

Pharmaceutical Biotechnology

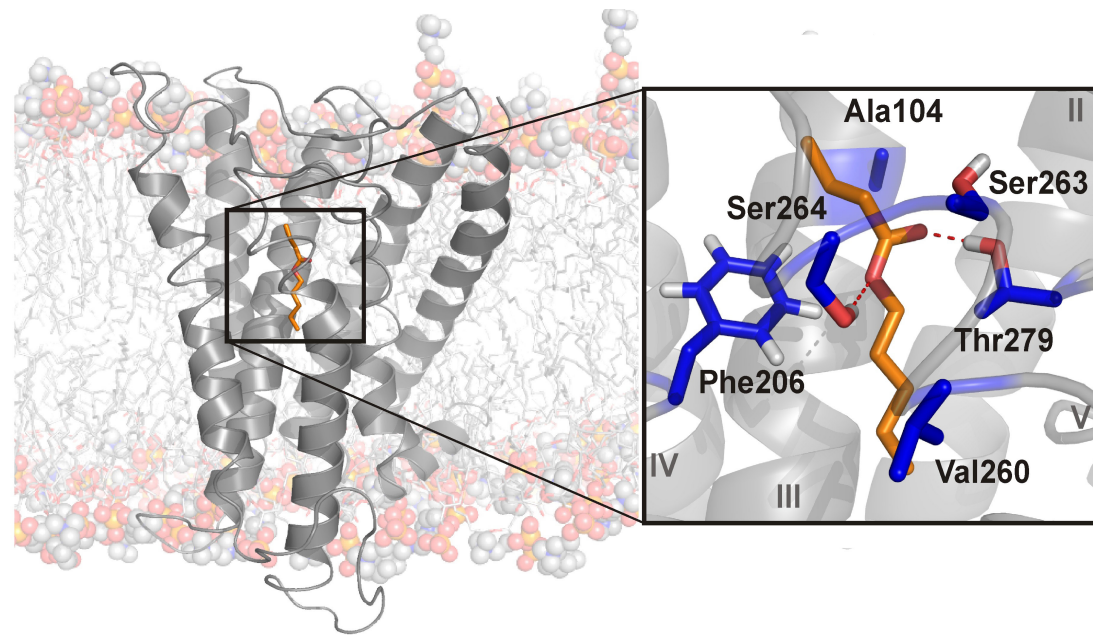
Code: BIOENG-437

Fall semester 2015

MER, Dr. Horst Pick



Odorant and taste receptors



Prof. Dr. Florian M. Wurm

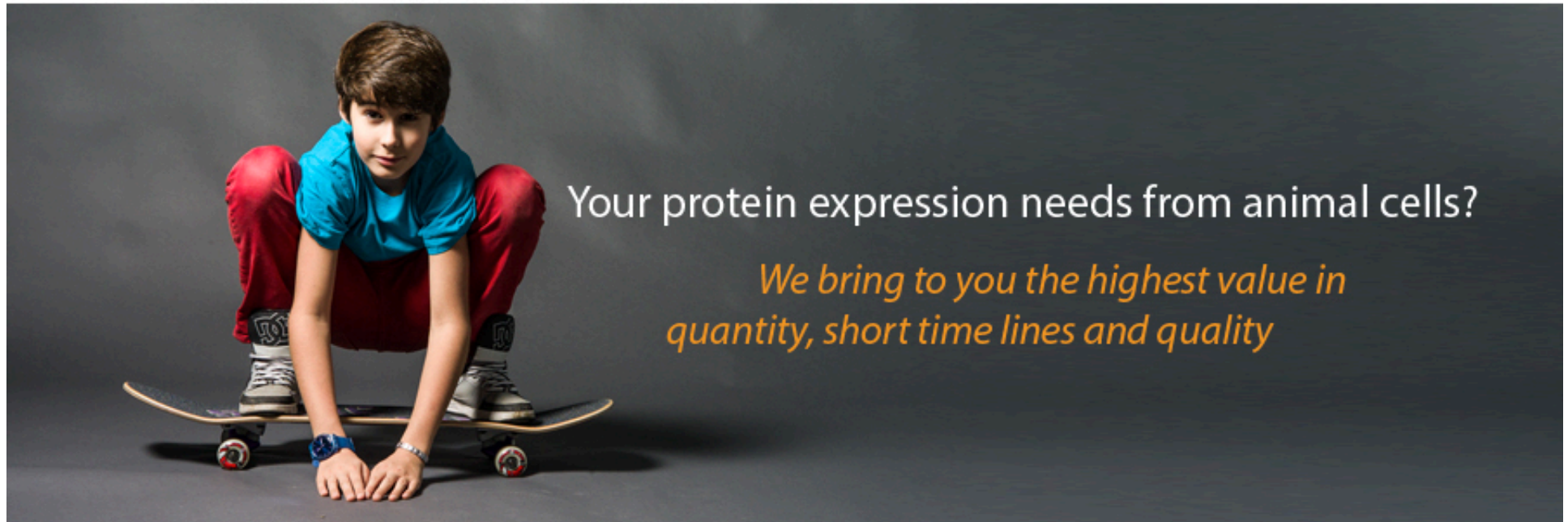


Cellular Biotechnology Laboratory LBTC, EPFL

Statement

- *The here provided Biotechnology lecture has been established and developed over 20 years of teaching by Prof. Wurm, who retired in 2015. I was given the opportunity to follow his lecture last year and have been permitted to modify it, according to my style. I am grateful for this opportunity.*

Founder of ExcellGene (2001)



Your protein expression needs from animal cells?

*We bring to you the highest value in
quantity, short time lines and quality*

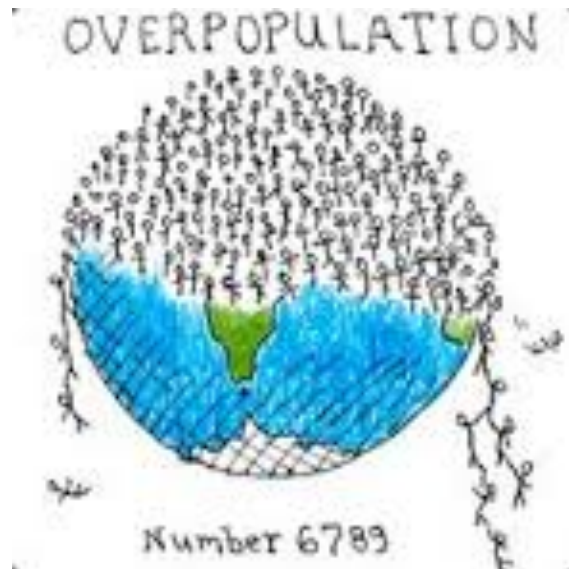
ExcellGene SA
Route de l'Île-au-Bois 1A
CH-1870 Monthey
Switzerland

Course contents



Chapter 1

- Food biotechnology



Sustainable intensification of agriculture



Urban farming on the rooftop/Basel since 2013



FOOD AND NUTRITION CENTER CNU (EPFL)



FOOD AND NUTRITION CENTER CNU

