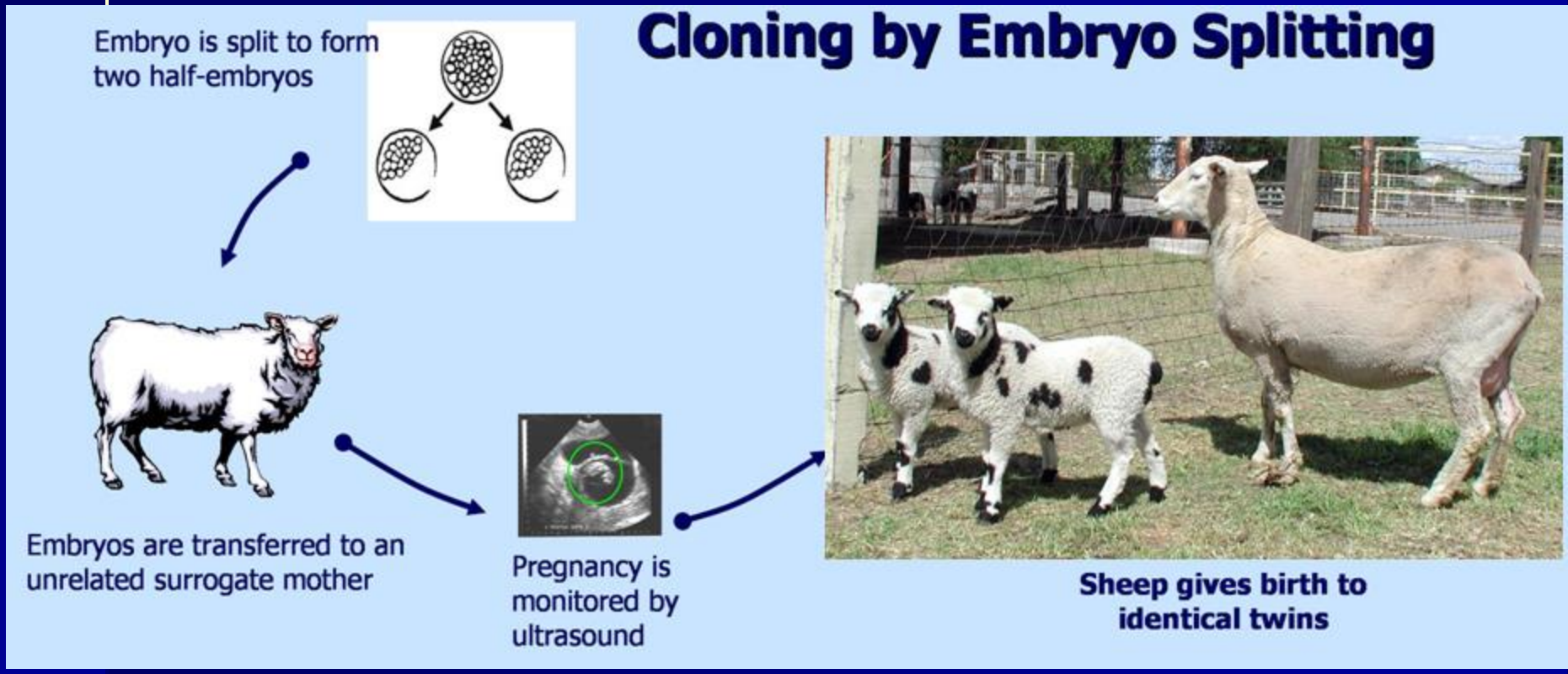
- Cloning, in horticulture and biology, any organism whose genetic information is identical to that of a "mother organism" from which it was created.
- Food from clones has been a part of our diet for years. Many common fruits (e.g., pears, apples, oranges and lemons) and several vegetables (e.g., potatoes and truffles) are clones.

What about cloned animals?

- Holstein Association USA (Brattleboro, VT) first registered clones from embryo splitting (ETS) in 1982 and clones from embryo nuclear transfer (ETN) in 1989.
- Most of us have probably ingested meat and dairy products from livestock cloned by natural reproduction (monozygotic siblings), mechanical embryo-splitting, or even nuclear transfer from an embryonic donor cell into an enucleated oocyte.

Cloning by "natural reproduction" (monyzgotic twins)

Mechanical embryo splitting



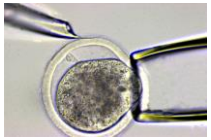
The Holstein association of America has registered 2319 embryo split clones (ETS) through October 2002 – probably the most widely recognized were DUPLICATE and DIVIDE.

Nuclear transfer from an embryonic donor cell into an enucleated oocyte.

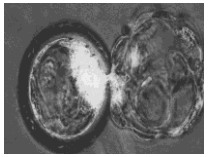
Embryo Transfer Laboratory

Donor Embryo

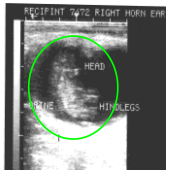
Transfer at UCDAVIS



Donor cell nucleus is transferred to recipient egg



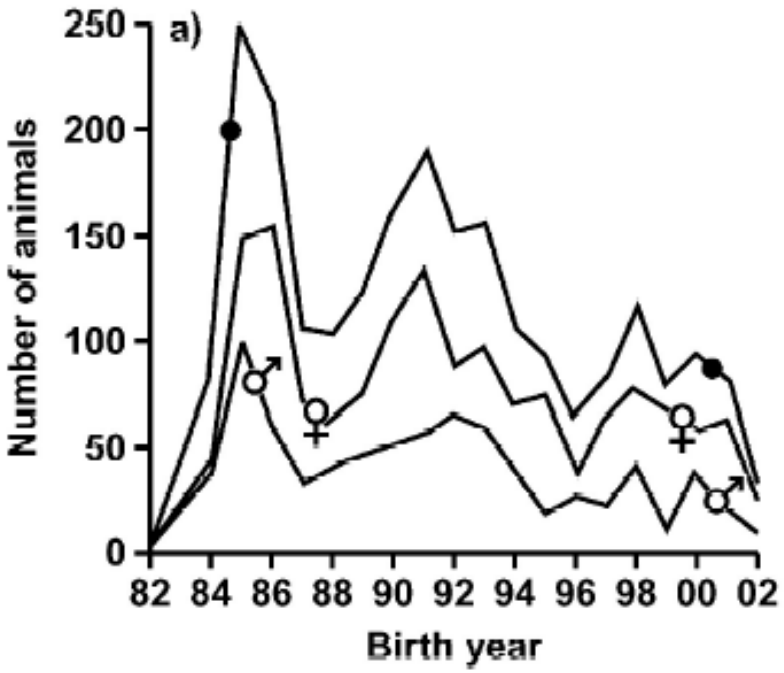
Cloned embryo is transferred to surrogate mother



