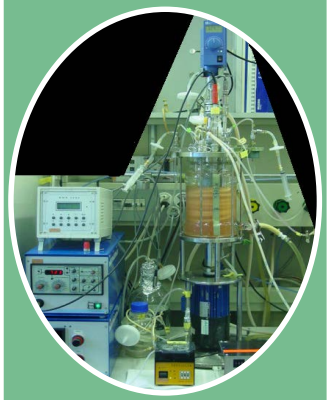


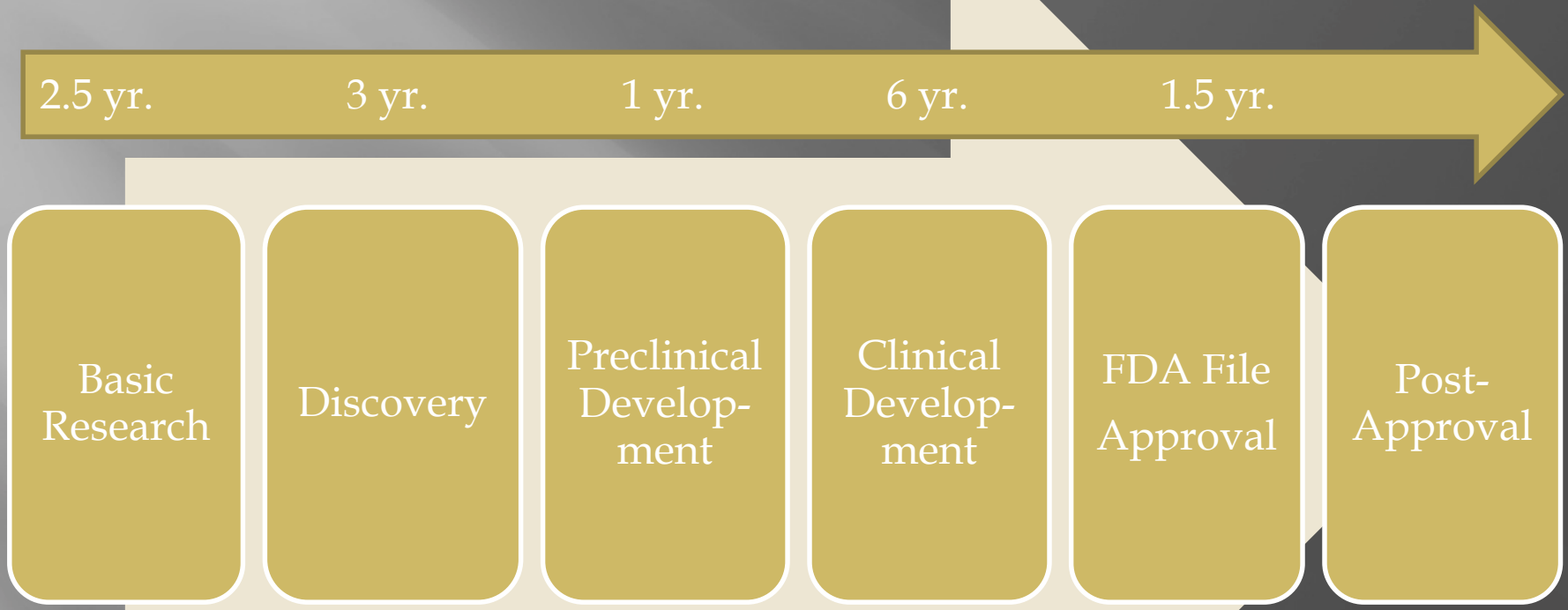
Engage | Explore | Explain | Elaborate | Evaluate

Biotechnology in North Carolina Today

# What is Biotechnology?

- Biotechnology
  - Uses cells as small factories for chemical synthesis
  - Bio (living) + technology (industrial, commercial or practical application of science)
- Pharmaceutical
  - Chemicals made with medical applications
  - Based on structures within the body and their functions
- Drug Development
  - Product that can apply to varied problems, trial and error
  - Scientific advances allow us to create therapies for a specific purpose.

