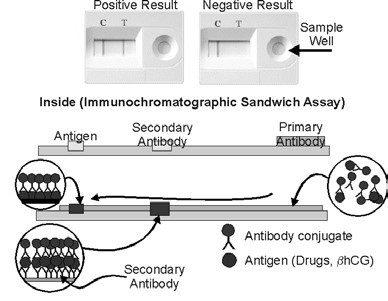
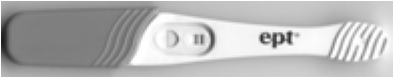
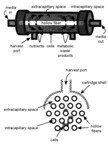
|  |  |  |
| --- | --- | --- |
| **Lecture 13: Biotechnology**  **Objectives**  Define biotechnology  Identify biotechnologies in common use  Differentiate between types of biotechnology  **Key Terms**:Recombinant DNA, fermentation, selection marker, bioremediation, Genetically Modified Organism, Sandwich assay, monoclonal antibody, gene therapy, transgenic, vector, bovine somatotropin, Bt, recombinant protein  **Useful Website** http://www.mhhe.com/biosci/genbio/raven6b/grap hics/raven06b/other/raven06b\_19.pdf |  | **Biotechnology**  **Definition:** Technology that is derived from living things and their natural processes.  **General Categories**   * **Medical Biotechnology**-Vaccines, diagnostics, pharmaceuticals * **Industrial Biotechnology** - Enzymes and microorganisms for processing products * **Environmental Biotechnology** -   Microorganisms for bioremediation   * **Agricultural Biotechnology** - Enhanced crops, feed and fertilizers |
| **Medical Biotechnology**   * **Diagnostics**   + **Every time you leave a sample…** * **Pharmaceuticals**   + **What are you putting in your mouth?**   + **Antibiotics, vaccines, chiral molecules and lots more** * **Gene Therapy** * **Vaccines** * **Xenograft and transplants etc..** |  | **Medical Biotechnology**   * **Antibody production**   + **Immunoglobins = globs that make you immune**   + **Glcosylated proteins**   + **Stick to one “epitope” specifically**   + **High affinity interaction (real sticky)** * **Recombinant protein**   + **Combine bacterial and somebody’s DNA**   + **Bacteria express protein (express = squeeze out)**   + **Protein from bacterial slaves is used for something** |
| **Agricultural Biotechnology**  •**Enhanced Plants**   * **Genetically Modified Plants (GMO)** * **Insect Resistance** * **Herbicide Resistance** * **Increased Nutrition**   •**Enhanced Animals** |  | **Environmental Biotechnology**  **Microorganisms for bioremediation**   * Miniature toxin demolition machines   Green technology for decontamination   * Plants that take toxins |
| **Industrial Biotechnology**   * **Enzymes**    + **Its not just soap!**   + **Its not really a stone** * **Microorganisms** – **Processing products**   + **Bioindicators** |  | **Medical Biotechnology**  **What is the antibody for?**  **Three questions you may have pondered**   1. **What happens when you pee on the stick?** 2. **What happens to the “specimen” on the other side of the wall?** 3. **Should this medical test really take three days?** |

# Medical Biotechnology



**Monoclonal Antibody Production**

* Key tool for finding small molecules in biological samples

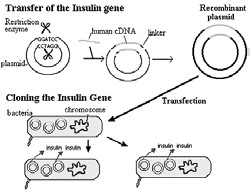


* Cells from a mouse are grown in a bioreactor
* Cells produce the antibody

|  |  |  |
| --- | --- | --- |
| **Medical Biotechnology**  **Recombinant Insulin**   * **Insulin is a hormone produced by the pancreas**   + **It is essential for the regulation of glucose in the body**   + **The pancreas of a diabetes patient has lost the ability to produce insulin.** * **Before recombinant biotech processes in the 1980's, only animal insulin was available.**   + **Usually sourced from pigs**   + **Only available in limited quantities** |  | **Medical Biotechnology**  **Recombinant Factor IX**   * **Hemophilia B**   + **A coagulation disorder characterized by a deficiency in Factor IX (no scabs)**   + **Excessive bruising, spontaneous bleeding**   + **Excessive bleeding follows moderate to severe trauma, dental work, or surgery** * **Treatment and management**   + **Factor IX Concentrate, or Fresh Frozen Plasma Risk of hepatitis B and C viruses and HIV**   + **Recombinant plasma and albumin-free Factor**   **IX**  **No risk of contamination** |

