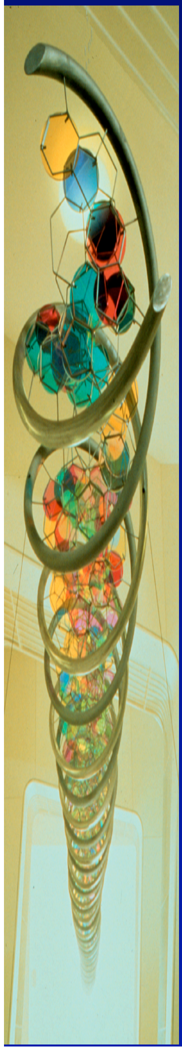
Use of GE crops and animals in CA agriculture



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Use of GE in California Ag

- California farmers grow over 350 crop and livestock commodities; CA leads the nation in production of 79 crops
- Genetically engineered varieties of 14 plant species that have been deregulated and approved for commercial production in the US
  - Soybeans, Corn, Canola, Cotton, Potato, Squash (yellow crook-neck squash and green zucchini) , Papaya, Tomato, Sugarbeets, Rice, Flax, Radicchio (red-heart chicory), and Alfafla
- Not all currently grown

Most common use of GE in California agriculture are two herbicide-resistant crops: cotton and corn

- ~ 54% of the 550,000 acres of upland cotton is estimated to be GE (herbicide-tolerant)
- ~ 57% of the 530,000 acres of field corn is estimated to be GE (mostly herbicide-tolerant)
- Herbicide-tolerant alfalfa has been approved and may be used on some of the ~1,050,000 CA alfalfa acres
- 60% of California's agricultural value is in horticultural crops (vegetables, fruits, nuts and ornamentals)
- The only GE horticultural crops that may be grown are genetically engineered virus-resistant squash and insect-resistant sweet corn and it is estimated that only small amounts of these are GE


ANTI-GMO ORDINANCES PASSED
ANTI-GMO ORDINANCE VOTED ON AND REJECTED, NOVEMBER 2004
ANTI-GMO ORDINANCES UNDER CONSIDERATION
ANTI-GMO ORDINANCE QUALIFIED FOR BALLOT
PRO-GMO RESOLUTION PASSED
Green outline denotes major GE-crop growing areas
As of 9/13/05
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
NEVADA
LAKE
COLUSA
SUTTER
YUBA
PLACER
YOLO
EL DORADO
Sacramento
SONOMA
NAPA
SOLANO
SACRA-MENTO
AMA-DOR
ALPINE
CALAVERAS
SAN FRANCISCO
MARIN
CONTRA COSTA
SAN JOAQUIN
TUOLUMNE
MONO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
FRESNO
SAN BENITO
INYO
MONTEREY
TULARE
KINGS
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
Los Angeles
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL

California 2004 data

- Estimated to be 260,000 acres of GE cotton and 300,000 acres of GE field corn grown in 2004
- 273 acres of organic cotton, and 383 acres of organic field corn (http://www.cdfa.ca.gov/is/i&c/docs/2004CountyReport.pdf)
- Since many different farming systems are employed in California, often on adjoining fields, *producers have a responsibility to cooperate to enable co-existence of these different production methods* and implement BMPS to minimize pollen drift and other forms of contamination.

Feeding livestock GE crops

- A recent comprehensive review (Flachowsky et al. 2005 *Animal nutrition with feeds from genetically modified plants.* Archives of Animal Nutrition 59:1-40) summarize the >100 studies in many species that have revealed that animals (beef cattle, swine, sheep, fish, lactating dairy cows and chickens) fed feed from GE crops show no difference in performance relative to animals consuming non-GE varieties of those same crops.
- GE insect-protected corn has been found to sustain less insect damage, and hence be less susceptible to contamination by fungal toxins, resulting in corn that is safer for livestock and human consumption (Flachowsky and Aulrich 2002; Munkvold, Hellmich, and Rice 1999; Munkvold, Hellmich, and Showers 1997).