Pregnancy is monitored by ultrasound

Holstein Association USA first registered clones from nuclear transfer in 1989

Cattle clones have been in US population since early 80s*



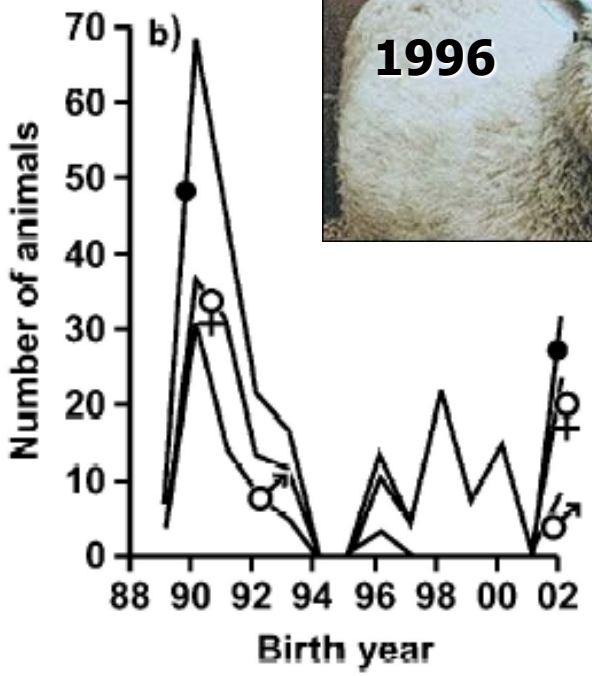
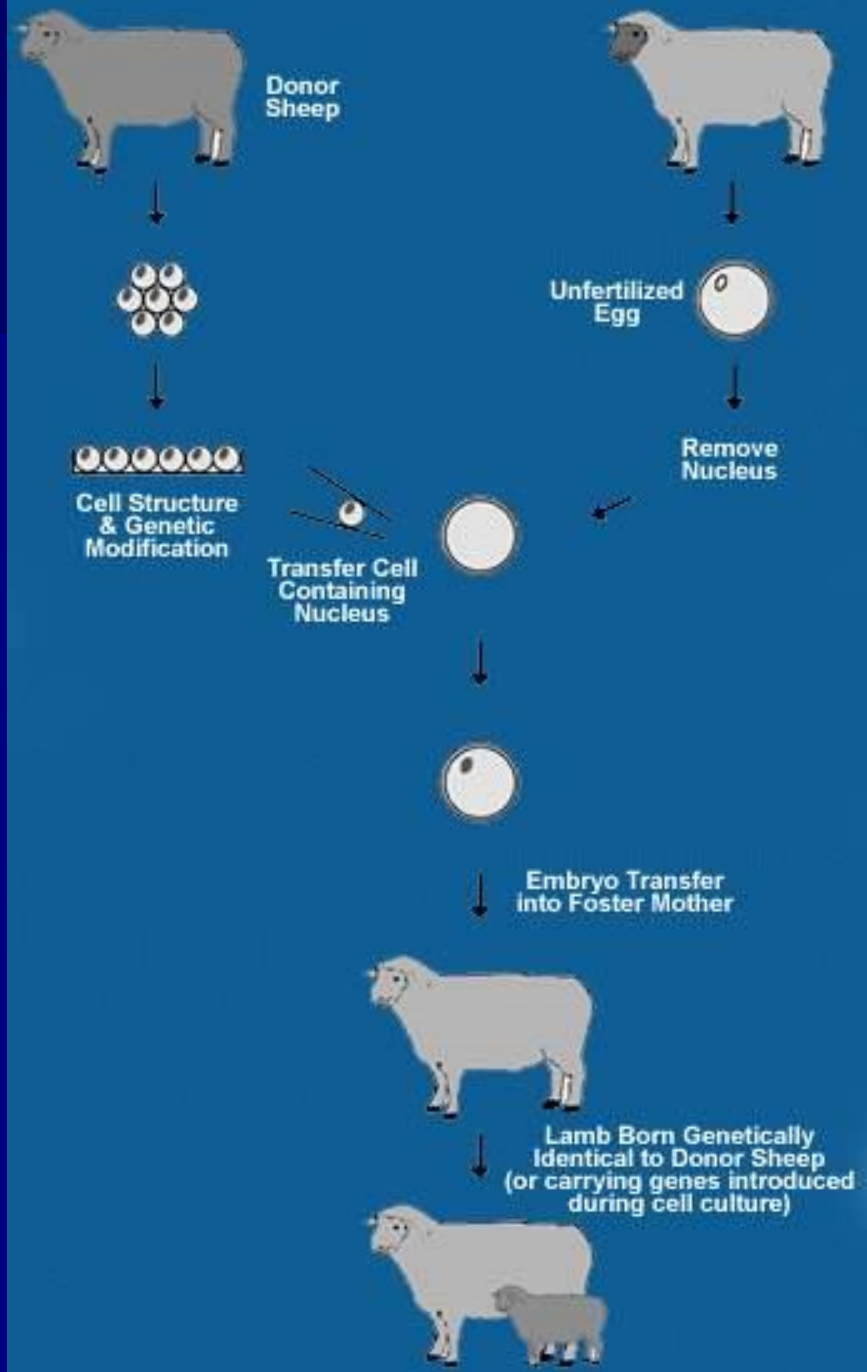


Figure 1. Numbers of registered US Holsteins resulting from a) embryo splitting or b) nuclear transfer by gender (all animals: ●, males: ♂, females: ♀) and birth year.

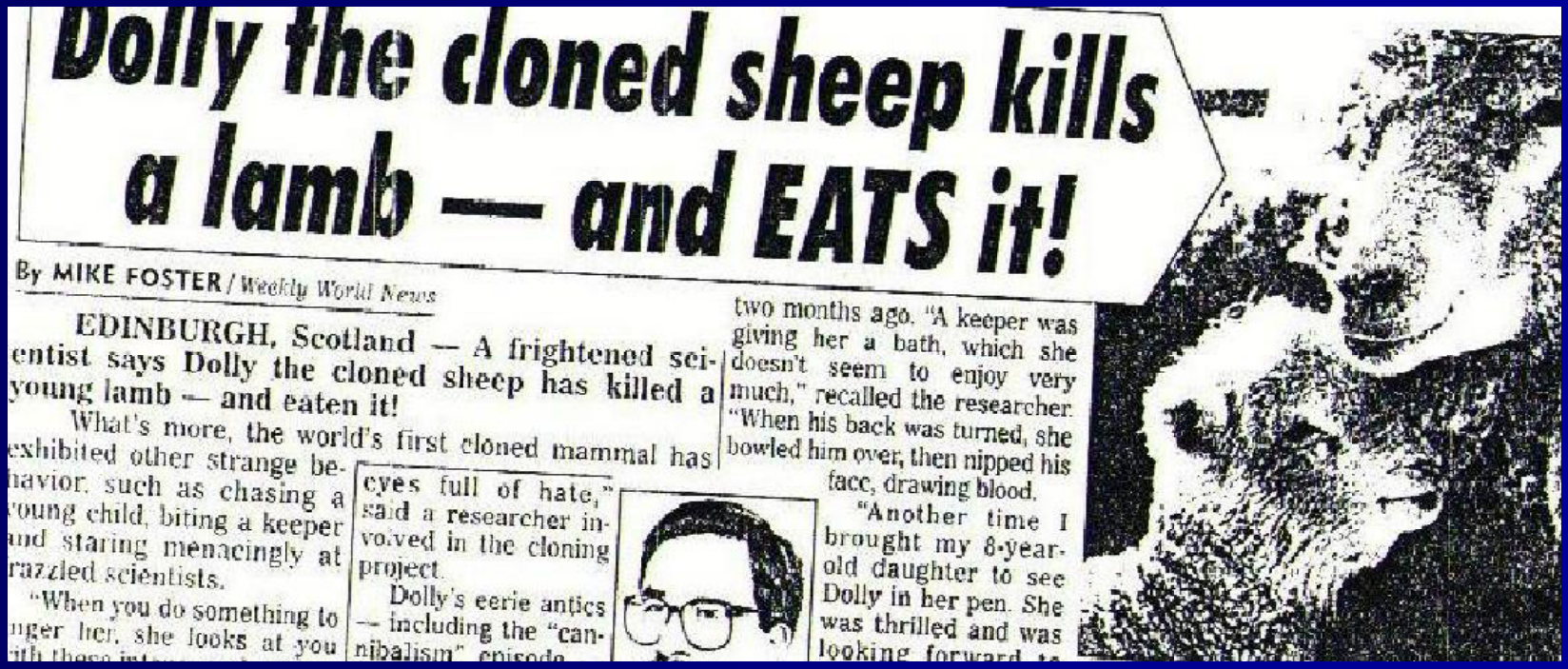
*Norman et al. Performance of Holstein Clones in the United States J. Dairy Sci. 2004. 87:729-738

Dolly (1996), the first adult somatic cell nuclear transfer (SCNT) clone



Cloning rapidly became entangled with the debate over human cloning

Ensuing discussion failed to elaborate on the reasons as to why cloning was developed



Dolly the cloned sheep kills a lamb — and EATS it!

By MIKE FOSTER / Weekly World News

EDINBURGH, Scotland — A frightened scientist says Dolly the cloned sheep has killed a young lamb — and eaten it!

What's more, the world's first cloned mammal has exhibited other strange behavior, such as chasing a young child, biting a keeper and staring menacingly at razzled scientists.

"When you do something to nger her, she looks at you ith these

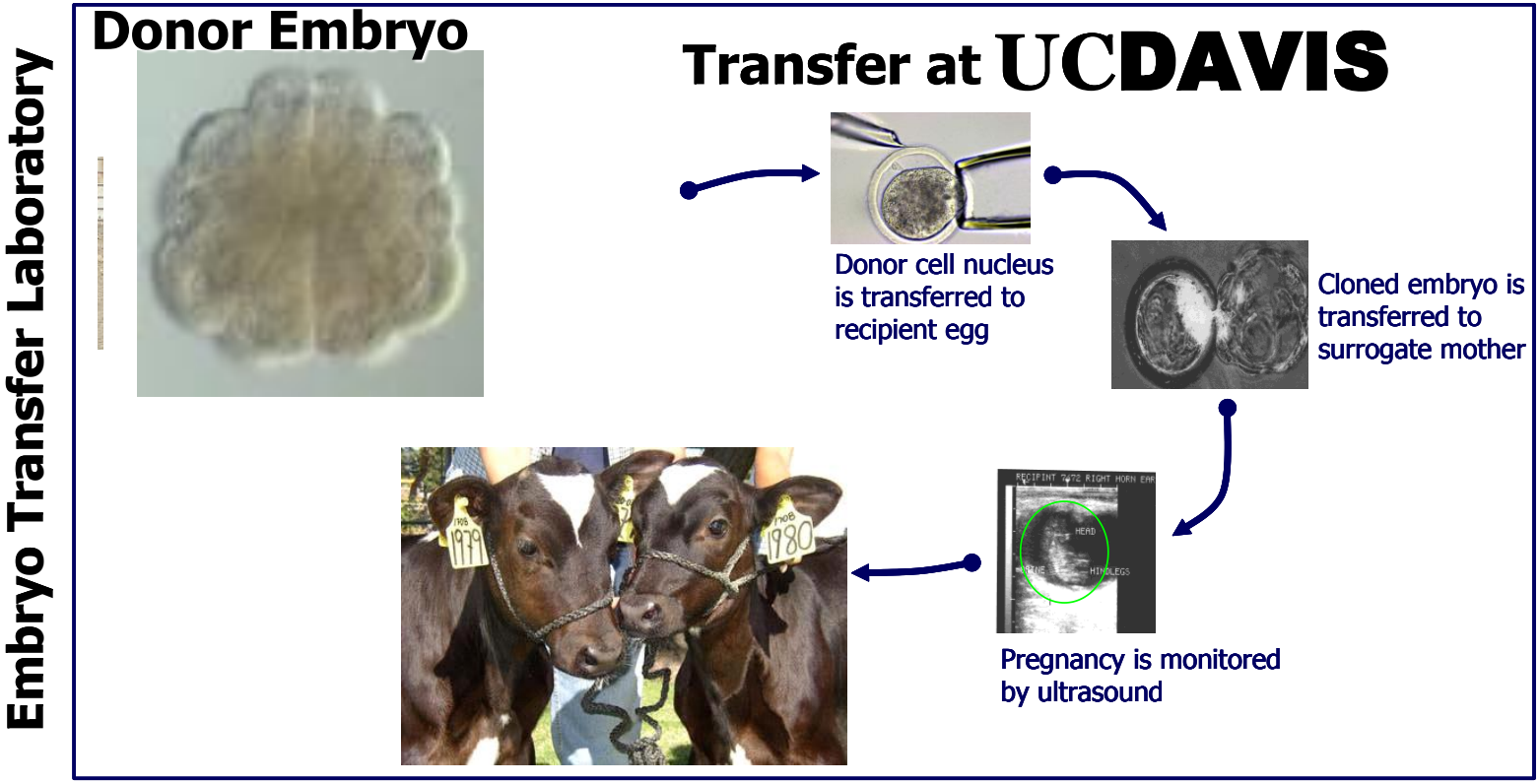
eyes full of hate," said a researcher involved in the cloning project.