# Recombinant Insulin

**Recombinant Insulin**



•

**Clone the human cDNA (spliced gene)**

•

**Transfer the plasmid to bacteria (**

***E. coli***

**)**

**Recombine human DNA into bacterial plasmid**

* **Grow a pot load of bacteria that make the insulin protein (fermentation)**
* **Isolate the protein from all the other stuff that was in the fermentation tank**



**(purification)**

* **Convert the insulin to its active form (processing)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **New Biomed Tech**   * **Gene Therapy**   + **Weak virus that makes a missing protein**   + **Thought to be the silver bullet for some genetic diseases.**   + **Drawbacks** * **Sometimes the virus is stronger that the patient.** * **Unexpected side affects** * **Gene Pills**   – **Transient expression- If its bad, it won’t last that long**  • **Antibody Drugs - Immunotherapy** |  | | **Gene Pill**   1. **Gene pill delivers DNA to Intestine** 2. **DNA is absorbed by gut cells** 3. **Protein drug is synthesized inside the cells** 4. **Protein drug is secreted into the blood** | |
| **Gene Therapy and**  **Gene Vaccines** | | | |  | | --- | | **Antibody Drugs**  **Immunotherapy**   1. **Use the immune system to attack targets** 2. **Use Ab to attach cancer drugs or radioisotopes.Key Point: Exogenous antibody is used to find targets**   **Applications**  **Cancer targets**  **Cancer cells have unique cell surface markers**  **By attacking the unique marker good cells are left alone**  **Importance**   * **Better defense against a big killer** * **And…** | | |
| |  | | --- | | **Antibodies as Pharmaceuticals**  **New Class of inflammation relief**  **Enbrel (Amgen)**  **Humira (Abbott)**  **Remicade (Schering-Plough)**  **Protein compounds that block signals that start inflammation …** | | | |  | |

|  |  |
| --- | --- |
| **Finding the Bulls in Biotech**  The sector is blazing, the science ever more titillating. But with share prices up 214% in three years, can biotech stocks go even higher? The right ones can.  FORTUNE  Tuesday, January 22, 2002  By Brian O'Keefe  If any one product is emblematic of trends in the biotech market, it's Rituxan. This soon-to-be blockbuster is already driving growth for two of the biggest biotechs--**IDEC Pharmaceuticals**, which makes the drug, and **Genentech**, which markets it. The two companies split sales of roughly $800 million in 2001. As its adoption spreads, Rituxan, which fights a type of cancer known as non-Hodgkin's lymphoma, is on track to surpass the $1 billion mark this year. And sales are expected to grow by 20% annually over the next five years. | **Key Point** |

# Agricultural Applications

* **Herbicide Resistance** – **Glyphosate (Roundup)**
* **Nitrogen Fixation (less fertilizer)**
* **Insect Resistance (less pesticide)** • **Nutritional Improvement** – **Rice and Malnutrition**



* **Vitamin A- Beta carotene**
* **Iron- ferritin, phytate, metallothionin**
* **Animals**
* **Bovine Somatotropin (BST)**
* **Transgenic lactoferrin (HLF)**
* **Cloning and Transgenics**

|  |  |  |
| --- | --- | --- |
| |  | | --- | | **Plant Biotechnology**  Plants can be modified to bring about  many types of changes which can be of benefit to consumers, the food industry, farmers and people in the developing world.  Genetic modification can also contribute towards a more sustainable form of agriculture and bring environmental benefits. | | **Plant Biotechnology**  **Bordeaux Mixture**  CHARLES DEXTER WARD  *Nature*  **404**  , 337 (2000) © Macmillan Publishers Ltd  .  **If at first you can't convince**  **people about the benefits of**  **GM crops — cheat.**  I'm spraying my tomatoes with bordeaux mixture and it feels great.  My wife says I do the tomatoes a disservice, dousing them with  Bergerac, when our pension could easily spare Clydebank  Cabernet. But the tomatoes love it. No sooner do I get to their row  with the sprayer, than their desiccated leaves flush with green; their  blooms perk up; their ripening fruits blush with a richer glow. They  love me, my tomatoes, and I love them back. Today is special —  it's 2090, and my tomatoes and I are celebrating the safe passage of  our life-giving Sun through yet another total eclipse. |