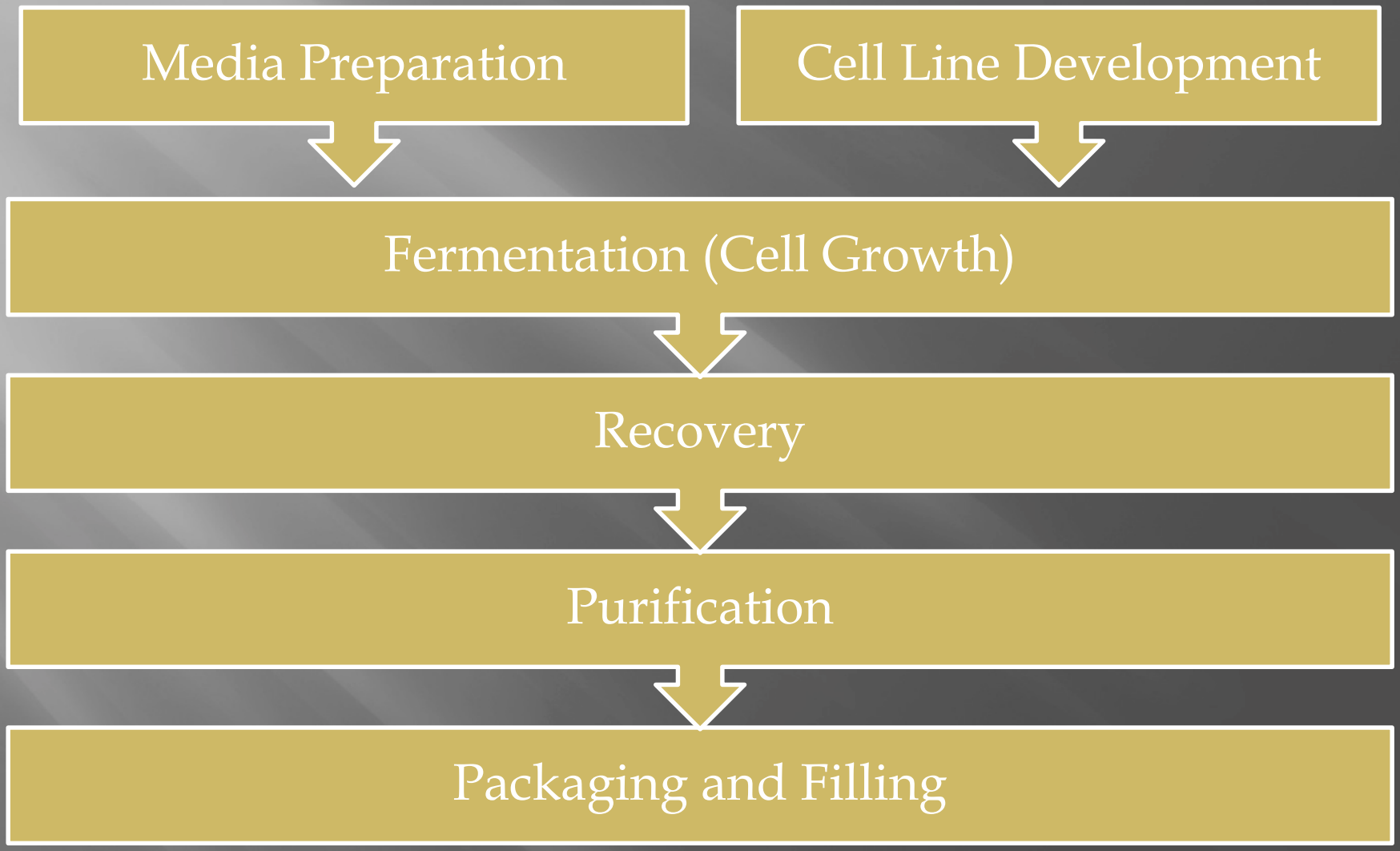
# Research and Development




**Cost ~ 900 million dollars per drug**

www.tysabri.com

# Biomanufacturing Process



# Media Preparation

- The liquid that the cells will grow in is called Media.
  - The media must provide all of the nutrients that the cells need to:
    - Grow
    - Reproduce
    - Make the chemical product that we want to harvest.
  - Media must be completely free of organisms or viruses (sterile).