Eating Livestock that ate GE Crops

- A number of scientific studies indicate that introduced DNA or proteins from biotech crops are not detected in milk, meat or eggs from animals that consume feed components derived from these crops
- See the following Federation of Animal Societies Web Site web address for a listing of the relevant peer-reviewed scientific literature http://www.fass.org/references/Transgentic_DNA.htm

Materials on Feeding Livestock GE Crops

- * http://www.fass.org/REFERENC.htm List of > 100 references on feeding transgenic crops to livestock (Federation of Animal Societies Web Site)
- * http://www.animalbiotechnology.org/abstc.pdf Review of literature on the performance of poultry and livestock fed biotech crops compared to their conventional counterparts
- * http://www.fass.org/geneticcrops.pdf Full color fact sheet entitled "Are the Milk, Meat, and Eggs of Livestock Fed Biotech Crops Safe to Eat?" (Federation of Animal Societies Web Site

Animal toxicology studies performed with genetically modified food crops

Table 3-3—Toxicity studies performed with genetically modified food crops[a]

Crop	Trait	Species	Duration	Measurements	Reference
Cottonseed	Bt endotoxin (*Bacillus thuringiensis*)	Rat	28 d	Body weight Feed conversion Histopathology of organs Blood chemistry	Chen and others 1996
Maize	Cry9C endotoxin (*B. thuringiensis* var. tolworthi)	Human		Reactivity with sera from maize-allergic patients	EPA 2000
Maize	Cry9C endotoxin (*B. thuringiensis* var. tolworthi)	Rat, mouse	91 d	Body weight Blood chemistry Blood count Organ weights Histopathology of immune-related organs Serum IgE, IgG, and IgA levels	Teshima and others 2002
Potato	Lectin (*Galanthus nivalis*) Ewen and Pusztai 1999	Rat	10 d	Histopathology of intestines	
Potato	Cry1 endotoxin (*B. thuringiensis* var kurstaki HD1)	Mouse	14 d	Histopathology of intestines	Fares and El Sayed 1998
Potato	Glycinin (soybean [*Glycine max*])	Rat	28 d	Feed consumption Body weight Blood chemistry Blood count Organ weights Liver and kidney histopathology	Hashimoto and others 1999a,b
Rice	Glycinin (soybean [*Glycine max*])	Rat	28 d	Feed consumption Body weight Blood chemistry Blood count Organ weights Liver and kidney histopathology	Momma and others 2000
Rice[b]	Phosphinothricin acetyltransferase (*Streptomyces hygroscopicus*)	Mouse, rat	acute & 30 d	Feed consumption Body weight Median lethal dose Blood chemistry Organ weight Histopathology	Wang and others 2000
Soybean GTS 40-3-2	CP4 EPSPS (*Agrobacterium*)	Rat, mouse	105 d	Feed consumption Body weight Histopathology of intestines and immune system Serum IgE and IgE levels	Teshima and others 2000
Soybean GTS 40-3-2	CP4 EPSPS (*Agrobacterium*)	Human		Reactivity with sera from soybean-allergic patients	Burks and Fuchs 1995
Soybean GTS 40-3-2	CP4 EPSPS (*Agrobacterium*)	Rat	150 d	Blood chemistry Urine composition Hepatic enzyme activities	Tutel'yan and others 1999
Soybean	2S Albumin (Brazil nut [*Bertholetta excelsa*])	Human		Reactivity with sera from Brazil nut-allergic patients	Nordlee and others 1996
Tomato	Cry1Ab endotoxin (*B. thuringiensis* var. kurstaki)	Rat	91 d	Feed consumption Body weight Organ weights Blood chemistry Histopathology	Noteborn and others 1995
Tomato	Antisense polygalacturonase (tomato [*Lycopersicon esculentum*])	Rat	28 d	Feed consumption Body weight Organ weights Blood chemistry Histopathology	Hattan 1996

[a]Reproduced from Kuiper and others 2001; Table 4). Data from publicly available reports.
[b]Mutagenicity also tested.

Chassy et al. 2004. *Nutritional and safety assessments of foods and feeds nutritionally improved through biotechnology: an executive summary*. Comprehensive Reviews in Food Science and Food Safety **3**:38-104. Full article available at