- **EPFL has inaugurated an interdisciplinary research center focused on nutrition and foods. The new Integrative Food and Nutrition Center (CNU) aims to bring together the big players in research and industry around issues related to food.**



Francesco Stellacci,
Director of the Food and Nutrition Center CNU

Main Trends

- **Traditional food**

Amelioration of existing products
Product Quality, Safety and Compliance
Enhancement of Consumer confidence
Product & Technology renovation

- **High - tech products (Functional Food)**

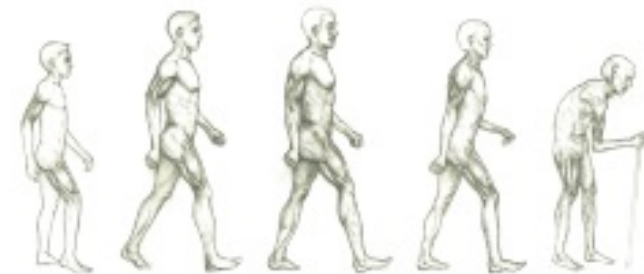
Functional food with test of bioavailability and bioefficacy --> Innovation
Active ingredients interaction with human metabolism
Food for a healthy life style, active aging and disease prevention

- **Sustainable food chain**

Food processes innovation, lower energy consumption and efficiency
Development of easy to handle, to use, to prepare food at home
Innovation in food renewable packaging and food preservation
Increasing the value of the by-products of agriculture materials
Enhancing cleaning processes. Adaptation to future climatic changes



Nestlé Institute of Health Sciences



- Fight against muscle loss in old age
- Diabetes
- Gastrointestinal health

MEAT



Insects as protein sources?