# Cell Line Development

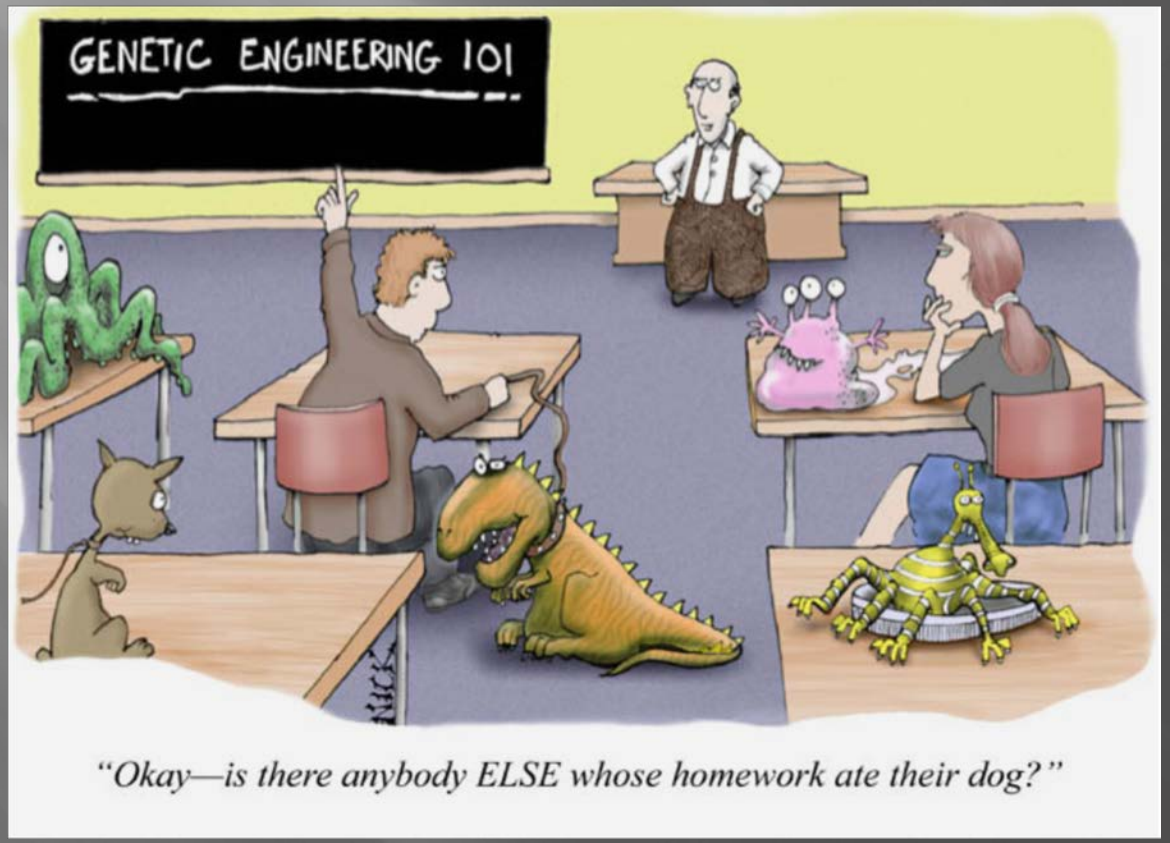
- Cells used for biotechnology must meet certain requirements.
- They must:
  - Grow fast
  - Not change as they reproduce (no mutations)
  - Be able to grow in a culture
  - Make the product
  - Grow on inexpensive nutrients.

