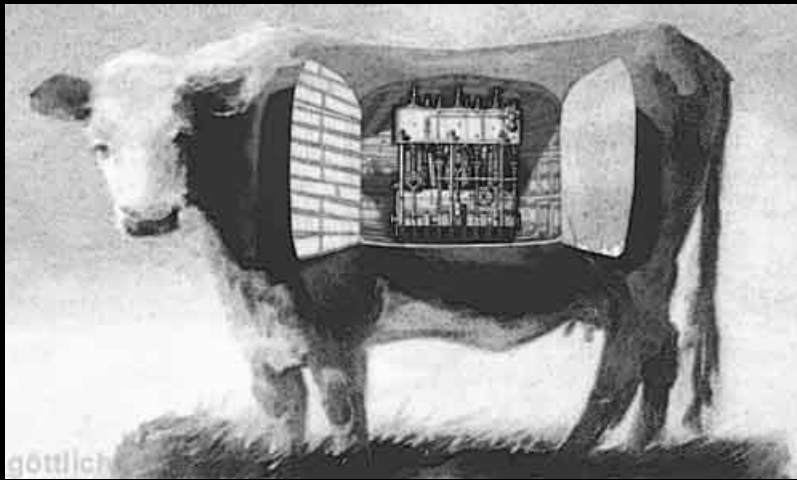


America's Future is Pharming



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- “Pharming” is the use of genetic engineering to insert genes of pharmaceuticals into host animals or plants that would not otherwise express those genes.
- Protein encoded by the transgene is secreted into the animals milk, eggs or blood and is then collected and purified.
- Plants, likewise are also widely being used to produce specific proteins within the pharmaceutical industry.
- Many are able to be delivered directly by eating the plant or drinking the milk.

-**Chlorogen, Inc.** – cholera, anthrax, and plague vaccines, albumin, interferon for liver diseases including hepatitis C, elastin, and insulin-like growth factor in tobacco chloroplasts

-**Dow Chemical Company** - anti-cancer antibodies

-**Epicyte** - spermicidal antibodies in corn

-**Genzyme** - antithrombin III in goat milk

-**Pharming** - C1 inhibitor, human collagen 1, fibrinogen, and lactoferrin in cow milk

-**PPL Therapeutics** - Alpha 1-antitrypsin for cystic fibrosis and emphysema in sheep milk

-**ProdiGene** - aprotinin, trypsin and a veterinary TGE vaccine in corn

-**SemBioSys** - insulin in safflower

-**University of Arizona** - Hepatitis C vaccine in potatoes

• [http://en.wikipedia.org/wiki/Pharming_\(genetics\)](http://en.wikipedia.org/wiki/Pharming_(genetics))

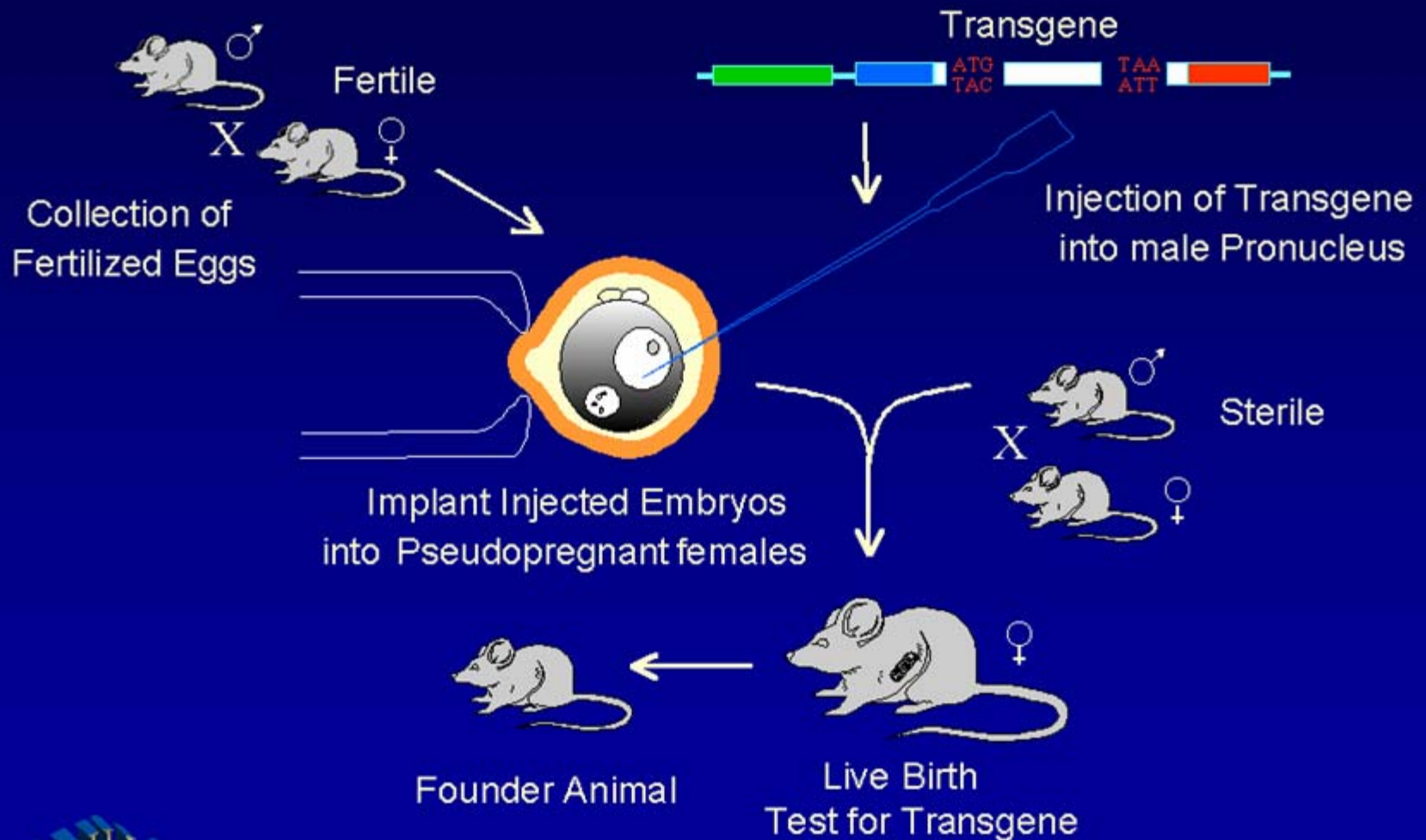
-Currently being used are cattle, sheep, goats, chickens, rabbits and pigs