- Not only are insects extremely high in protein, but they also emit a fraction of the greenhouse gases, require little or no water and can be raised on food waste.

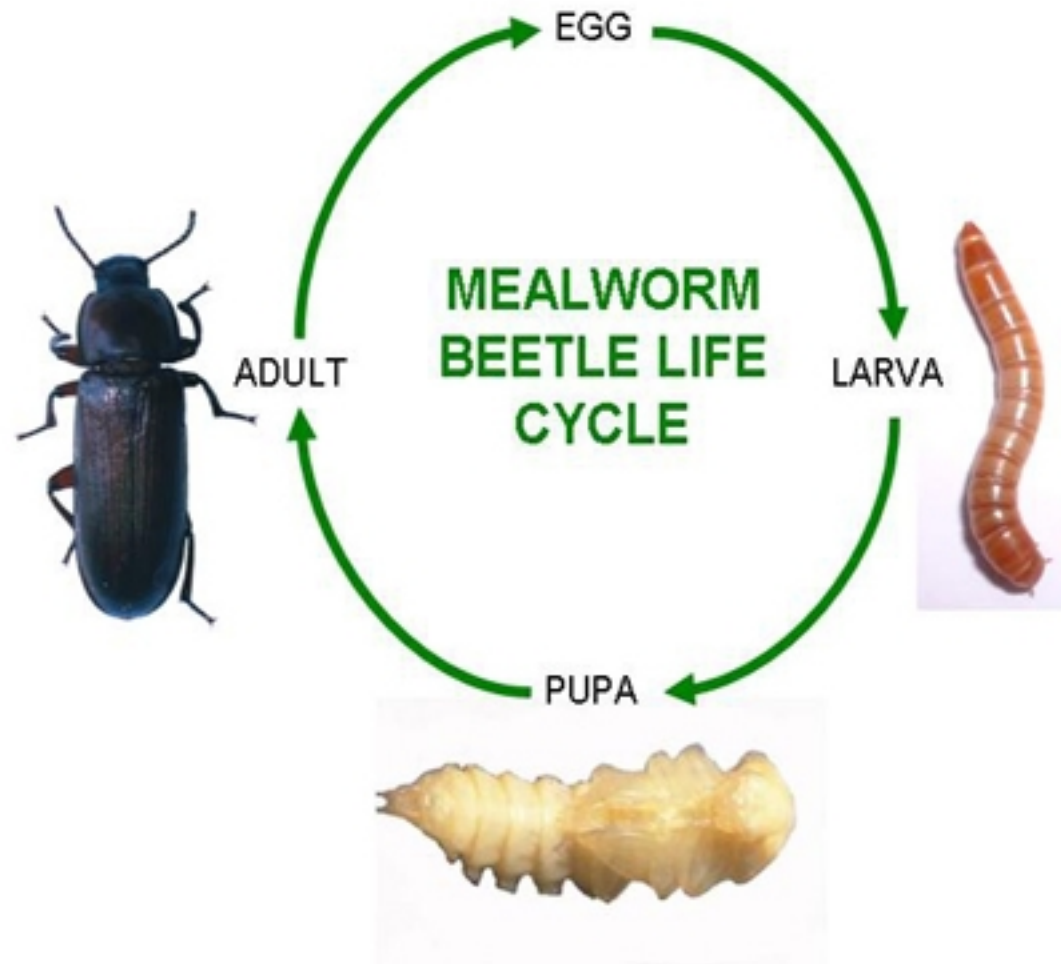


Mealworms



C-fu, a patent-pending technique for extracting protein from mealworms

Life cycle of *Tenebrio molitor*: Mealworm



Cornell University/New York

- Less impact on the environment
- Less planet-warming gasses compared to larger animals like cattle and poultry
- Less land



Rhode Island 3140 km²
Enough space for mealworm
protein production for 2 billion
people.
Switzerland: 41285 km²

Indigenous people in Asia, Africa, Australia, South America, and Mexico commonly eat these insects when they are in their immature stages



The most commonly consumed insect in Africa, according to the Food and Agriculture Organisation (FAO), is the cricket

Ready for the Bug Mac?



