Ethics and Societal Aspects of Animal Biotechnology

The boys from Brazil
The possibility of human cloning, raised when Scottish scientists at Roslin Institute created the much-celebrated sheep "Dolly" (Nature 385, 810-13, 1997), aroused worldwide interest and concern because of its scientific and ethical implications.

Should we clone humans?

Due to the inefficiency of animal cloning (only about 1 or 2 viable offspring for every 100 experiments) and the lack of understanding about reproductive cloning, many scientists and physicians strongly believe that it would be unethical to attempt to clone humans. Not only do most attempts to clone mammals fail, about 30% of clones born alive are affected with "large-offspring syndrome" and other debilitating conditions. Several cloned animals have died prematurely from infections and other complications. The same problems would be expected in human cloning.

(US Govt factsheet)
I don’t want to achieve immortality through my work. I want to achieve it through not dying.

*Woody Allen*
Should humans be offered mortality?

In 2002, the Netherlands legalized euthanasia. The practice "allows a person to end their life in dignity after having received every available type of palliative care."
Should one human be offered another's mortality?

Amnesty urges Iran to spare hanging survivor's life
Cat Cloning is Wrong-Headed States
The Humane Society of the United States

February 14, 2002

WASHINGTON - The Humane Society of the United States, the nation's largest animal protection organization, expressed strong disapproval with the practice of cloning cats, in the wake of reports from scientists at Texas A&M University who claim to have succeeded in completing this experiment.
Its all about the cost and the benefit

So is there a difference between the lab and the stud farm?
Whether for a Deceased Pet or a Farm Animal, Cloning Is an Idea Not Worth Repeating

By Wayne Pacelle

In December 2004, a kitten named Little Nicky was presented to his owner, a Dallas woman who shelled out $50,000 for the honor of being the first person to own a commercially cloned pet.
Should we clone mice?

Remember, cats were probably first domesticated to kill mice
And remember, some people think it perfectly normal to eat cats
As do snakes!
Whose “rights” are we really interested in?

- Do different values apply when considering
  - Human’s rights vs animal’s rights?
  - The rights of different animal species?
  - The rights of different human races?

- Who decides these “rights”?
Ethics of transgenic animals

Mule

Quagga

Liger
Please sir, I have a problem...
COST: BENEFIT analysis
Cost benefit example: animal research project

**Cost**
- Experimental infection
- Antibiotic therapy
- Most
- Immediate pain
- Analgesia
- All

**Benefit**
- Mammary Biopsy
- Improvement knowledge
- Improve diagnosis
- Improve treatment
- Reduce disease
- Long term infection
- Some
- Short term infection
- Most
- Antibiotic therapy
- Improve treatment
Home Office Project Licence

- Are you skilled and qualified?
- Are your facilities and resources appropriate?
- What is the purpose?
- Does the project involve:
  - Tobacco, Microsurgery training, Primates, Wild-caught primates
- Do the procedures involve:
  - Primates, Release to the wild, Ascites induction for MAB production, Skin corrosivity testing, Skin photosensitivity testing, Cosmetic testing
Reduce, Refine, Replace

- Have you designed your experiments to reduce animal numbers?
- Have you optimized avoidance of suffering?
- Have you considered and excluded non-animal alternatives?
Cost benefit example: rBST

Cost
- Cow health
- Consumer health
- Consumer safety

Benefit
- Company profit
- Farmer profit
- Feeding affluent
- Feeding needy
- Reduced disease
Food chain bioterrorism: the next "big issue"?
Fig. 1. Location of the major orange producing areas of the world.
Second update on Scottish salmon withdrawal
Tuesday 19 February 2008

The Agency has issued a second updated Food Alert for Information on the withdrawal by a number of retailers of fresh Scottish salmon because of a risk of a taint, resulting in an unpleasant taste. The salmon has been supplied by Marine Harvest, which is currently investigating the cause of the taint. They believe that the source of the contamination is diesel. The chemicals implicated in the problem are present at low levels, which are very unlikely to be a risk to health.
Table 2
Sample of recent product recalls due to pathogen contamination in the USA (USDA FSIS, 2002)

<table>
<thead>
<tr>
<th>Company</th>
<th>Product recalled</th>
<th>Contaminant</th>
</tr>
</thead>
<tbody>
<tr>
<td>ConAgra, CO</td>
<td>Ground beef</td>
<td>E. coli O157: H7</td>
</tr>
<tr>
<td>Cargill Turkey, TX</td>
<td>Poultry products</td>
<td>L. monocytogenes</td>
</tr>
<tr>
<td>Bar-S Foods, GA</td>
<td>Meat and poultry</td>
<td>L. monocytogenes</td>
</tr>
<tr>
<td>Excel Corp, GA</td>
<td>Ground beef/pork</td>
<td>E. coli O157:H7</td>
</tr>
<tr>
<td>American Foods, WI</td>
<td>Ground beef</td>
<td>E. coli O157:H7</td>
</tr>
<tr>
<td>Savoie’s, LA</td>
<td>Cajun dressing mix</td>
<td>Salmonella</td>
</tr>
<tr>
<td>Zartic, GA</td>
<td>Chopped beef steak</td>
<td>Salmonella</td>
</tr>
</tbody>
</table>