-Biotech firms arguing in favor of pharming, say that it will become especially important in developing nations where hospitals are short on syringes. Drs. Can instead dispense edible drugs.

- “A traditional protein factory costs \$200-\$400 million to build in 3-5 years. A new strain of livestock costs \$100 million to develop in only 18 months. If more capacity is needed, more animals can be bred, or fields planted.”

CONSTRUCTION OF A TRANSGENIC MOUSE



How does cloning work?

<http://learn.genetics.utah.edu/units/cloning/whatiscloning/scnt.cfm>



Implications

- Advancing Technologies are allowing us to use animals as bioreactors as apposed to building huge facilities that will cost hundreds millions of dollars and take years to the finish construction.
- A herd of transgenic animals could be produced in 18 months at a fraction of the cost compared to the traditional methods of pharmaceutical production.



Derived Antibiotics, and Medical Uses

- Antithrombin III which is a plasminogen activator used in the treatment of blood clots.
- Erythropoietin is used in the treatment of anemia and hemophilia.
- Alpha-1-antitrypsin is used in the treatment of emphysema and cystic fibrosis.



Why Goat Milk?

- Using goats as the bioreactors for the production of pharmaceuticals allow production to start within 18 months because goats have A short gestation period of about 5 months and reach maturity in 1 year.



Economics of Production

- Using a herd of goats to produce pharmaceuticals allows the drugs to be produced at a fraction of the cost. An operation which uses the goats as the bioreactors cost 5% of the cost of a conventional protein making facility. This comes roughly to about \$10 million needed to start production.



Survey Says!

- A poll done by the Pew Initiative found that 81% support the use of transgenic crops to produce affordable drugs, and 49% supported the use of transgenic animals to produce affordable drugs.
- The European Medicines Agency is considering the final stage of an application to license Atryn which is extracted from goats milk.



Companies using Transgenic Animals for Pharmaceutical Production

- GTC Biotherapeutics of Framingham Massachusetts. The firm has created 65 potentially therapeutic proteins 45 of which occur in concentrations of one gram per liter or higher.
- Nexia a Montreal Based company is breeding transgenic goats to produce proteins that protect against chemical weapons. Also is producing Bio Steel which is Spider Silk Protein that is harvested from the milk.
- Netherlands based company Pharming is using cows and rabbits to produce therapeutic proteins.



The Pros and Cons of GMOs



GMOs are Nothing New

- Early on in the history of Agriculture we have been modifying our plants and animals
- Selective breeding
- Cabbage, broccoli, and Brussels sprouts all originated from one species of mustard



- GMOs became an issue to most people once we started making animal and plant in labs
- Tobacco + firefly
- Zebrafish + Jellyfish

Pros



*Grow the Feed,
Not the Weeds.™*

- Don't have to spray as much pesticide/ Herbicide
- Better Yields
- Improved resistance to disease
- Increased nutrients
- Improved taste
- More efficient (medication in crops)
- Enhance growth and cold tolerance
- Longer shelf Lives

Pros



- In Future
 - Livestock that produces leaner meat
 - Animals as a source of transplant organs
 - Mass produce drugs through animals and crops



Cons



- Unknown long term effect on organisms
- Increased stress for animals
- Roundup Ready crops promote monocultures
- Animal Health Problems cancers, brain problems diabetes