Feb. 2015
Britain's first insect-only restaurant
serves bug burgers and cricket kebabs
Haverfordwest, South Wales

Insects for human consumption available in the supermarket

- [AFSCA, the Belgian food safety authority, in December 2013 to allow the sale of ten different types of insects for human consumption, two of the leading Belgian multiples, Delhaize and Carrefour, have entered this new protein segment](#)



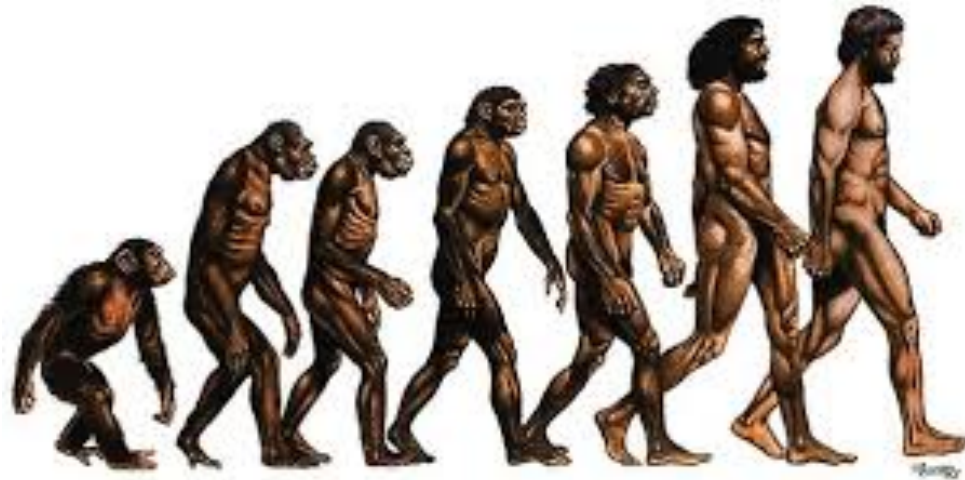
Insects for human consumption in Switzerland

- In 2014, the Swiss authorities promised to put edible insects on the market (Isabelle Chevalley, member of the National Council of Switzerland)



Human evolution

- Where do we come from? Who are we?



We are Neanderthal + Denisovan

- Hominid cousins interbred. We carry their DNA.



Denisovan finger bone fragment
41,000 years ago, female

Fire as a central biotech invention of “homo”



Diversity in human appearance



Transition hunter/gatherers to farmers

- Genome changes/gene activity changes



Chapter 2

- Infectious diseases transmitted by animals

Smallpox

- Eradicated 1980



Influenza

- Pandemic **1918** (Spanish flu) involving H1N1 influenza virus
- 50 Mio people died
- Pandemic 2009