# Genetic Engineering

- Wild cells that occur in nature usually do not meet these needs.
- Genetic engineering is the process of placing the genes that produce the proteins we want into a cell that will:
  - Grow in a culture
  - Express the gene for producing that protein
  - Make the protein in the form we need.
- Cells frequently used include Chinese Hamster Ovary (CHO) cells and E. coli cells.
- Tysabri made by Biogen Idec uses CHO cells

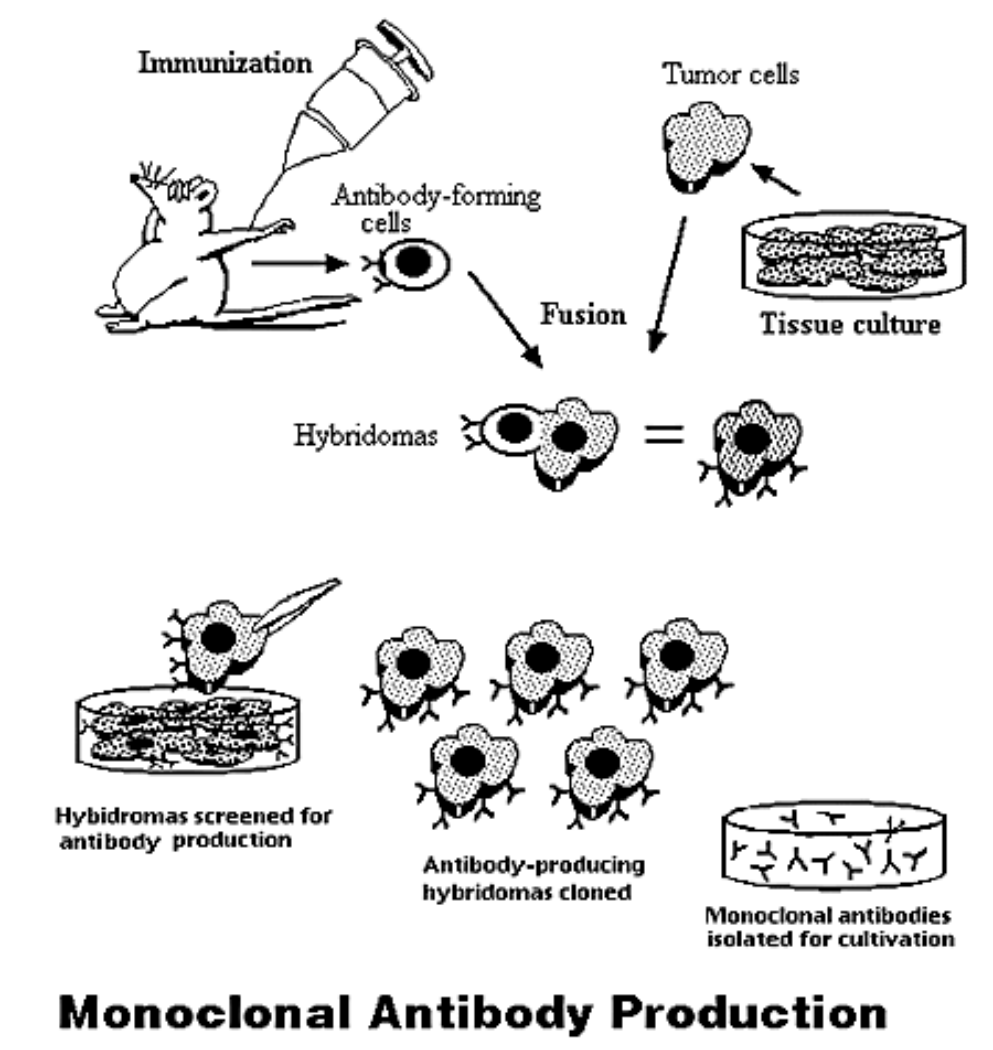
# What Genetic Engineering Isn't

Genetic Engineering doesn't change an organism into a different organism, it only gives them a gene to make a protein that they wouldn't ordinarily make.