Cons

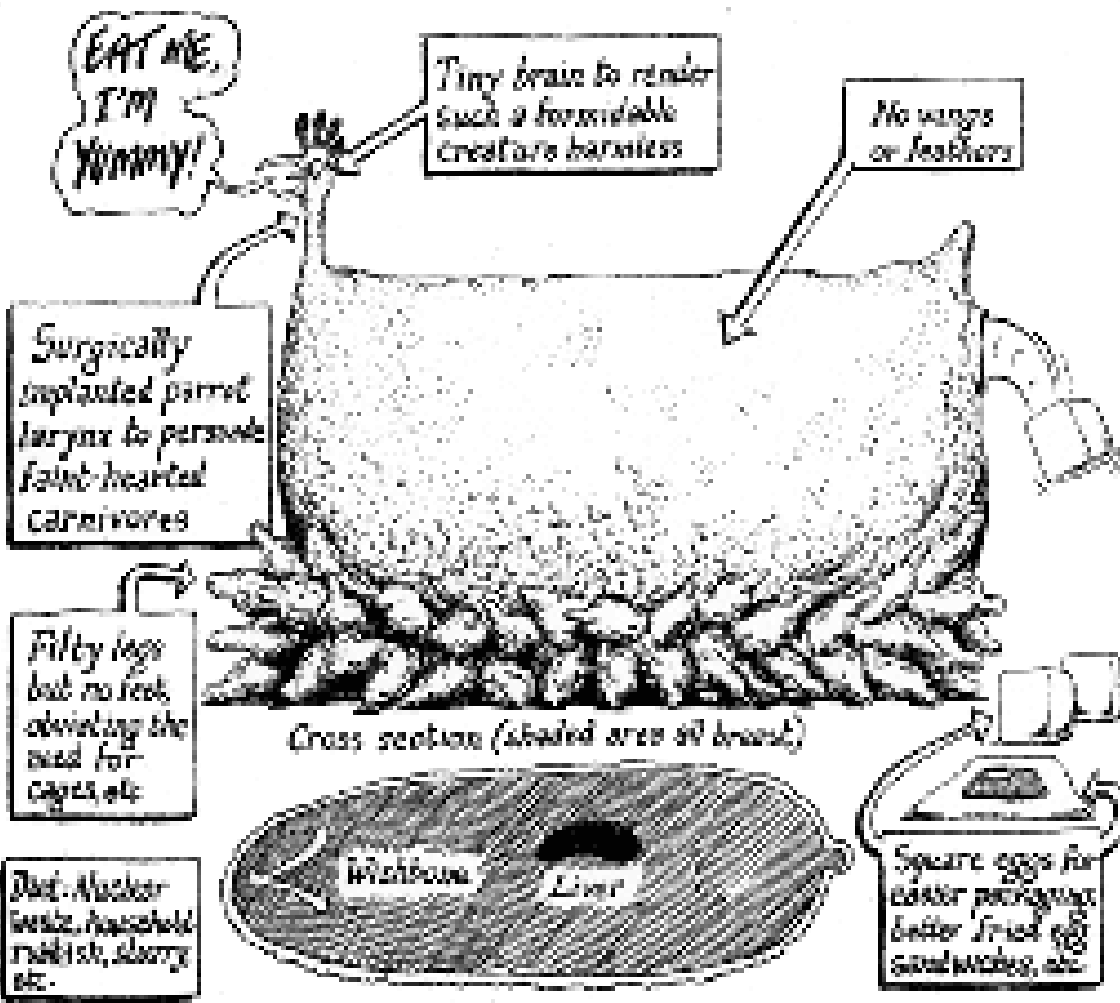


- Domination of food production
- Altering nature by mixing genes with different species
- Mixing of GM crops with non-GM crops

Success Rate

- 1% of injected eggs will survive and contain the transgene
- Once they have a successful carrier of the transgene the new technology of cloning allows them to replicate the animal with much greater success rates.

No. 8: THE CHICKEN REDESIGNED BY THE FOOD INDUSTRY



NO. 9: THE CHICKEN REDESIGNED BY THE CHICKEN



Walter Rouse

Work Cited:

- <http://www.ifgene.org/proscons.htm>
- http://www.ornl.gov/sci/techresources/Human_Genome/elsi/gmfood.shtml
- “Fear of Farming, Controversy swirls at the crossroads of agriculture and medicine.” September 20, 2004
<http://www.sciam.com/article.cfm?articleID=0003CA37-5C57-114B-9C5783414B7F0000>
- “Cave Pharming Yields Big Crops”
<http://www.wired.com/news/technology/0,67305-0.html>
- “Pharming Sheep and Corn”
<http://www.ncpa.org/iss/hea/2003/pd040303f.html>

Work Cited Continued:

- “Biohazards: The Next Generation?”
http://www.saynotogmos.org/molecular_pharming.htm
- “Genetically Engineering Crop Plants that Manufacture Industrial and Pharmaceutical Proteins”
http://en.wikipedia.org/wiki/Genetically_modified_organism
- *Down on the pharm.*, Economist, 00130613, 9/18/2004, Vol. 372, Issue 8393
“Pharming for Farmaceuticals”
<http://learn.genetics.utah.edu/features/pharming/>
- “Pharmed goats seek drug licence”, published on 02/22/2006
<http://news.bbc.co.uk/go/pr/fr/-/2/hi/science/nature/4740230.stm>