Amount recalled

8.6 million kg
7.6 million kg
6.6 million kg
86 000 kg
240 000 kg
225 000 kg
1.2 million kg
Fig. 3. Pathogen specific testing and total market size.
## GMOs are big business

### Table 4
US market for food testing products

<table>
<thead>
<tr>
<th>Segment</th>
<th>($ Millions) 2000</th>
<th>($ Millions) 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pathogens</td>
<td>122.6</td>
<td>192.5</td>
</tr>
<tr>
<td>Pesticides</td>
<td>8.9</td>
<td>12.9</td>
</tr>
<tr>
<td>Genetically modified organisms</td>
<td>18.0</td>
<td>34.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>149.5</strong></td>
<td><strong>239.4</strong></td>
</tr>
</tbody>
</table>
Food forensics: Biosensors and HACCP

Market analysis of biosensors for food safety

Evangelyn C. Alocilja *, Stephen M. Radke

Agricultural Engineering Department, Michigan State University, 204 Farrell Hall, East Lansing, MI 48824, USA

Received 25 May 2002; received in revised form 25 September 2002; accepted 24 October 2002
Food bioterrorism: is it an issue?

U.S. is unprepared for major bioterrorism attack, commission finds

Network News Washington Post Wednesday, January 27, 2010

The panel's "report card" comes 13 months after the congressionally appointed body warned that a major attack using weapons of mass destruction somewhere in the world was "more likely than not" to occur by 2013, unless significant steps were taken.
Accidental and deliberate microbiological contamination in the feed and food chains — How biotraceability may improve the response to bioterrorism

Rickard Knutsson a,*, Bart van Rotterdam b, Patrick Fach c, Dario De Medici d, Martina Fricker e, Charlotta Löfström f, Joakim Ågren a, Bo Segerman a, Gunnar Andersson a, Peter Wielinga b, Lucia Fenicia d, Jeffrey Skiby f, Anna Charlotte Schultz f, Monika Ehling-Schulz e
### Need for agreed terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agroterrorism</td>
<td>“Deliberate introduction of a disease agent, either against livestock or into the food chain, for purposes of undermining stability and/or generating fear”.</td>
</tr>
<tr>
<td>Animal biosecurity</td>
<td>“Is the product of all actions undertaken by an entity to prevent introduction of disease agents into a specific area. Animal biosecurity differs from biosecurity which measures are taken to reduce the risk of infectious agent theft and dispersal by means of bioterrorism”.</td>
</tr>
<tr>
<td>Biodefense</td>
<td>“Is the science and technology and policy of how to protect against infections caused by biological weapons of terrorism and emerging infections”.</td>
</tr>
<tr>
<td>Biological agent</td>
<td>Biological agents shall mean micro-organisms, cell cultures and parasites, which may be able to provoke any infection, allergy or toxicity in humans, animals, or plants and includes any of these materials which have been genetically modified</td>
</tr>
<tr>
<td>Biopreparedness</td>
<td>“Is a biological all-hazard approach covering a broad scope of activities relating to the protection of public health. In other context — laboratory environments, the research community, health care as well as manufacturing facilities, field investigations and transport”.</td>
</tr>
<tr>
<td>Biorisk</td>
<td>“The probability or chance that a particular adverse event (accidental infection or unauthorized access, loss, theft, misuse, diversion or intentional release), possibly leading to harm, will occur”.</td>
</tr>
<tr>
<td>Laboratory Biosafety</td>
<td>“Laboratory biosafety describes the containment principles, technologies and practices that are implemented to prevent the unintentional exposure to pathogens and toxins, or their accidental release”.</td>
</tr>
<tr>
<td>Laboratory Biosecurity</td>
<td>“Laboratory biosecurity describes the protection, control and accountability for valuable biological materials within laboratories, in order to prevent their unauthorized access, loss, theft, misuse, diversion or intentional release”.</td>
</tr>
<tr>
<td>Biosecurity</td>
<td>“Biosecurity is managing the risks and potential harm to the economy, the environment and the community, of pests and disease, entering, emerging, establishing or spreading in a region”.</td>
</tr>
<tr>
<td>Bioterrorism</td>
<td>“Bioterrorism involves the use of etiological or biological toxins in a terrorist act” or “the use by non-state actors of microorganisms (pathogens) or the products of living organisms (toxins) to inflict harm on a wider population”</td>
</tr>
<tr>
<td>Biotraceability</td>
<td>“Biotraceability is the ability to use downstream information to point to materials, processes or actions within a particular food chain that can be identified as the source of undesirable agents”.</td>
</tr>
<tr>
<td>Food terrorism</td>
<td>&quot;An act or threat of deliberate contamination of food for human consumption with chemical, biological or radio nuclear agents for the purpose of causing injury or death to civilian population and/or disrupting social, economic or political stability&quot;.</td>
</tr>
</tbody>
</table>
Modelling deliberate microbial contamination of food chain