|  |  |
| --- | --- |
| • | **Plant Biotechnology**  **Improve taste and appearance.**  – Better color, longer shelf life, more sugar/starch etc.. |
| • | **Improve nutritional qualities**  – oil seed with reduced saturated fat content. |
| • | **Enhance processing and harvesting**  **(cheaper faster cleaner)**  – Modification of tomatoes to delay ripening has led to cheaper tomato products. |
| • | **Increased ability to fight insects, disease and weeds**   * Increased virus resistance * Decreased pesticide use * Herbicide tolerance |
| • | **Resistance to drought or environmental stress**  – benefits for parts of the world where the demand for food is increasing significantly and there is not enough good arable land. |

# Genetically Modified Foods



• **60-plus plant species**

–**Tomatoes** –**Canola**

–**Potatoes** –**Soybeans**

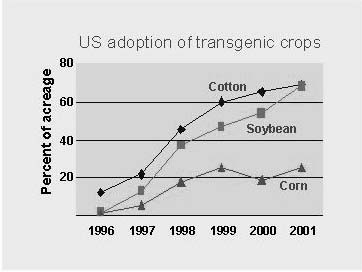
–**Corn** –**Sugarbeets**

–**Rice** –**Sugarcane**

**Most major crops have been genetically modified, …and the list is growing.**

**Plant Biotechnology**

Do you use transgenic plant products?

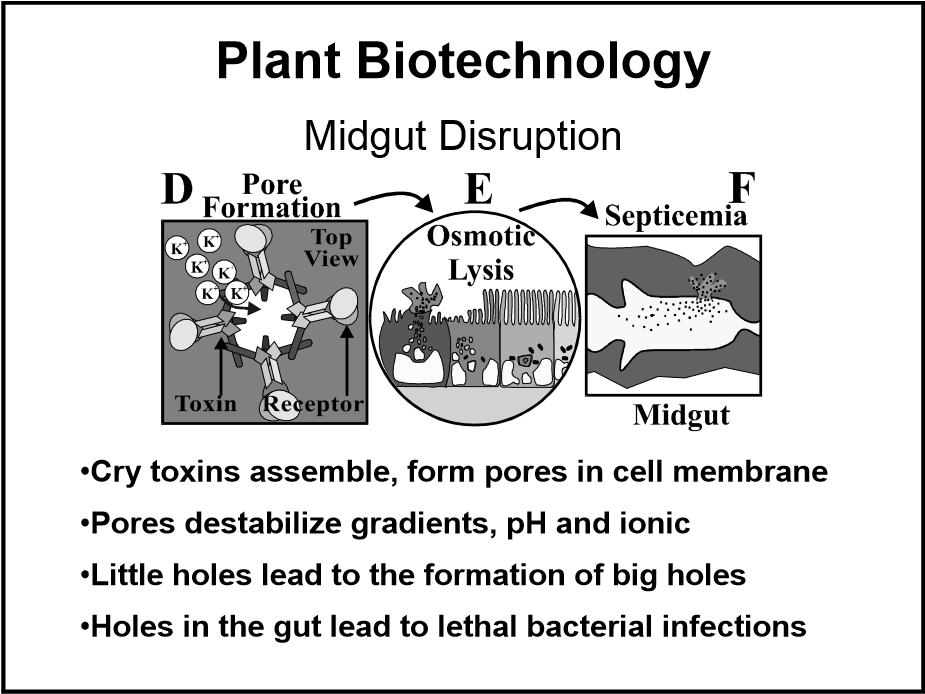
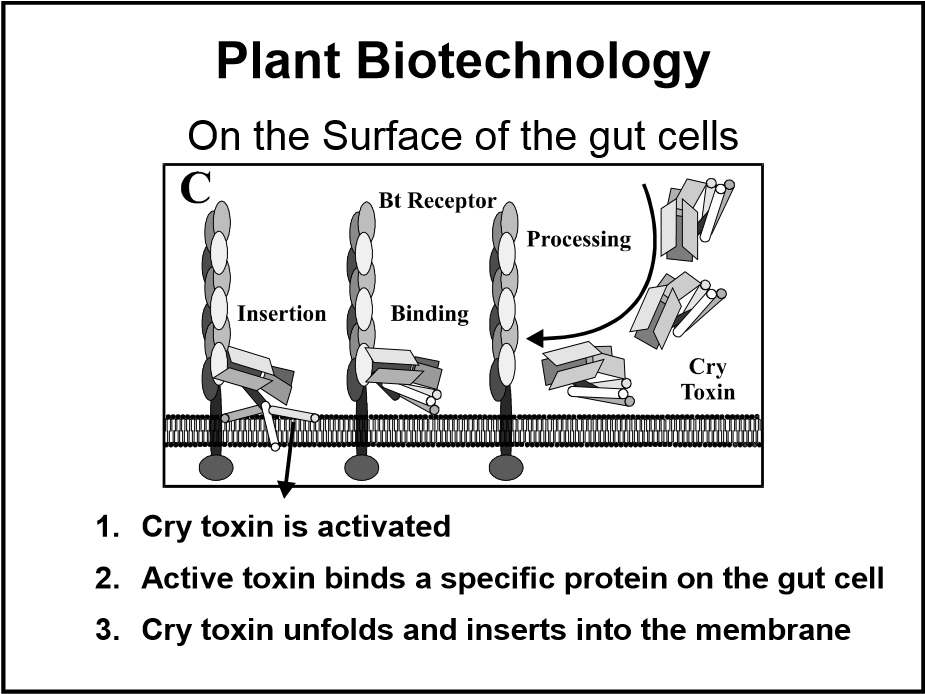


