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.

http://www.saynotogmos.org
- **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)
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

Collection of Fertilized Eggs → Implant Injected Embryos into Pseudopregnant females → Injection of Transgene into male Pronucleus → Sterile → Founder Animal

Live Birth Test for Transgene
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 opposed 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 costs 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 afford 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

- 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

Surgically implanted parrot larynx to persuade faint-hearted carnivores

Tiny brain to render such a formidable creature harmless

No wings or feathers

Fifty legs but no feet, obviating the need for cages, etc.

EAT ME. I'M YUMMY!

Cross section (shaded area all breast)

- Wishbone
- Liver

Extra head for more packing

Venom tipped beak & vicious teeth

Huge legs for rapid flight, fighting, etc.

Flush extraordinarily poisonous throughout

Thick shelled dum-dum eggs. Explode on contact with tea spoons, bread soldiers, etc.

Duet: people

Duet: chickens
Work Cited:

- http://www.ifgene.org/proscons.htm


- “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”
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

  “Pharming for Farmaceuticals”
  http://learn.genetics.utah.edu/features/pharming/

• “Pharmed goats seek drug licence”, published on 02/22/2006