Dolly's eerie antics — including the "cannibalism" episode

two months ago. "A keeper was giving her a bath, which she doesn't seem to enjoy very much," recalled the researcher. "When his back was turned, she bowled him over, then nipped his face, drawing blood.

"Another time I brought my 8-year-old daughter to see Dolly in her pen. She was thrilled and was looking forward to

Nuclear transfer from an adult donor cell into an enucleated oocyte.

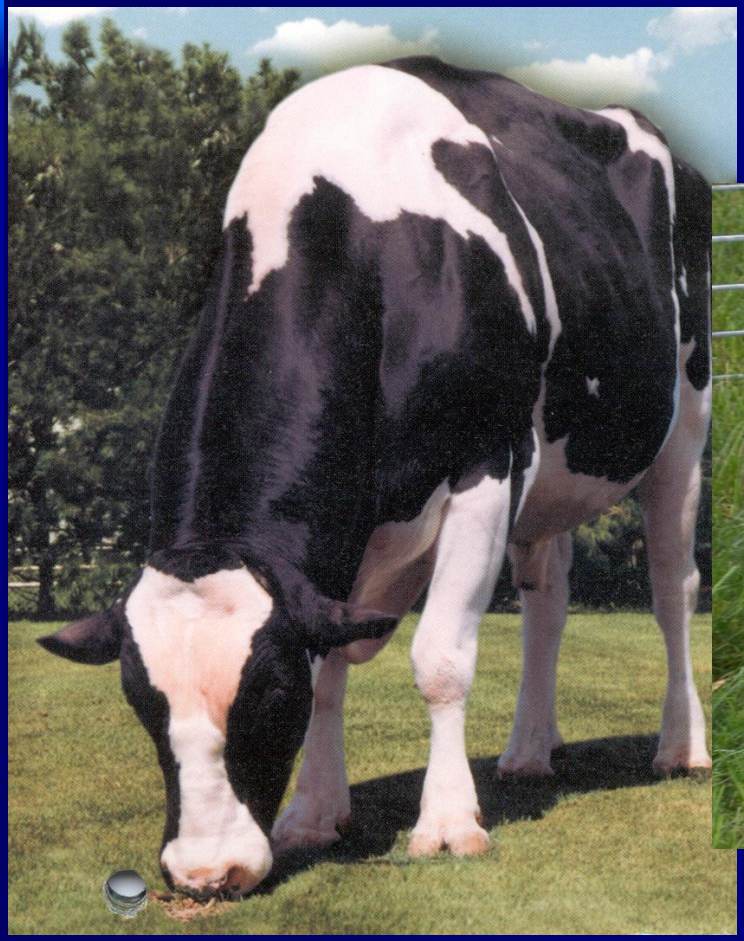


Many animal species have been since been cloned from adult cells

Who's Buying?

$20,000

Regancrest Emory Derry died unexpectedly.



Who's Buying?

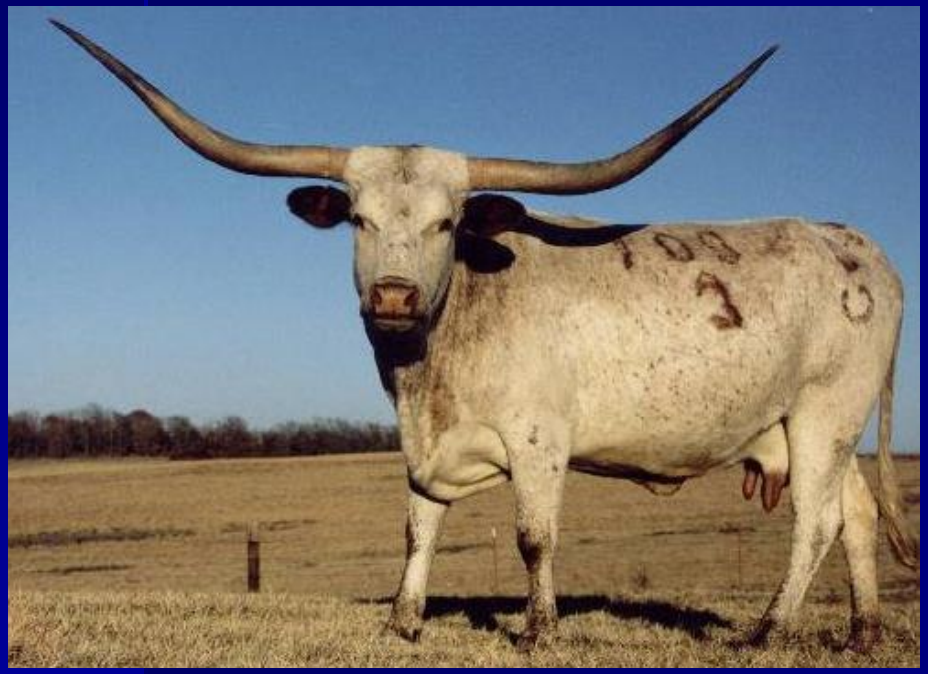
- **Full Flush**

  Unable to supply market demand for his semen

Who's Buying?

Specialty Cattle Producers

Starlight: record 77 inches 'tip to tip'



The FDA continues to call for a voluntary prohibition of the marketing of milk or meat from adult SCNT clones and their offspring

Are the milk and meat from SCNT clones safe for human consumption?

1. All studies have shown that food products derived from clones fall within normal industry standards or previously reported values for milk and meat.
2. Sample sizes are small in all studies – although there are an increasing number of studies published

FDA ASSESSMENT OF ANIMAL CLONING

"food products derived from animal clones and their offspring are likely to be as safe to eat as food from their non-clone counterparts, based on all the evidence available."

"Birth of cloned calf poses test for Europe's food safety regulations"

January 2007: The Food Standards Agency is seeking urgent legal advice after farmers announced the birth of a calf whose genetic mother is the clone of an American prizewinning dairy cow.

"Paradise"
A Supreme Champion

Cloning gives you the ability to realize the value of a truly great cow both from the breeding and merchandizing standpoint

Vandyk-K Integrity Paradise, the two time Supreme Champion at the World Dairy Expo, was an easy choice for her owners to clone. When you have an individual this good you need to have more copies of her to realize her true value. Cashing in on her value is just what they did when they sold a Paradise clone for $50,000. The merchandising options you get from cloning are just fantastic, because you still have the genetic material to work with.

Paradise's Clone Wins!!!

Paradise 2 Selected All-American Sr. 2 Year Old

What clones will be banned?

"Reacting to reports that a cloned cow from the United States has birthed a calf on a British farm, virtually all major British grocery chains have pledged to boycott meat from clones or their offspring.

Tesco, Wal-Mart's Asda chain, Morrisons and Marks & Spencer were among the chains participating in the boycott, which would include meat, milk or "anything else from clones or their offspring," according to an Asda spokesperson."

How can you test/trace/verify an identical copy?

Question to processors who plan to ban clones.....

Do you plan to monitor and prevent the milk and meat from clones created by embryo splitting and embryonic cell nuclear transfer from entering your processing chain?

Estimates for the prevalence of these clones currently in the food supply are difficult to find as these animals are not specifically tracked in any way.

If you plan to exempt these clones from your ban, then has better be more specific in your language and limit your claim to prohibiting only "adult somatic cell nuclear transfer" clones. The term "clone" encompasses more than that specific subset, and it may in fact include animals that are currently being used in your supply chain.