Armed Forces Institute of
Pathology / National Museum of
Health and Medicine

Syphilis

- sheep



Susan Lindsley/CDC



MERS Middle east respiratory syndrom

- Outbreak in 2013 in Saudi Arabia. 282 people died



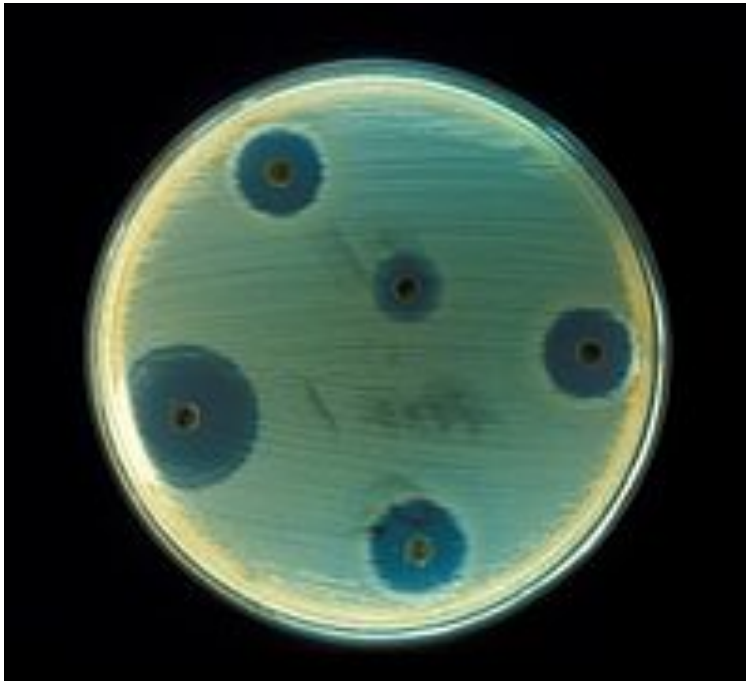
Vaccine development

- Different types of vaccines



Antibiotics

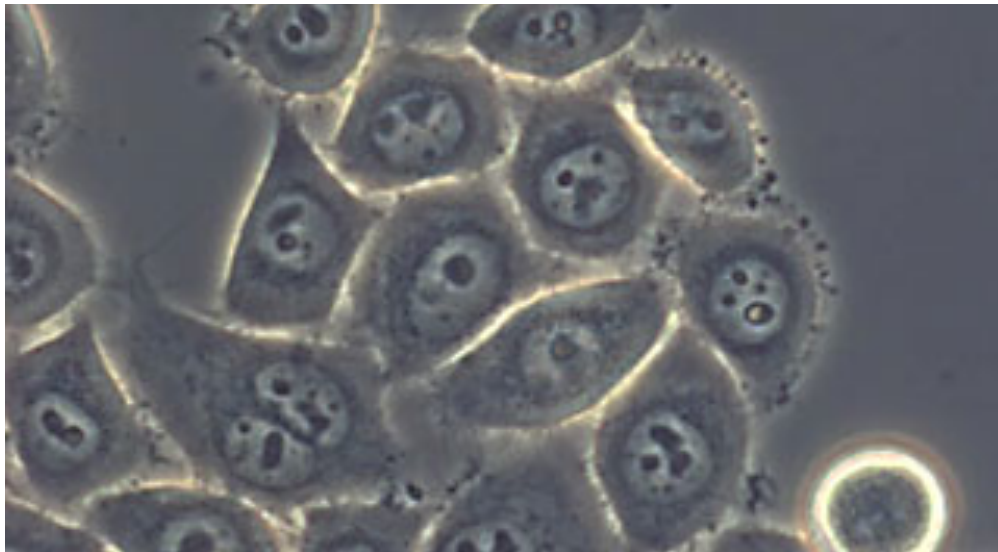
- Sources for novel antibiotics



Chapter 3: Biologicals

- Production of therapeutic proteins using cell technologies

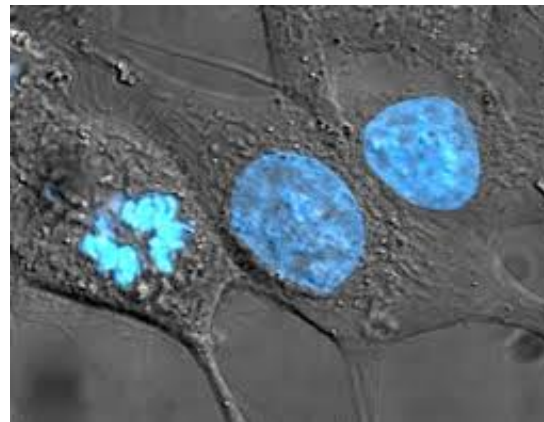
HeLa cells (immortalized tumor cells)



Henrietta Lacks
(1920-1951)

Basics of animal cell culture

- Media components etc.



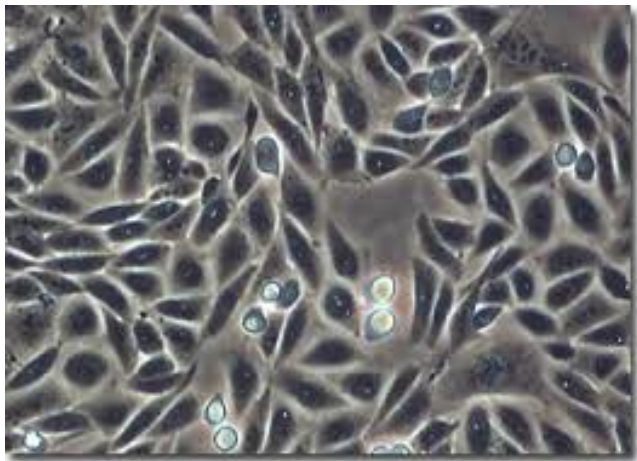
Chinese Hamster Ovary cells (CHO)