**More than 75% of US Cotton is Transgenic**



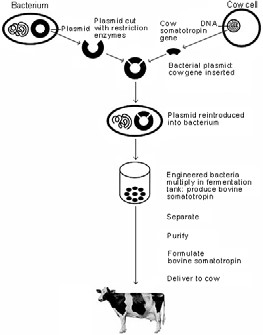
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Plant Biotechnology**  **Transgenic Cotton**  **Product used: Cellulose Plant Fiber**  **Transgenic Corn**  **What do we use from corn?**   * **Highly Purified Products-**   • **Corn Oil, Corn Starch, Corn Sugar**   * **Protein- Feed stock for agriculture** * **Whole Corn- We don’t eat much** |  | **Plant Biotechnology**   |  |  | | --- | --- | | **32 Pounds of Starch**  Adhesives, Batteries, Detergents,  Crayons, Degradable Plastics, Dyes, Plywood, Antibiotics, Chewing Gum | **1.6 Pounds of Corn Oil**  Cooking Oil, Margarine, Mayonnaise,  Salad Dressing, Shortening, Soups, Printing Ink, Soap, Leather Tanning | | **OR** | AND | | **33 Pounds of Sweetener**  Shoe Polish, Paper, Soft Drinks &  Juices, Cereal, Licorice, Peanut Butter, Pickles, Catsup, Marshmallows | **11.4 Pounds of 21% Protein Gluten Feed**  Livestock & Poultry Feed, Pet Food | | **OR** | AND | | **2.5 Gallons of Ethanol/Alcohol**  Motor Fuel Additive, Alcoholic  Beverages, Industrial Alcohol | **3 Pounds of 60% Gluten Meal**  Amino Acids, Fur Cleaner, Poultry  Feed | |  |  |   **What do you get out of a bushel or corn?**  http://www.iowacorn.org/one\_bushel.htm |