*"Okay—is there anybody ELSE whose homework ate their dog?"*

# Monoclonal Antibodies



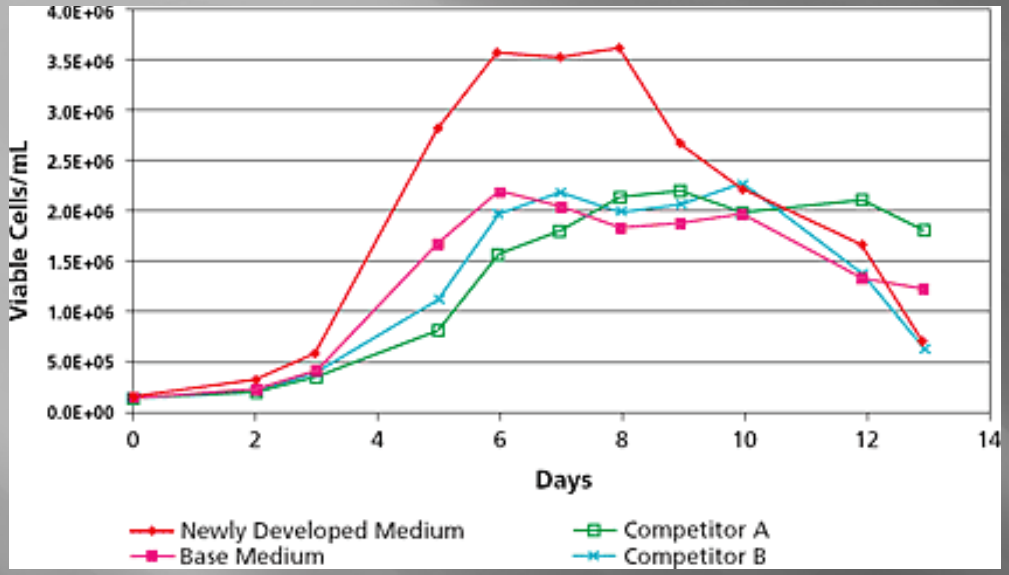
# Cell Growth

- Once the cells have been developed and tested, they must be grown in production quantities so they can make enough medicine to sell.
- Inoculation is the introduction of cells into the media where they will grow.
- Cells are often grown in containers of gradually increasing size – called "staging" starting with a small vial, a "seed batch."

# Cell Growth

- Bioreactors are the growth chambers for cells.
  - STERILE – to prevent the growth of unwanted organisms.
  - Stirred, with many sterile inlets and outlets for fluids and gases
  - Can be as large as 100,000 L (4 tanker trucks)
  - Monitored constantly – temperature, pH, number of cells, oxygen levels, $CO_2$, etc.
- Cells may take a week to grow or only a few days depending on the type.

# Cell Growth


4.0E+06
3.5E+06
3.0E+06
2.5E+06
2.0E+06
1.5E+06
1.0E+06
5.0E+05
0.0E+00
Viable Cells/mL
0
2
4
6
8
10
12
14
Days
Newly Developed Medium
Base Medium
Competitor A
Competitor B

# Recovery and Purification

- Once the cells have grown enough, the product must be recovered and purified.
- This must be done carefully, because the chemical product can often be easily damaged.
- Recovery involves:
  - Removal of the cells and cell debris
  - Removal of excess water (concentration)
- Purification involves:
  - Removal of all other chemical compounds other than a solvent the product may be dissolved in.

# Recovery and Purification

- There are often many steps involved in this process. Think of it as trying to get the orange pigment out of the carrots that are in a chicken soup.
- Steps may include:
  - Filtration – which gets rid of things based on size – small things can pass through the filter and large things cannot
  - Centrifugation – which spins the media and can be used to remove denser materials that sink to the bottom
  - Column chromatography – which can hold on to certain substances based on their chemical or physical properties. Then those substances can be washed out in a new solvent.

# Recovery-Purification

Filtration

Chromatography Column

# Packaging and Filling

- The last step in the process is to put the product in the form used by the customer and put it into a container.
- Forms can be:
  - Granular- like the enzymes that go in detergents
  - In sterile solution – like medicines that have to be injected
  - Or others
- Like the other steps, if the product is a medicine or food then everything must remain sterile for the whole operation.
- The smallest contaminant could kill a patient.

# Packaging and Filling

# Biotechnology's Future

- Testing for and Prevention of disease
- Boosting Nutrition of foods
- Biomarkers for disease
- Targeted Therapies for disease
- Gene Therapies for disease
- Xenotransplantation to grow replacement organs for humans in other animals
- Regenerative Engineering to grow back dead or diseased organs
- Vaccines to prevent infectious disease

# Citation

- Images and some content courtesy of Biogen Idec.
- North Carolina Biotechnology Center publications, including Bioworks curriculum, for some content.