- Wildtype chinese hamster

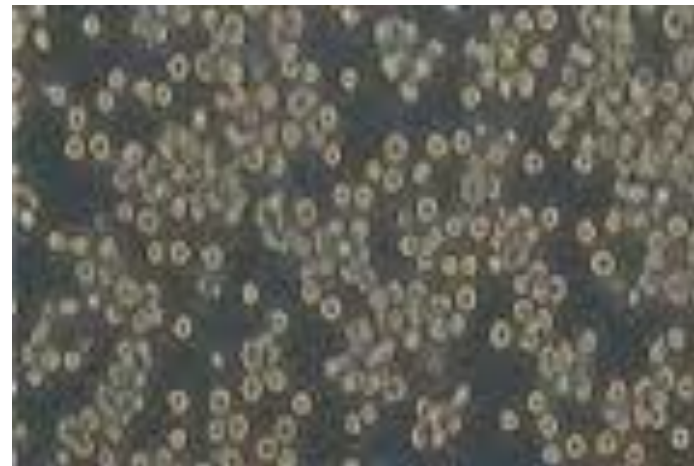


Chinese Hamster Ovary cells (CHO)

- Major host cell type for recombinant protein production



(adherent growth)

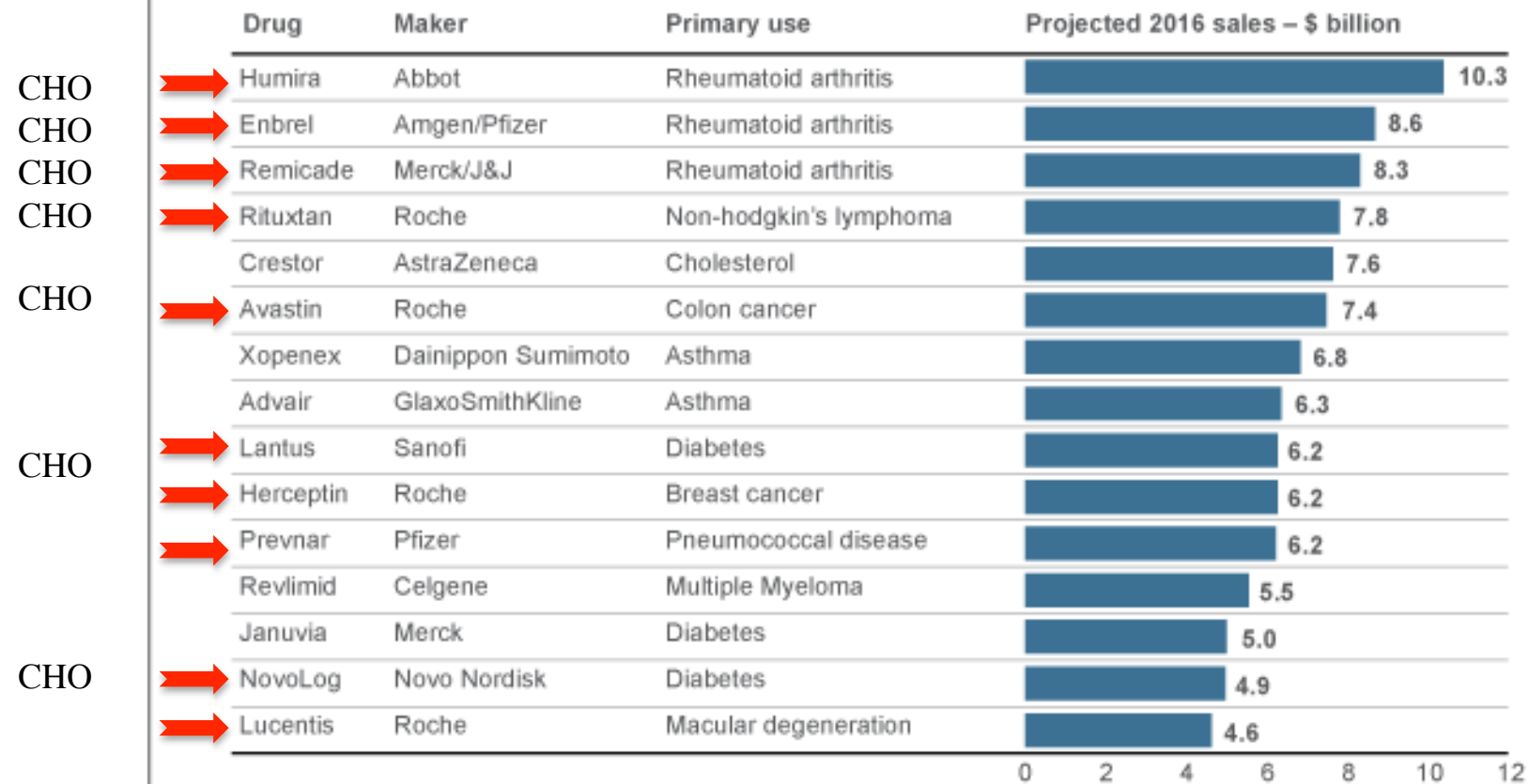


(suspension growth)