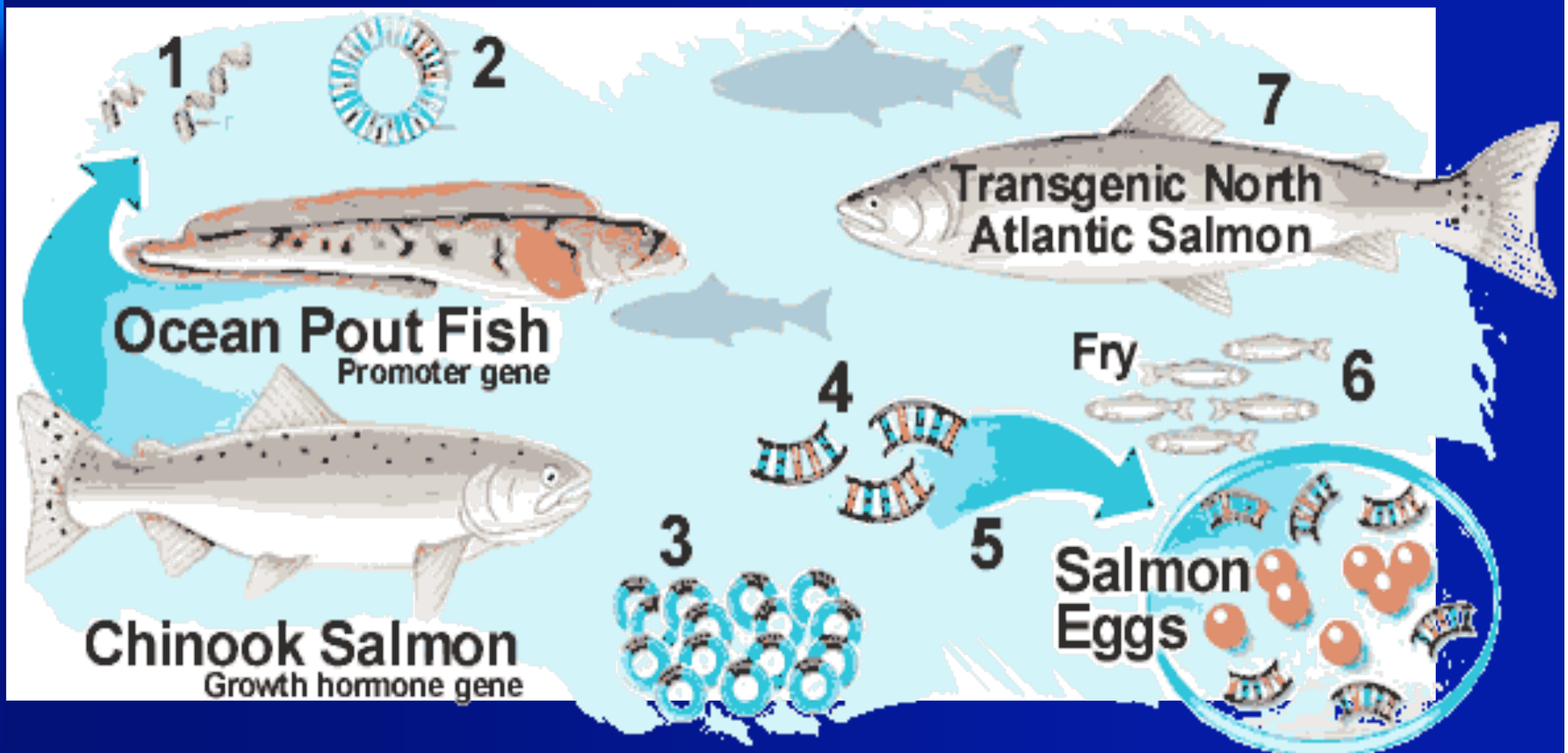
http://agbios.com/docroot/articles/05-002-001.pdf

No GE food animals on the market

Three common misconceptions:

1. Cloning is not GE
2. Treating a cow with rBST does not make her GE. rBST is a protein produced by GE bacteria, but it does not alter the DNA of the cow being treated with rBST in any way
3. There are some live "pox vectored" GE viruses used in livestock as vaccines for certain diseases e.g. avian encephalomyelitis (http://www.biomunecompany.com/)

Aqua Bounty - Growth-enhanced salmon up for approval to FDA – first submitted to FDA in 1995



http://www.aquabounty.com/

Transgenic Growth-Enhanced Tilapia being grown in Cuba

Maclean and Laight. 2000. *Transgenic fish: an evaluation of benefits and risks*. Fish and Fisheries **1**:146-172.

Existing regulations governing GM aquatic organisms in CA

CA Senate Bill 245 “bans aquaculture of salmon, exotic (non-native) and transgenic (genetically-engineered) fish in state waters, including the ocean from 0-3 miles offshore.”

Existing regulations governing GM aquatic organisms in CA

Additionally, California Fish and Game department regulations require the possession of a permit to raise GE fish in contained onshore systems in California.