|  |  |  |
| --- | --- | --- |
| |  | | --- | | **How do you make transgenic plants?**   * **Plants can be regenerated from a single cell** * **Add the new gene**   + **Biolistics: Fire DNA gold particle into the cell**   + **Vector transport: Agrobacterium** * **Bacteria “drops” the DNA into the cell** * **Select a cell with the gene** – **Marker genes for selection** * **Protects cells that have it**. | | **How do you make transgenic**  **plants?**  **1**  **. Add gene to individual cells**  **2**  **. Poison cells with out new DNA** |
| |  |  |  | | --- | --- | --- | | **Insect Resistance** **Stored Product Protection** | | | |  | **Weevils are a major**  **pest of most stored products.** |  | |  |



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **BioPharm**  **Pharmaceuticals made in plants**   * **Protein Based Drugs**   + **Expensive: high processing cost**   + **Hard to make in large quantities** * **Produced in seeds, leaves and tubers** • **Benefits**   + **Low capital, Scaleable production**   + **Small acreage, High profit for growers** * **Risks**   + **Pollen, Co-Mingling, Exposure, Environment**   http://www.colostate.edu/programs/lifesciences/TransgenicCrops/index.html |  | **BioPharm from Plants** | | | |
|  | **Product** | **Definition** | **Examples** |
| **Antibodies** | **Proteins for immune defense responses** | **Specific antibodies developed to fight cancer, treat inflammation, and fight viral and bacterial dieseses.** |
| **Antigens (vaccines)** | **Stimulate production of antibodies that protect against disease** | **Vaccines for protection against cholera, diarrhea (Norwalk virus), and hepatitis B** |
| **Enzymes** | **Proteins that catalyze**  **biochemical reactions** | **Enzymes used to treat and to diagnose disease.** |
| **Hormones** | **Chemical messengers** | **Insulin for diabetics** |
| **Structural proteins** | **Proteins for structural support to cells or tissues** | **Collagen is a structural protein found in animal connective tissues and used in cosmetics** |
| **Anti-disease agents** | **Variety of proteins** | **The anti-infection agents interferon and lactoferrin, and aprotinin have been engineered in plants** |
| **http://www.colostate.edu/programs/lifesciences/TransgenicCrops/index.html** | | |

# Animals in Biotechnology



**VS.**

**Recombinant**

**Bovine**

**Somatotropin**

**(**

**rBST**

**)**



## Agricultural Biotechnology

* **Genetically modified products for animals**
* **Genetically modified animal products**

|  |  |  |  |
| --- | --- | --- | --- |
|  | |  | **Food**  **The addition of 80 million people a year to an overpopulated world of nearly 6 billion people places unprecedented**  **pressures on social and biological systems globally. The**  **world population is depleting the living systems on which life depends. This poses significant challenges for continued economic and social growth.** |
|  | **got** |
| **milk?** |
| * **Researchers are using biotechnology and genomics to develop products that integrate food, agriculture and health.** * **Health-enhancement traits can be added to crops, erasing the line between agriculture and pharmaceuticals** * **An example in pharmaceuticals is adding a substance that lowers cholesterol into a food crop. Then the crop actually contains a product that will help you lower your cholesterol. -Monsanto Company**   http://www.mobio.org/a\_BioSci.asp |

**Motivation?**

**The Real Price of a Big Mac**

**Filmmaker Morgan Spurlock discusses life as a human guinea pig**



Spurlock, wired to an

EKG machine, learns

firsthand the human

costs of America’s love

affair with fast food



Want fries

with that?

**30**

**days**

**and**

**nothing**

**but Mac**



**Obese kids take The children's lawyer, McDonald's to court Samuel Hirsch, called November 29, 2002 McDonald's food "a very**



**insipid, toxic kind of**

A group of New York children are **thing."**

suing McDonald's, claiming the Clown let them down. They didn't realize a steady diet of Big Macs and fries could make them obese and diabetic.

The lawsuit accuses the burger chain of violating US consumer fraud laws by failing to fully explain the health risks of their Mcfood.