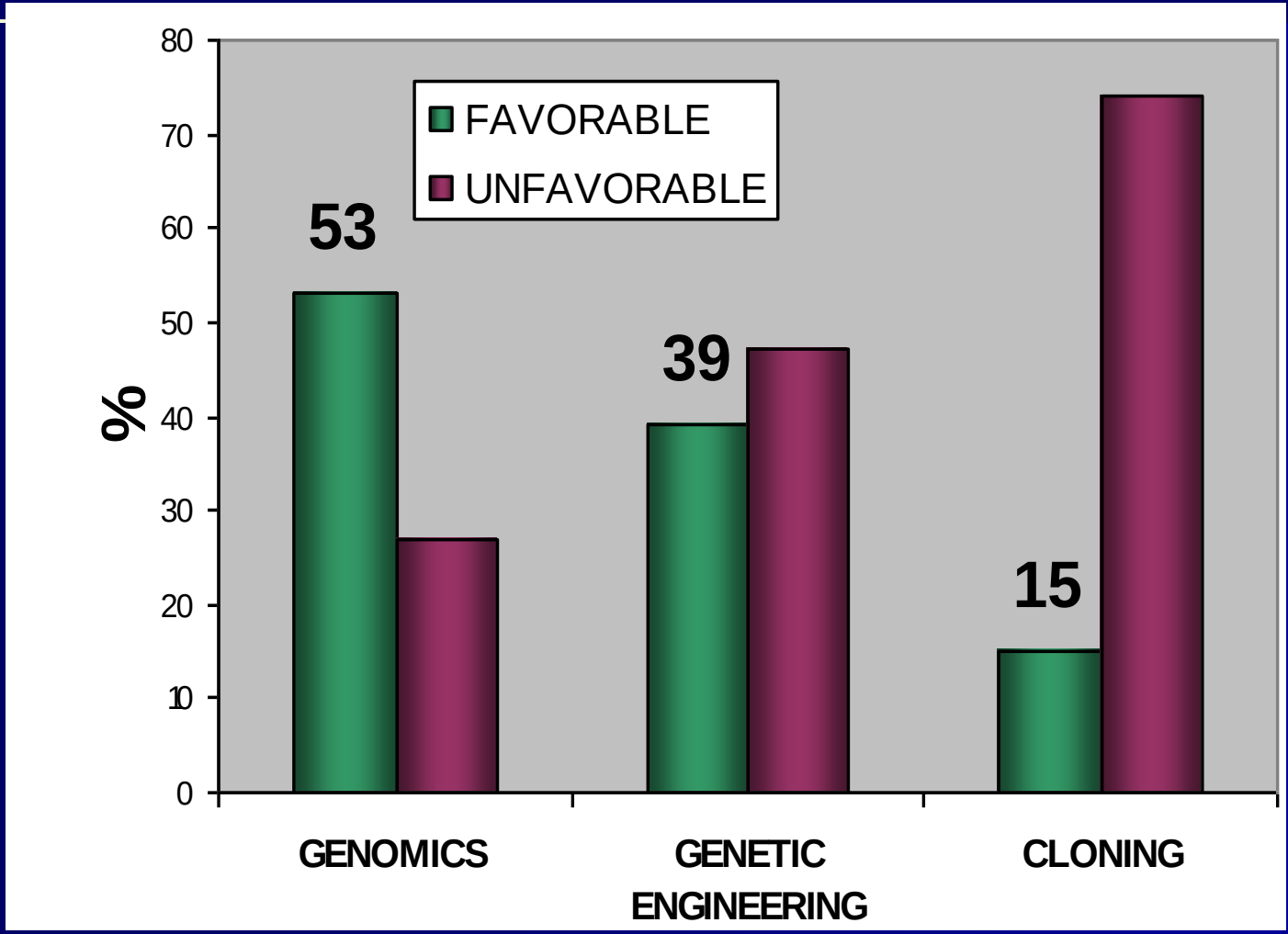
Animal Welfare Concerns

- Large calf syndrome
- Under-developed respiratory, cardiovascular, and renal systems

FDA ASSESSMENT OF ANIMAL CLONING

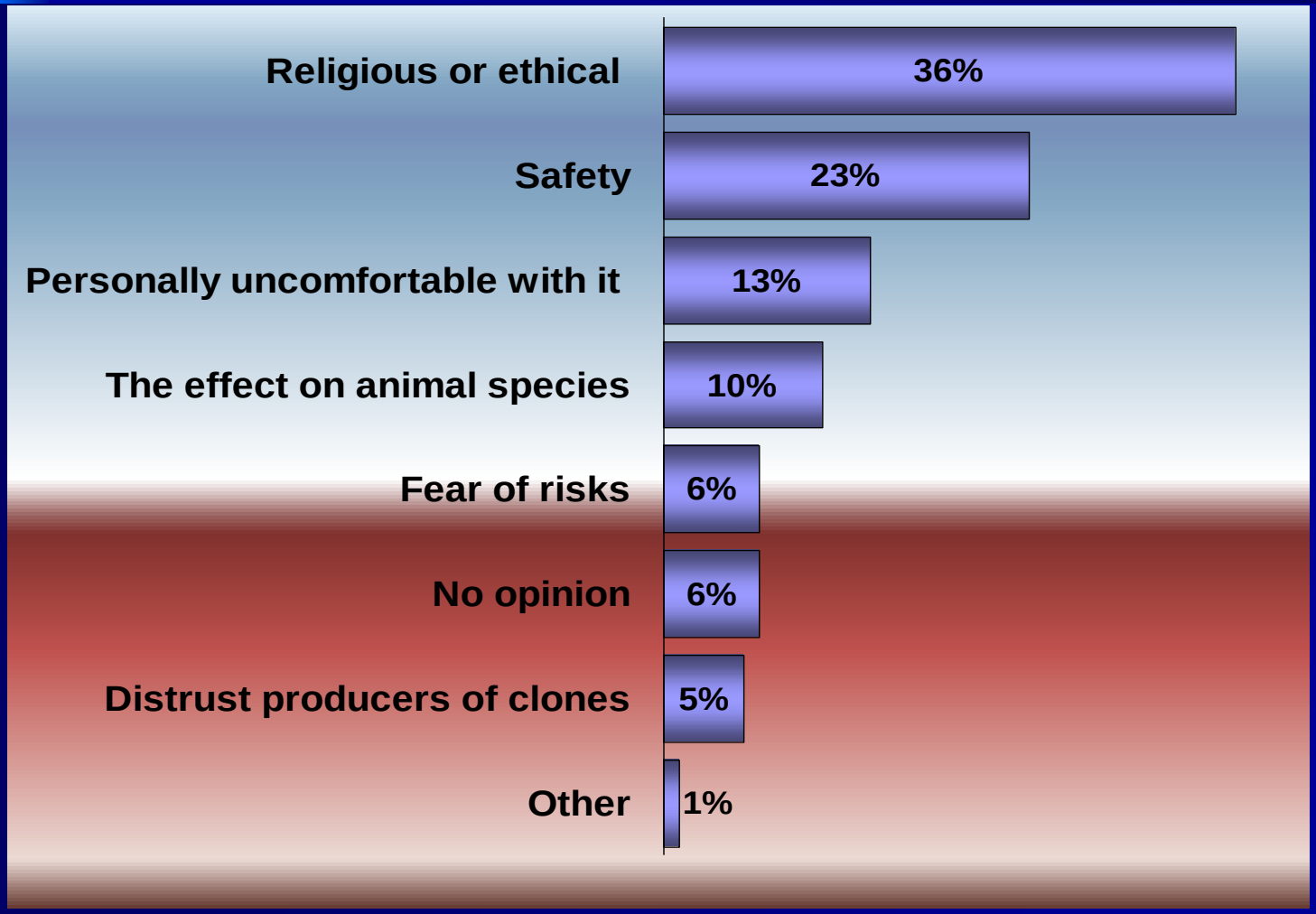
"Cloning technology does not present any type of risk that is not present with other forms of reproduction. However, the adverse outcomes may occur at a higher frequency with cloning than with other assisted reproductive technologies now in common use, such as *in vitro* fertilization or embryo transfer."