R. Knutsson et al. / international journal of Food Microbiology 145 (2011) S123–S128

Fig. 1. Overview of a (deliberate) microbial contamination event in food chain to improve decision making during the response phase.

HACCP replaced by full scenario risk modelling
Stable to table?
FIGURE 24.4 Outline of DNA Fingerprinting Procedure

A pattern of different-sized DNA fragments is generated during DNA fingerprinting. The sequence of the DNA determines where the restriction enzyme cuts in the first step; thus different people will have a different pattern of fragments for the same restriction enzyme. These differences may be used to identify people.
VNTR fingerprinting

**FIGURE 24.6 VNTR Fingerprinting**
Genomic DNA has regions with repeated sequences. In each individual, the number of repeats varies, and therefore the lengths of these regions can be compared to distinguish identities. The repeated region is isolated using restriction enzymes from three individuals marked A, B, and C. The fragments are run on agarose gels to compare the lengths.
Multiplex STR using PCR

**FIGURE 24.8 Multiplex STR Fingerprinting**

Three different STR loci are amplified using PCR primers. Each set of primers is labeled with a different fluorescent label to distinguish each locus from the other. The PCR products are run on an agarose gel to determine the length of the fragment, and hence the number of repeats. This individual is heterozygous for each locus because there are two different-sized bands for each PCR primer set.
Next generation SNP analysis

Improving human forensics through advances in genetics, genomics and molecular biology

Manfred Kayser* and Peter de Knijff*
Genealogy research

**A) MITOCHONDRIAL ANCESTRY**

Albert of Saxe-Coburg = Queen Victoria of England

Louis IV of Hesse = Alice

Victoria = Louis of Hesse

Tsarina Alexandra = Tsar Nicholas II

Alice = Prince Andree of Greece

Olga Tatiana Marie Anastasia Alexei

Prince Philip
Duke of Edinburgh

**B) STR ANALYSIS**

<table>
<thead>
<tr>
<th></th>
<th>15,16</th>
<th>13,16</th>
<th>15,16</th>
<th>13,16</th>
</tr>
</thead>
<tbody>
<tr>
<td>STR-1</td>
<td>15,16</td>
<td>15,16</td>
<td>15,16</td>
<td>15,16</td>
</tr>
<tr>
<td>STR-2</td>
<td>8,10</td>
<td>8,10</td>
<td>8,10</td>
<td>8,10</td>
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<tr>
<td>STR-3</td>
<td>5,7</td>
<td>5,7</td>
<td>5,7</td>
<td>5,7</td>
</tr>
<tr>
<td>STR-4</td>
<td>12,13</td>
<td>12,13</td>
<td>12,13</td>
<td>12,13</td>
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<tr>
<td>STR-5</td>
<td>32,56</td>
<td>32,56</td>
<td>32,56</td>
<td>32,56</td>
</tr>
</tbody>
</table>

**FIGURE 24.16 Russian Royal Family**

(A) Family tree showing the ancestry of Tsarina Alexandra, Tsar Nicholas II, and their children. The yellow highlights show people with identical mitochondrial DNA. (B) STR analyses of the skeletal remains of Tsar Nicholas II and his family. The remains were examined with PCR primers for five different STRs (labeled 1–5). The three children had combinations of STR fragments found in either parent. The number of the STR is color coded, with red from Tsar Nicholas II and blue from Tsarina Alexandra. Two children’s remains were missing from the grave.
Look into my eyes!

DNA information used to predict eye colour

Retinal scanning
Animals have IDs too

Modeling the retention of rumen boluses for the electronic identification of goats

S. Carné,* G. Caja,*1 J. J. Ghirardi,*2 and A. A. K. Salama†

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Determining the optimal age for recording the retinal vascular pattern image of lambs

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*Grup de Recerca en Remugants (G2R), Departament de Ciència Animal i dels Aliments, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain; †Unitat d'Assessorament Estadístic (STR), Universitat de Girona, 17003 Girona, Spain; and ‡Servei d'Estadística, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain

Readability of visual and electronic leg tags versus rumen boluses and electronic ear tags for the permanent identification of dairy goats

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