Biologicals are the future

Top projected drugs by sales in 2016

Pfizer Inc's Lipitor, the world's top-selling prescription drug of all time with peak annual sales of about \$13 billion, is about to face competition from cheap generics. Here are the medicines expected to be the world's top sellers by 2016

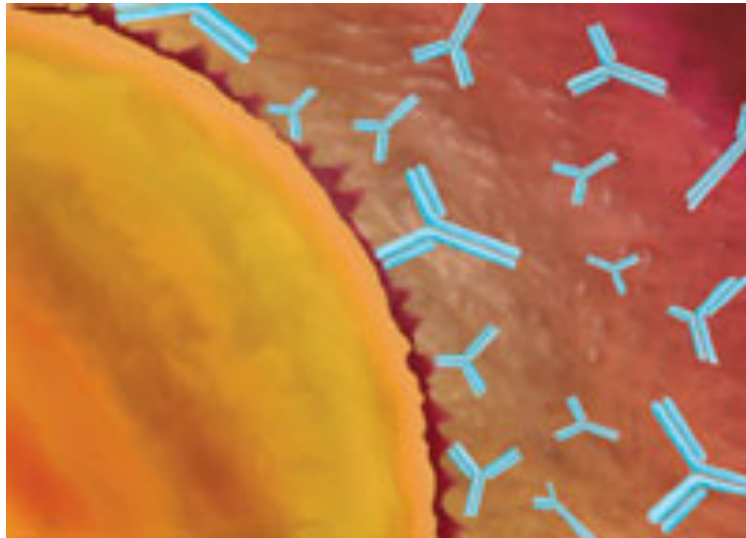


Source: Thomson Reuters Forecast



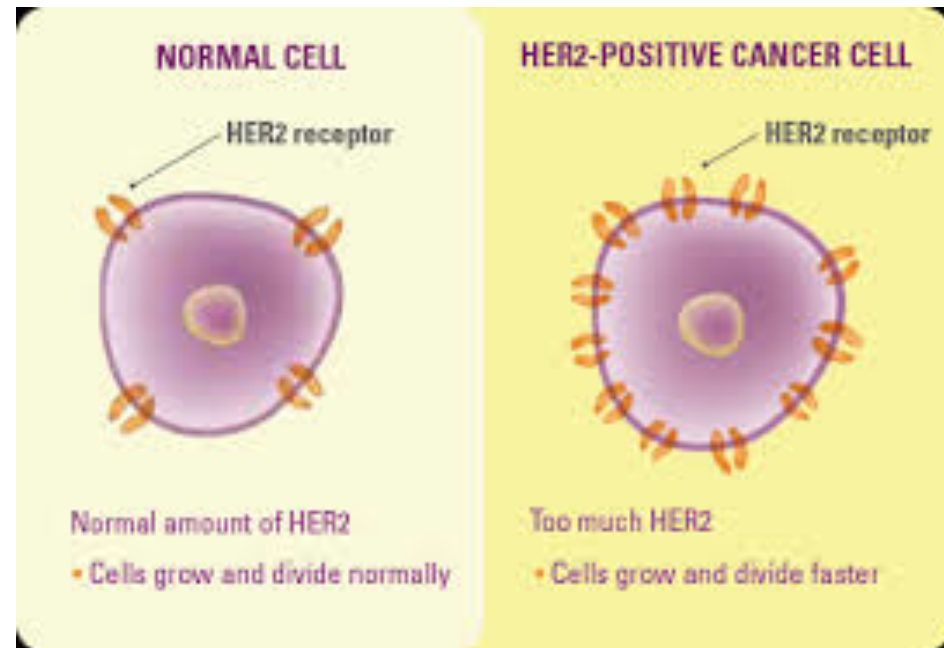
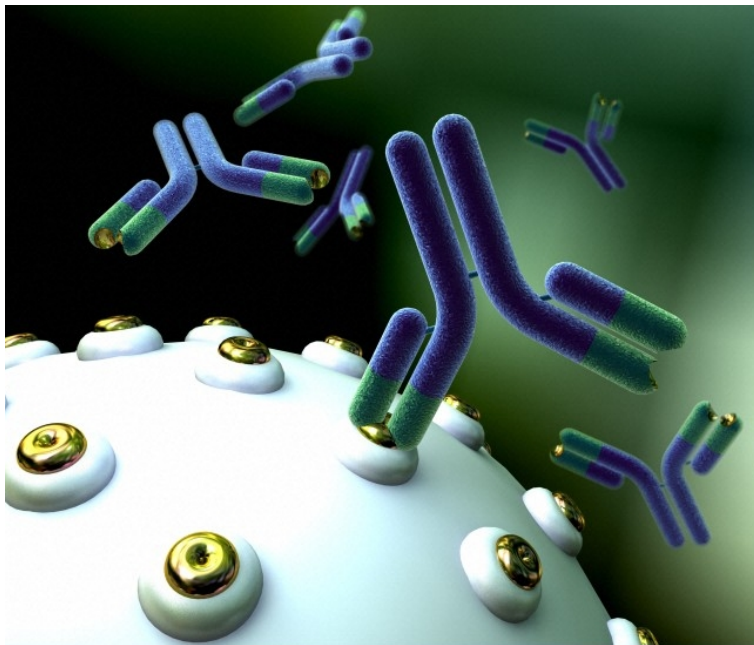
CHO cells for recombinant antibody production