Public Attitudes Towards Specific "Animal Biotechnologies" (IFIC, 2005)



http://ific.org/research/upload/2005BiotechSurvey.pdf

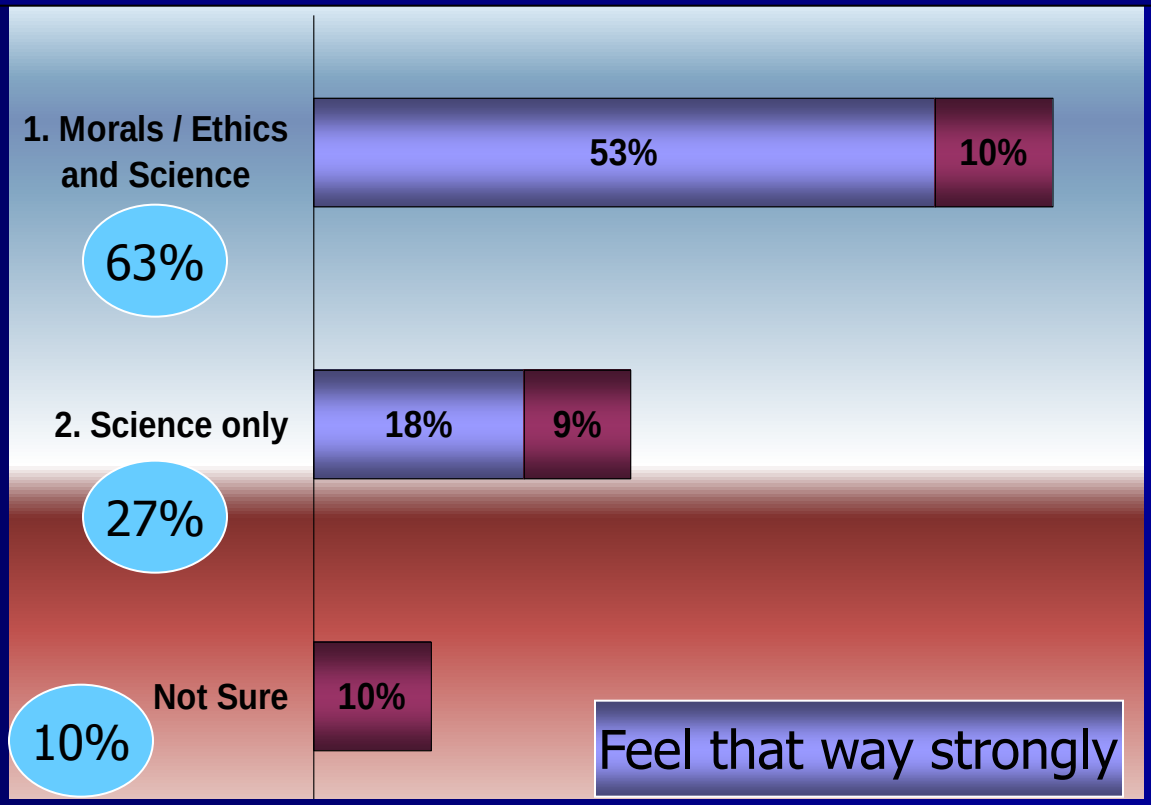
Of the Americans who are uncomfortable or unsure about animal cloning; their primary concern is:



10/2005

1. Government regulators ***should include ethical and moral considerations***, in addition to scientific evaluation of risks and benefits, when making regulatory decisions about cloning or genetically modifying animals.

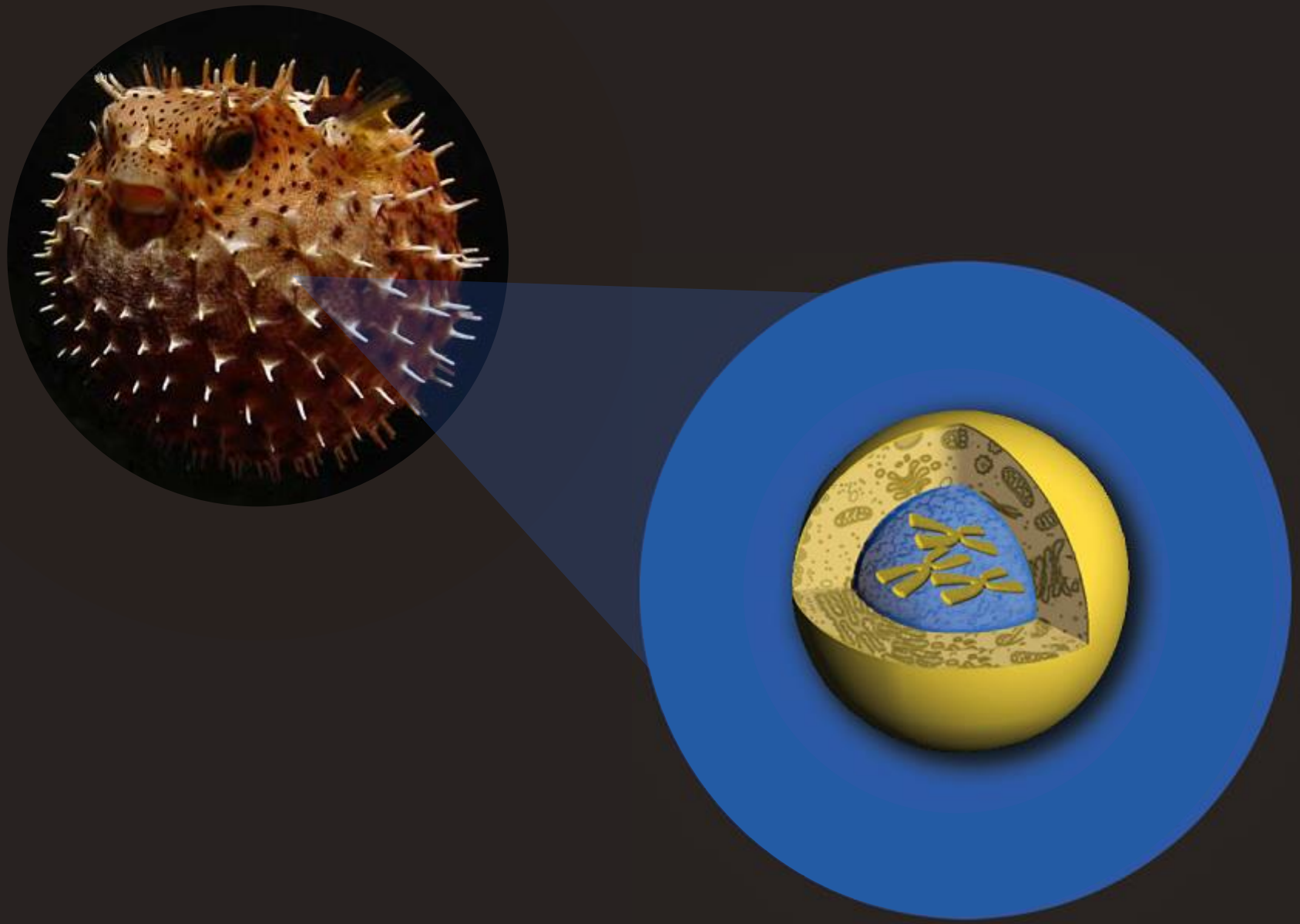
2. Though ethical and moral considerations are important, government regulators ***should consider only scientific evaluation of risks and benefits*** when making regulatory decisions about cloning and genetically modifying animals.

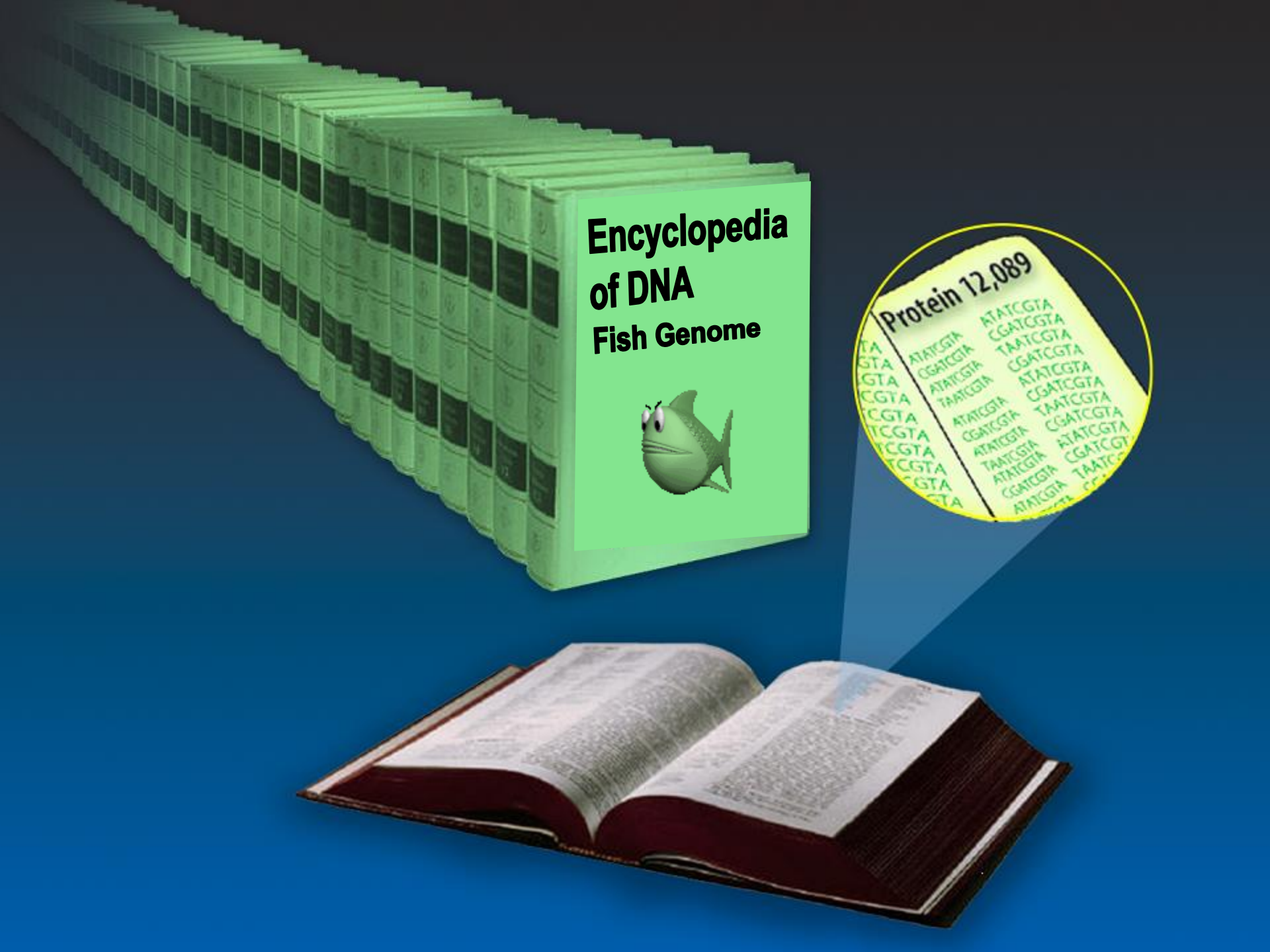


http://pewagbiotech.org/research/2005update/2005summary.pdf

SUMMARY

- Embryo split and embryo nuclear transfer "clones" have been in the food supply for over 20 years.
- Unlikely that somatic cell nuclear transfer (SCNT) clones will be produced in large numbers for commercial agricultural purposes.
- A voluntary moratorium on marketing products from adult SCNT clones and their progeny has been in effect for over 6 years despite the finding that clones and their progeny are as safe to eat as food from non-clones.
- Ethical and animal welfare concerns dominate the public discussion about cloned animals.