GloFish™ – on sale except in CA

"Because tropical aquarium fish are not used for food purposes, they pose no threat to the food supply. There is no evidence that these genetically engineered zebra danio fish pose any more threat to the environment than their unmodified counterparts which have long been widely sold in the United States. In the absence of a clear risk to the public health, the FDA finds no reason to regulate these particular fish."

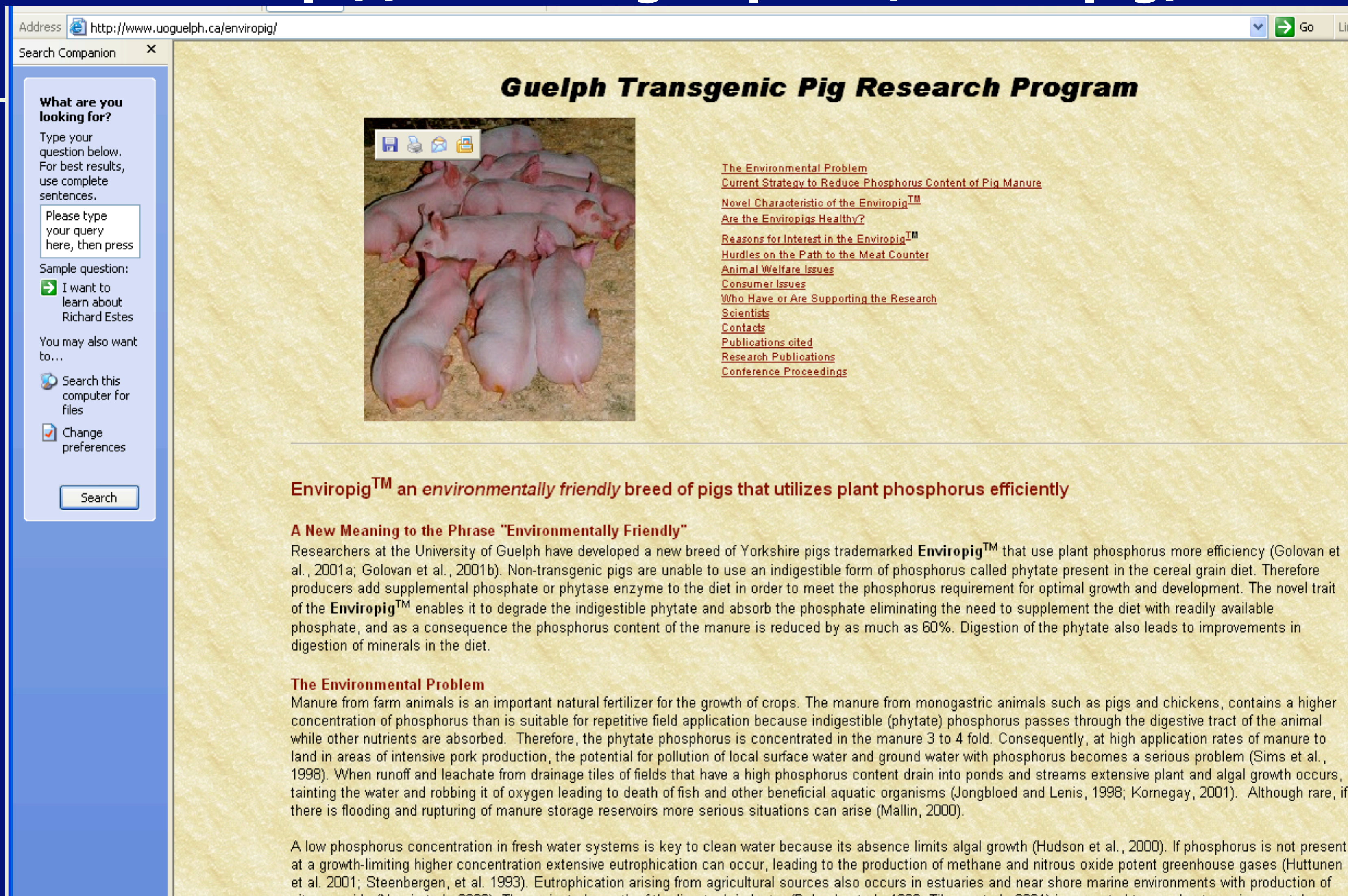
http://www.fda.gov/bbs/topics/NEWS/2003/NEW00994.html

"Transplantation-friendly" miniature GE pigs….