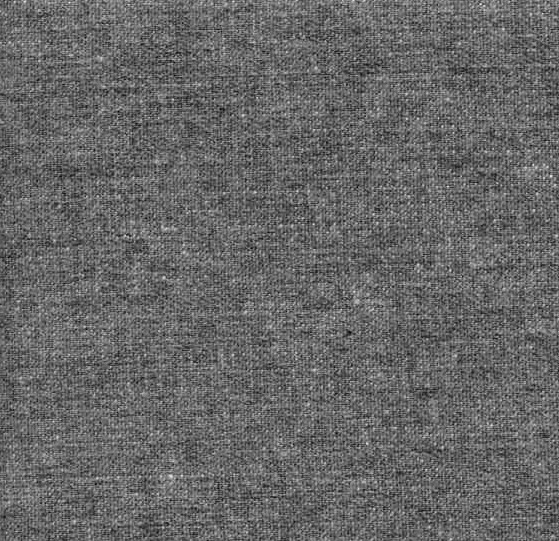
|  |  |  |
| --- | --- | --- |
| **Plant Biotechnology**  **Ethics and Regulations**  **Potential health risks**  **Is GM food dangerous**  **Are GMO’s environmentally safe**  **How do you know if it’s GMO** |  | **Key Issues in the Debate**  **The arrogance and economic vestedness of science in GMO technology…**  **Gene mixing: “sanctity of species”…**  **Human health effects from eating GMO’s**  **Gene escape & the ruin of ecology**  **Resistance & sustainability**  **Multinationals & global food security Gene ownership:** |

|  |
| --- |
| **Industrial Biotechnology**  **Invisible Biotech “White Biotech”**   * **There are loads and loads of industrial biotechnology processes** * **Many of them are really important and make people loads of money** * **What industrial biotech products do you use? (These are the most important ones)** |

# Industrial Biotechnology

**If you are wearing denim please stand up**

**When you bought your denim was it stiff as a board and very dark blue? If yes sit down**



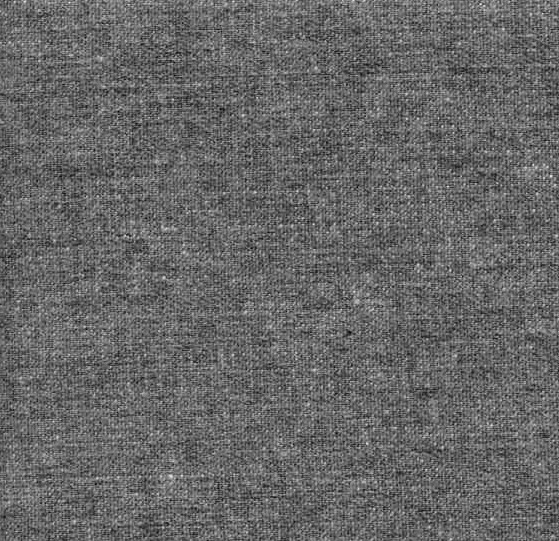
**Was it actually “stone washed”, ie, was there grit in the fabric? If yes sit down**

**How did it get the used look?**

# Industrial Biotechnology

## Enzymes and the textile industry

1. **Amylases- desizing, starch to sugar**
2. **Proteases- detergents, removing protein stains**
3. **Cellulases- “biostone” de-pill, degrade cellulose**
4. **Pectinases- retting and cleaning, fiber separation and removing plant impurities**
5. **Catalases- peroxide bleaching, degrades peroxide**



1. **Laccases- decolorize indigo, denim finishing**

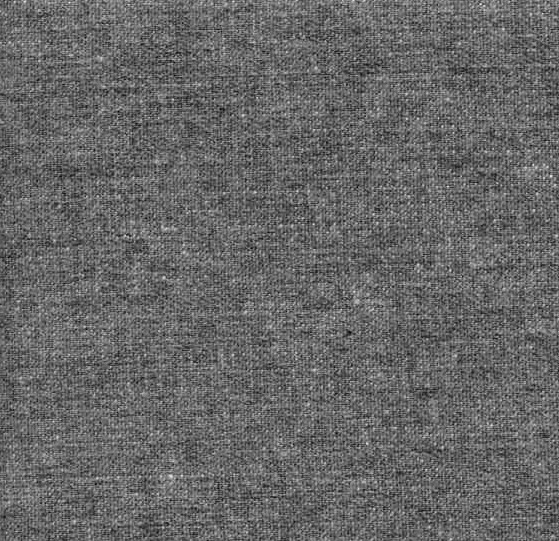
# Textile Biotechnology

**Sizing**

* Cotton fibers are coated with starch to prevent damage during weaving.
* The starch has to be removed before dying