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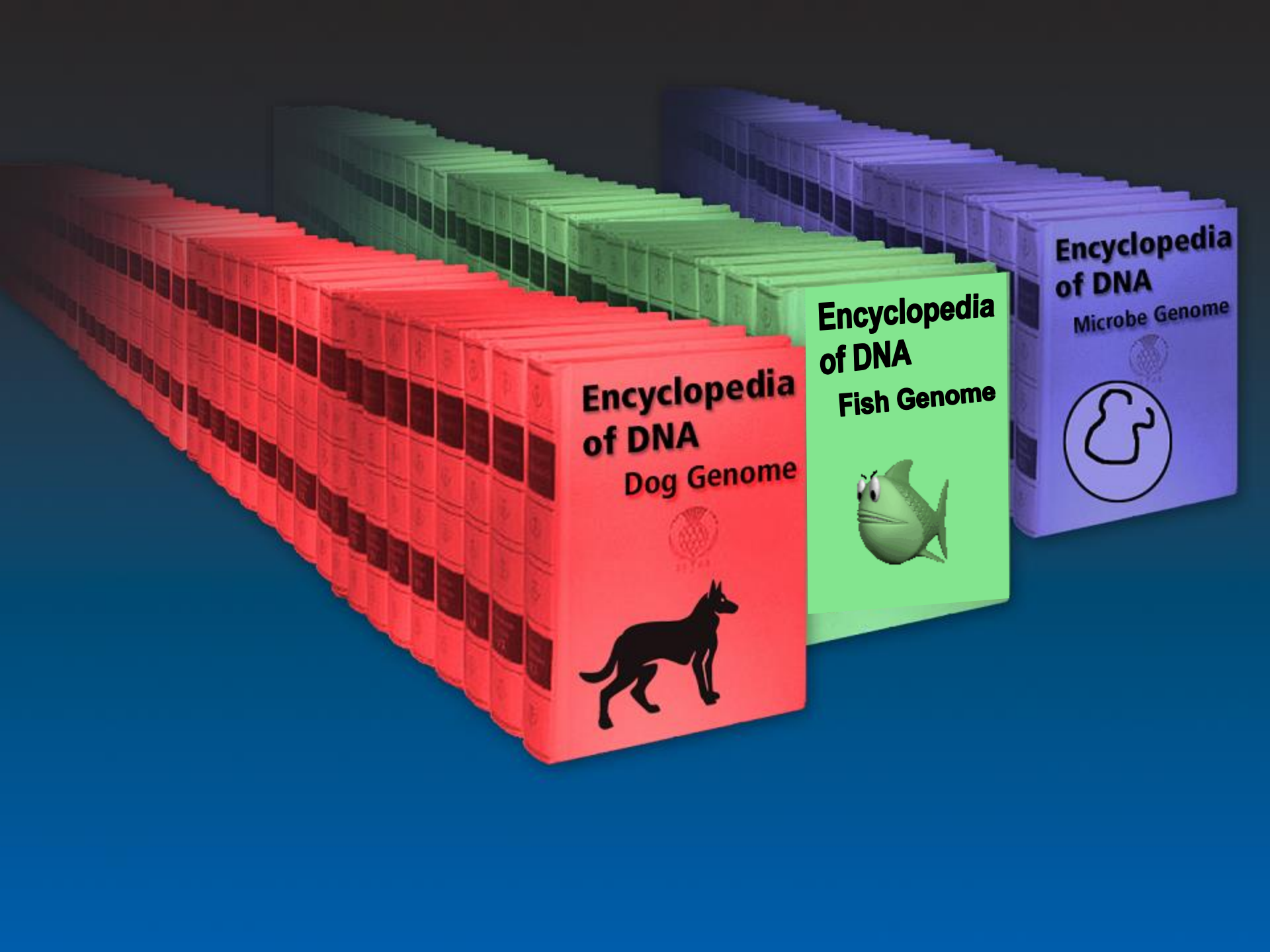
Fish Genome
Protein 12,089