Takahagi et al. 2005. Production of alpha 1,3-galactosyltransferase gene knockout pigs expressing both human decay-accelerating factor and N-acetylglucosaminyltransferase III. *Molecular Reproduction and Development* **71**, 331-338

Low "P" emissions Enviropig™

http://www.uoguelph.ca/enviropig/



Address http://www.uoguelph.ca/enviropig/

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Guelph Transgenic Pig Research Program

The Environmental Problem
Current Strategy to Reduce Phosphorus Content of Pig Manure
Novel Characteristic of the Enviropig™
Are the Enviropigs Healthy?
Reasons for Interest in the Enviropig™
Hurdles on the Path to the Meat Counter
Animal Welfare Issues
Consumer Issues
Who Have or Are Supporting the Research
Scientists
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Enviropig™ an *environmentally friendly* breed of pigs that utilizes plant phosphorus efficiently

A New Meaning to the Phrase "Environmentally Friendly"

Researchers at the University of Guelph have developed a new breed of Yorkshire pigs trademarked **Enviropig**™ that use plant phosphorus more efficiency (Golovan et al., 2001a; Golovan et al., 2001b). Non-transgenic pigs are unable to use an indigestible form of phosphorus called phytate present in the cereal grain diet. Therefore producers add supplemental phosphate or phytase enzyme to the diet in order to meet the phosphorus requirement for optimal growth and development. The novel trait of the **Enviropig**™ enables it to degrade the indigestible phytate and absorb the phosphate eliminating the need to supplement the diet with readily available phosphate, and as a consequence the phosphorus content of the manure is reduced by as much as 60%. Digestion of the phytate also leads to improvements in digestion of minerals in the diet.

The Environmental Problem

Manure from farm animals is an important natural fertilizer for the growth of crops. The manure from monogastric animals such as pigs and chickens, contains a higher concentration of phosphorus than is suitable for repetitive field application because indigestible (phytate) phosphorus passes through the digestive tract of the animal while other nutrients are absorbed. Therefore, the phytate phosphorus is concentrated in the manure 3 to 4 fold. Consequently, at high application rates of manure to land in areas of intensive pork production, the potential for pollution of local surface water and ground water with phosphorus becomes a serious problem (Sims et al., 1998). When runoff and leachate from drainage tiles of fields that have a high phosphorus content drain into ponds and streams extensive plant and algal growth occurs, tainting the water and robbing it of oxygen leading to death of fish and other beneficial aquatic organisms (Jongbloed and Lenis, 1998; Kornegay, 2001). Although rare, if there is flooding and rupturing of manure storage reservoirs more serious situations can arise (Mallin, 2000).

A low phosphorus concentration in fresh water systems is key to clean water because its absence limits algal growth (Hudson et al., 2000). If phosphorus is not present at a growth-limiting higher concentration extensive eutrophication can occur, leading to the production of methane and nitrous oxide potent greenhouse gases (Huttunen et al. 2001; Steenbergen, et al. 1993). Eutrophication arising from agricultural sources also occurs in estuaries and near shore marine environments with production of nitrous oxide (Naqvi et al., 2000). The projected growth of the livestock industry (Delgado et al., 1999; Tilman et al., 2001) is expected to accelerate environmental

BSE resistant cows…


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Last Update: Monday, December 15, 2003. 11:28am (AEDT) Print Email

Scientists clone mad cow resistant calves

Scientists clone Mad Cow resistant calves (Reuters)

A group of South Korean scientists have cloned cows they believe are resistant to the deadly mad cow disease and will test the animals in Japan for five years, the leader of the research team said.

Professor Hwang Woo-suk at Seoul National University, who led the team, told *Reuters* the group had duplicated with cows an experiment conducted in creating genetically altered mice with resistance to bovine spongiform encephalopathy (BSE).

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Japanese and U.S. scientists have genetically engineered a bovine embryo that is resistant to the deadly mad cow disease and they plan to breed several of the cows to use them to make medicines to treat human diseases, an official said May 31, 2004. Kuroiwa et al. 2004. *Sequential targeting of the genes encoding immunoglobulin-mu and prion protein in cattle*. *Nature Genetics* 36, 775-780

SUMMARY – GE ANIMALS

- No GE food animals on the market
- Cloning is not GE
- rbST does not make cows GE
- No change in animal performance or detection of GE DNA or protein in animal products when livestock fed using GE crops
- FDA will regulate GE food animals
- CA has specific regulations about GE fish and this prohibits the CA ownership of GloFish
- Future uses of GM animals are varied and may address important societal needs