**Desizing: Two options**

* 1. **Harsh alkaline wash or treatment with strong oxidizers.** - **What do you do with the chemical waste**

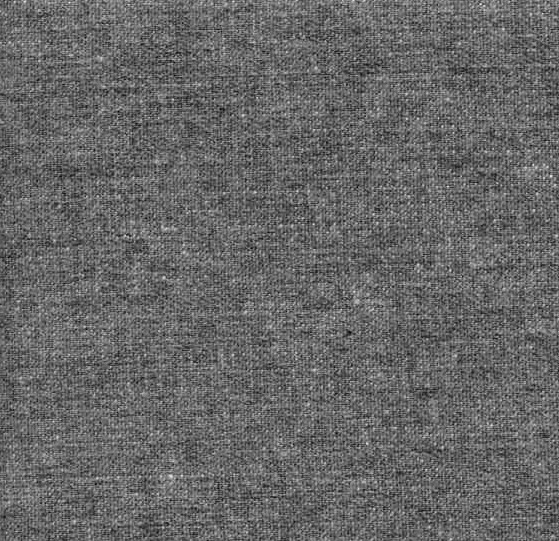


* 1. **Enzymatic digestion of starch with amylase**
* **Try this at home: Suck on a cracker and the amylase in your spit will begin to turn the starch into sugar.**
* **Waste material is biodegradable**

# Textile Biotechnology

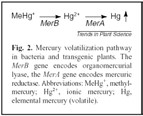
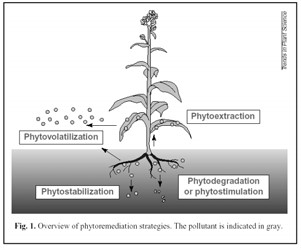
**Carbonizing wool**

* **Plant material must be removed from wool before dying.**



* **Fabric treated with strong Sulphuric Acid and heat to “burn” off the plant matter**
* **Enzymatic treatment with cellulases and pectinases to remove cellulose and lignin**

**Mercury Phytoremediation**



*Trends in Plant Science*

, 2000,

**5**

:

*6*

:235-236

**Strategy for**

**Cleaning up**

**Mercury**

**Contamination**

**1**

**.Dilute Hg in**

**the air**

**2**

**.Make Hg insoluble**

**Move bacterial genes into plants (transgenic)**

# Environmental Biotechnology

## Cleaning up messes in the ground

**Schoolkraft Michigan-** Stored grain products treated with halogenated hydrocarbons

**Treatment-** Sterilize grain to prevent rot, insect and mammal contamination **Problem-** Ground and water contaminated under the slab where treatment occurred **Solution**- Bacteria that break down the toxin were selected in labs at MSU and released into the upper ground water layers



**Results-** …

|  |
| --- |
| 1. **Are transgenic plants safe to eat (T/F)** 2. **Should GMO plant containing products be labeled (T/F)** 3. **If GMO produce or food products are labeled**   **QUIZ**   * 1. **I will avoid it like the plague**   2. **I will actively choose normal over GMO**   3. **I will not actively discriminate agains GMOs**   4. **I will actively select GMOs**  1. **Organic food is more healthy than GMO foods (T/F)** 2. **Do you use biotechnology products (T/F)** 3. **Did you know you were using biotechnology products (T/F)** |

|  |
| --- |
| **Final Slide**  **Study guide will be posted by the Monday following spring break**  **Before the exam:**  **In class review (Tuesday normal time)**  **Out of class review (Wednesday evening)**  **Next: Eric Hoffman**  **Dr. Mark Whalon** |

1