Encyclopedia
of DNA
Dog Genome
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Fish Genome
Encyclopedia
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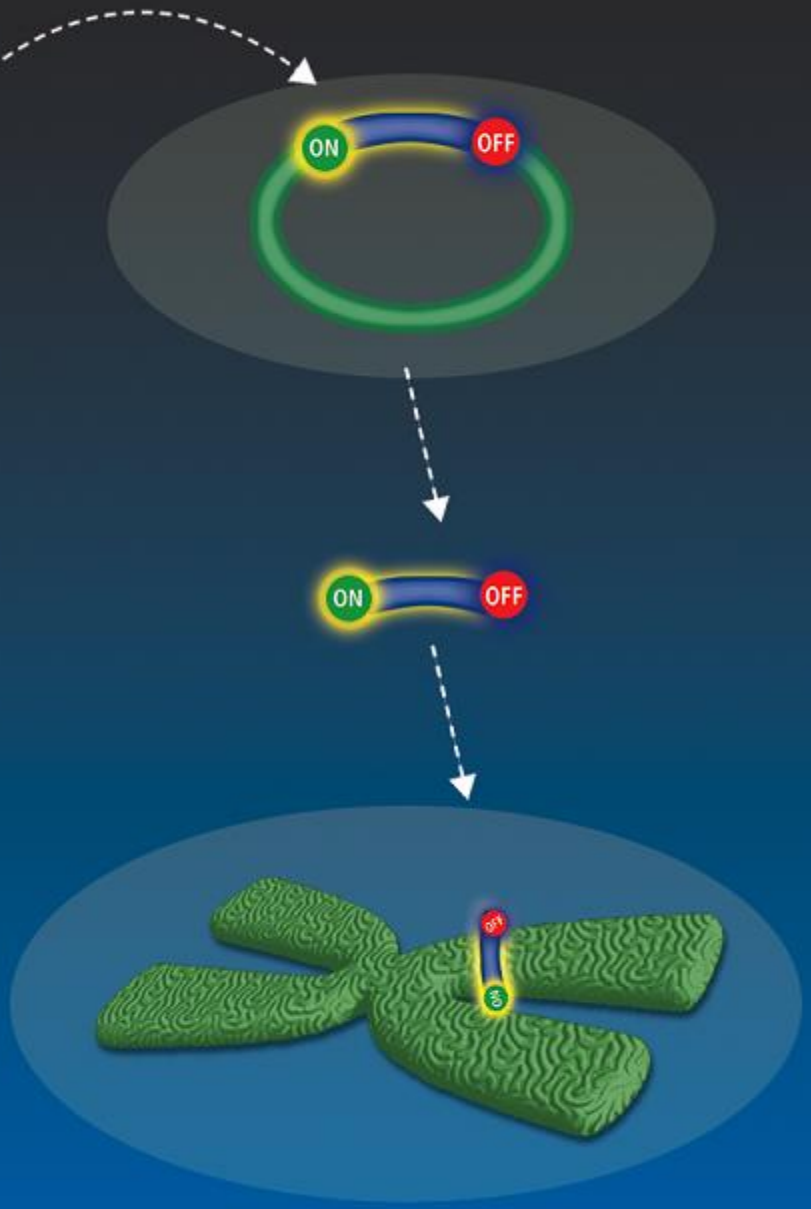
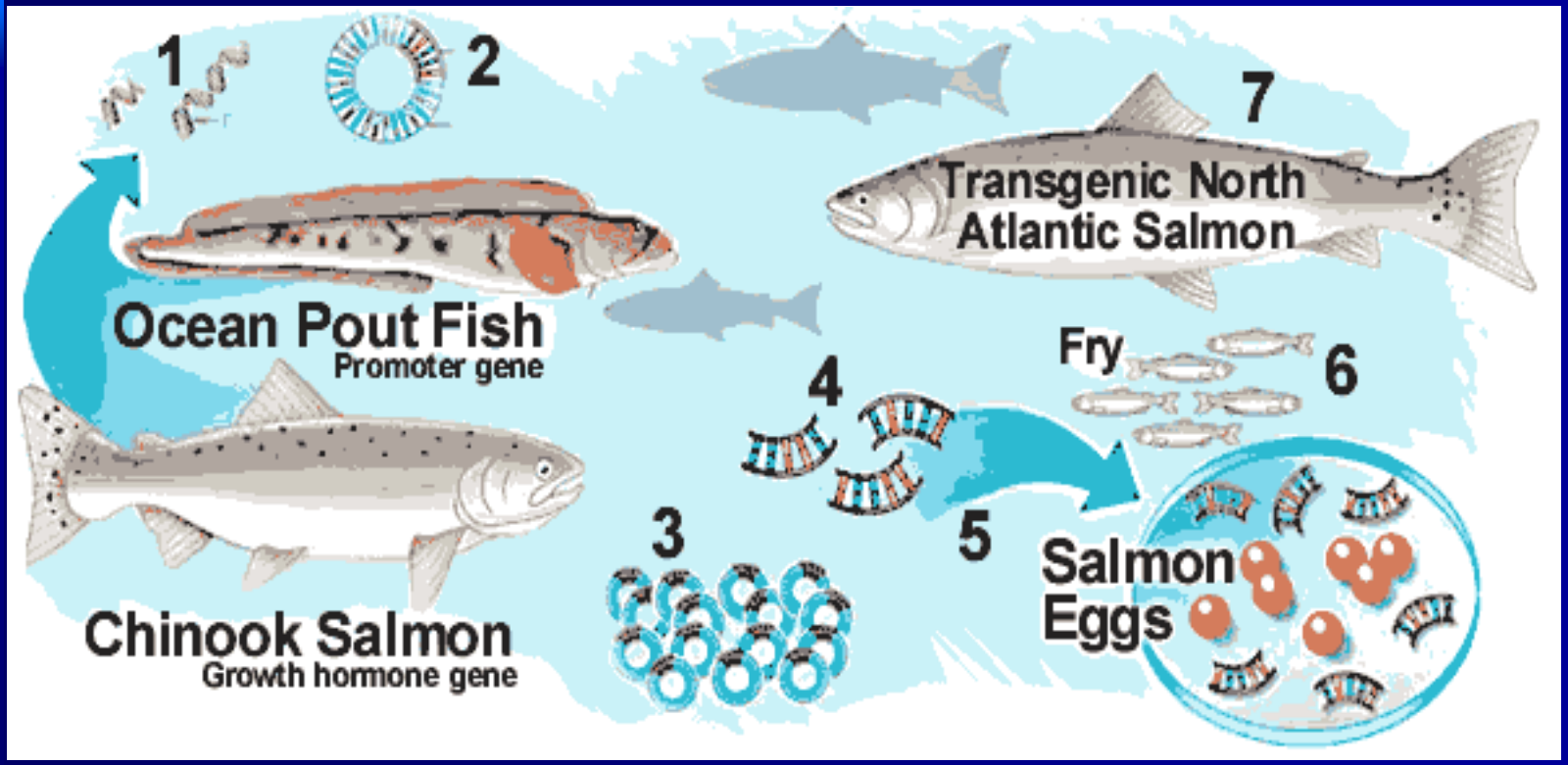
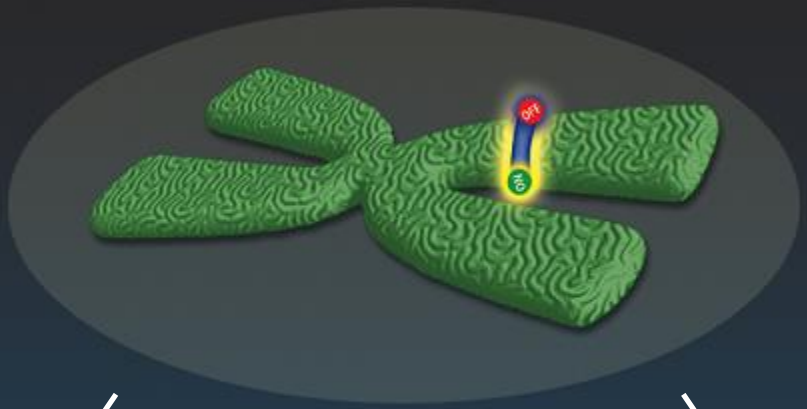
Microbe Genome

World Record 97 lb 4 oz. chinook salmon
(Les Anderson, Kenai River, AK 1985)



Growth-enhanced Atlantic Salmon





18 month old salmon

European panel now recommends GTC anti-clotting drug's surgical use

OCTOBER 15 2006
FRAMINGHAM — A European drug regulation committee reversed itself yesterday and recommended that a GTC Biotherapeutics Inc. anti-clotting drug (human antithrombin) drawn from the milk of genetically altered goats be approved for use in surgical patients

PharmAthene Awarded $213 Million Department of Defense Contract for Advanced Development of Protexia

September 25, 2006

PharmAthene, Inc., announced today that it has been awarded a multi-year contract valued at up to $213 million from the Department of Defense (DoD) U.S. Army Space and Missile Command, for advanced development of the Company's broad spectrum chemical nerve agent prophylaxis, Protexia(R).

Recombinant proteins in the milk of transgenic BELE® goats from which they are extracted.

"Transplantation-friendly" miniature GE pigs….

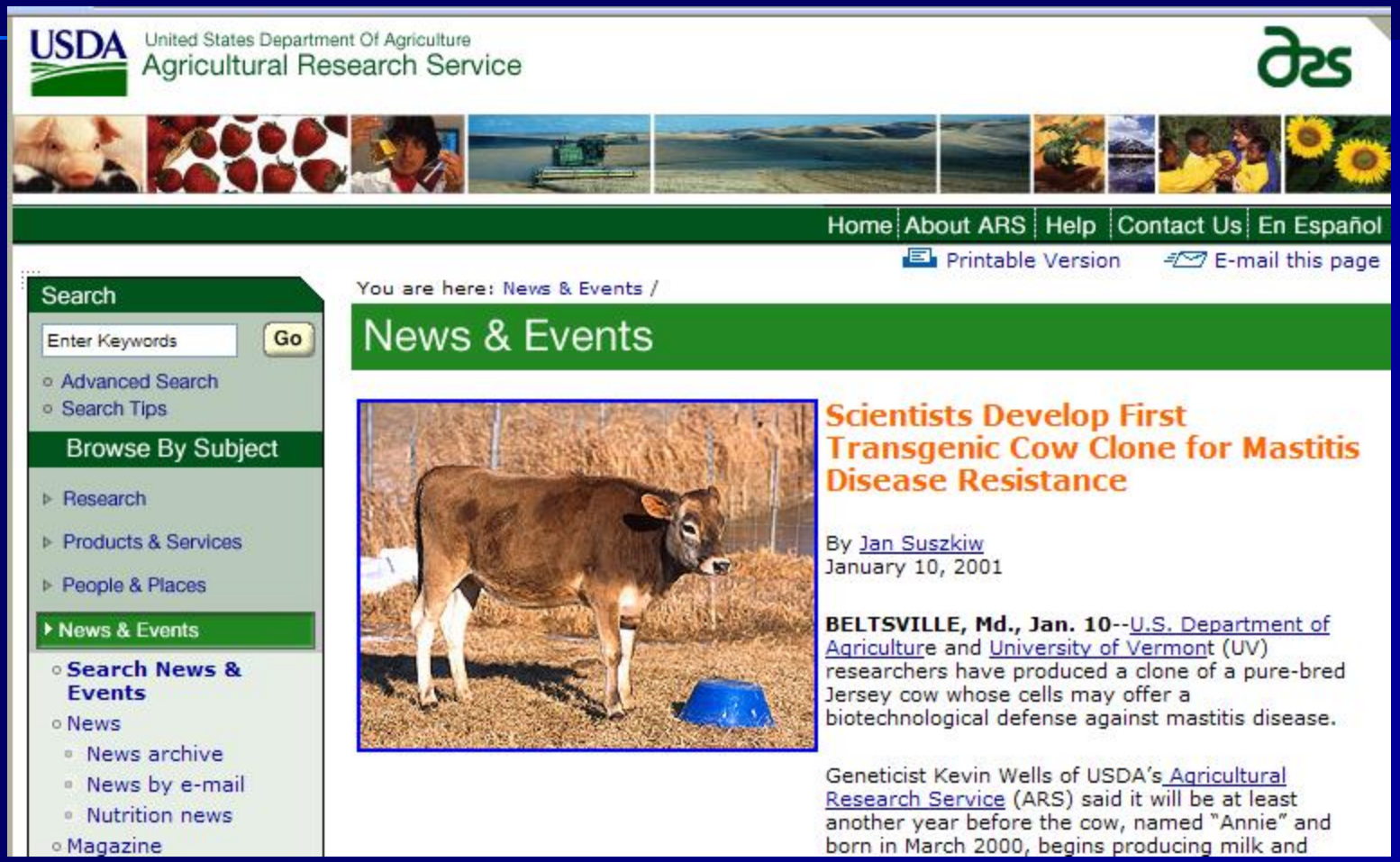
Lack the allergenic proteins that cause the rejection of animal organs when used in human xenotransplantation surgeries

Genetically engineered food animals

Enviropig™ (Low-phosphorus manure) http://www.uoguelph.ca/enviropig/

Nature Biotechnology, 19, 741 - 745, (2001).

Transgenic cows expressing an antibacterial endopeptidase in their mammary glands show enhanced resistance to mastitis.

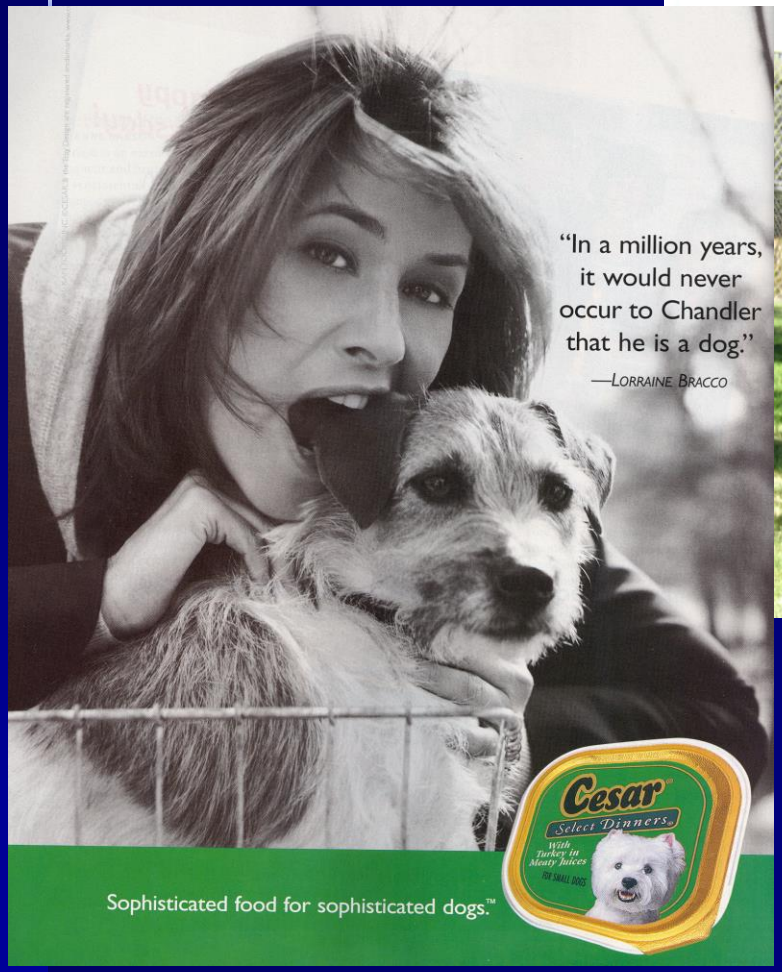


Wall,R.J. *et al.* 2005. **Genetically enhanced cows resist intramammary Staphylococcus aureus infection.** *Nature Biotechnology* **23**, 445-451.

Would there be general acceptance of transgenic technology if it could be applied to engineering resistance to influenza in poultry and therefore lessen the risk of an influenza epidemic, such as the one in 1918 that killed more than 20 million people?

Clark,J. & Whitelaw,B. 2003. A future for transgenic livestock. *Nat. Rev. Genet.* **4**, 825-833

Animals, especially pets, occupy a special place in our society. The public is often unaware of animal agricultural practices.



Genetically engineered fish and cloned cats – oh my…

GloFish™

Genetic Savings & Clone, Inc.
GENE BANKING & CLONING OF EXCEPTIONAL PETS

GloFish™ – barred on ethical grounds in California - "just a pet"

“just a floral arrangement”

GE animals raise unique moral, ethical, and cultural questions

- Animal "integrity"
- Animal welfare
  - related to breeding goals
  - related to biotechnology
- Environmental issues with regard to gene flow from GE animals to native populations.

"Biotechnology must be used within ethical constraints. It is the task of bioethics to help society develop those constraints"

- American consumers (75%) and scientists (70%) agree that cloning and genetic engineering of animals raise some moral and ethical issues
- However public is much less likely to approve (21-25%) of these technologies than scientists (60-68%)

Keystone Research Center (2004) – Biotechnology and ethics: a national survey of consumers and scientists. Report to the Biotechnology Industry Organization. KRC Research, Washington DC, 29pp.

"*Biotechnology must be used within ethical constraints. It is the task of bioethics to help society develop those constraints*"

- American consumers (75%) and scientists (70%) agree that cloning and genetic engineering of animals raise some moral and ethical issues
- However public is much less likely to approve (21-25%) of these technologies than scientists (60-68%)
- Animal scientists must become conversant and willing participants in the consideration of ethical issues and concerns surrounding the implementation of their work if they wish to be involved in reaching the societal consensus as to ***which ethical constraints*** will ultimately be applied in determining acceptable uses of animal biotechnology

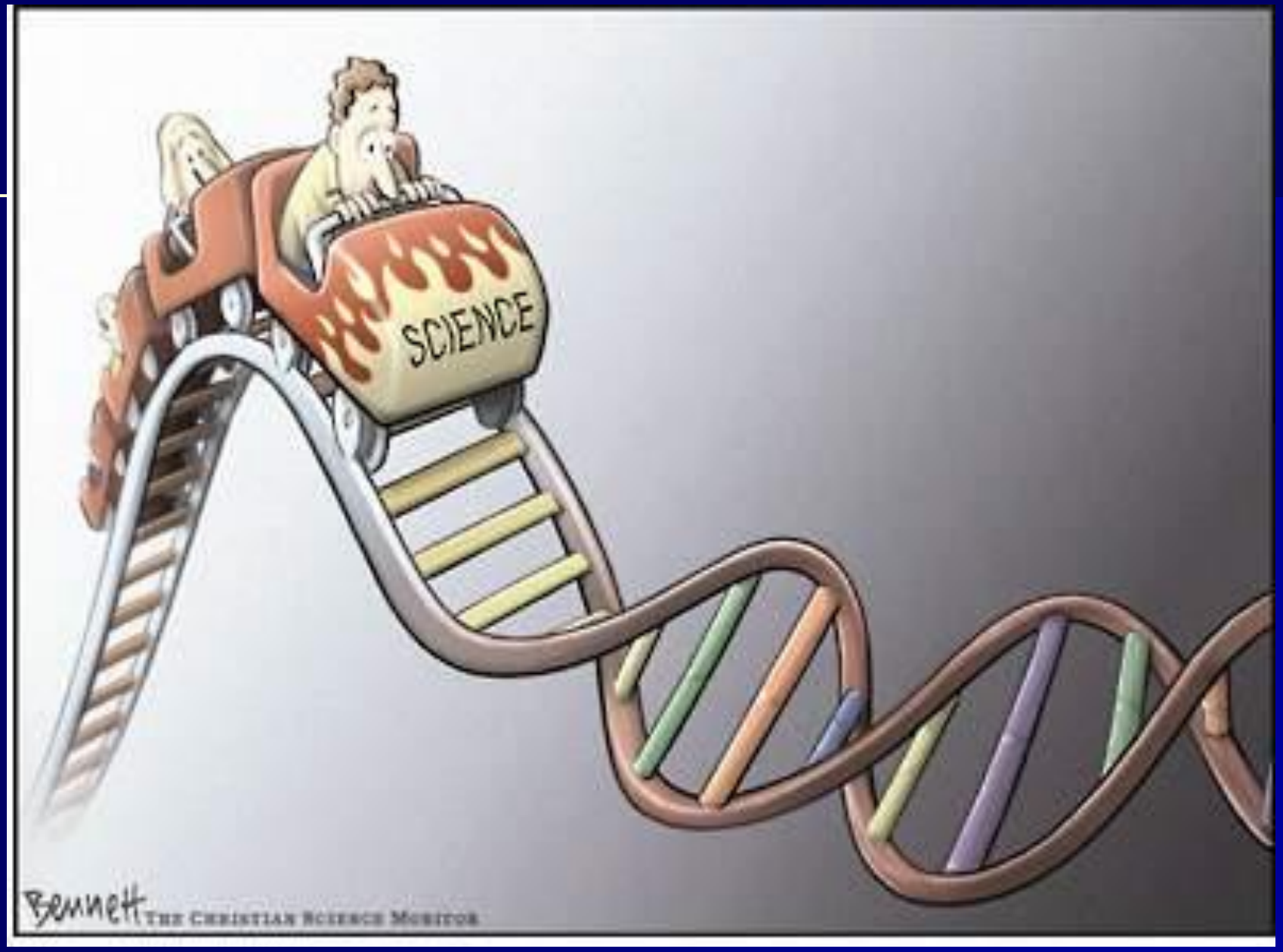
SUMMARY

- No GE or SCNT cloned food animals currently on the food market
- FDA regulates GE/cloned food animals
- Future uses of GM animals could be diverse and may address important societal needs
- Yet to see if the expense of the technology is commercially viable
- GE animals raise unique moral, ethical, and cultural questions


B
Red
Orange
Yellow
Green
Wild Type


GMO'S
TREATOR
TRICK?


HUMAN GROWTH HORMONE GENE
MT
PROMOTER
pBR


SCIENCE
Bennett
THE CHRISTIAN SCIENCE MONITOR