- Recombinant monoclonal antibody production
- Herceptin (Roche/Genentech), estimated worldwide sale **2012**: \$6.08 billion



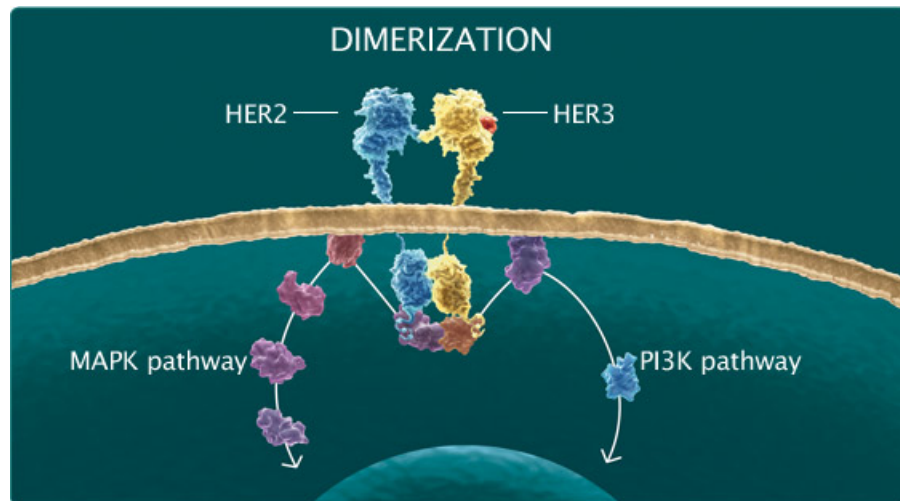
Therapeutic monoclonal antibodies

- Humanized monoclonal antibody (HERCEPTIN/Roche) HER2 positive breast cancer



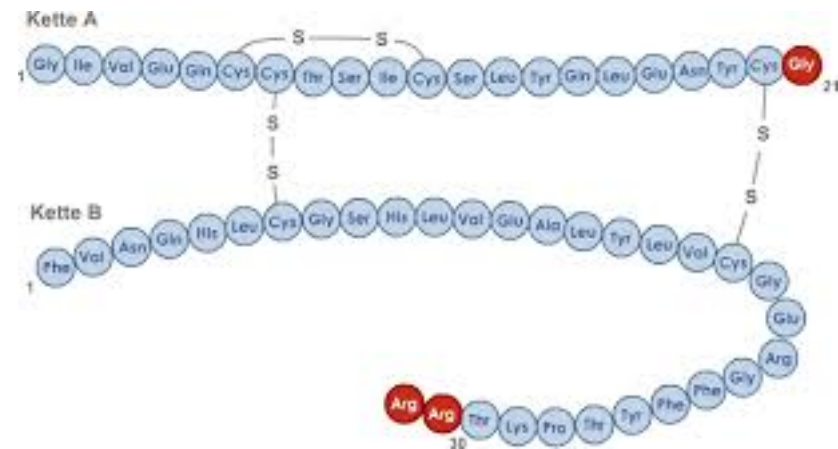
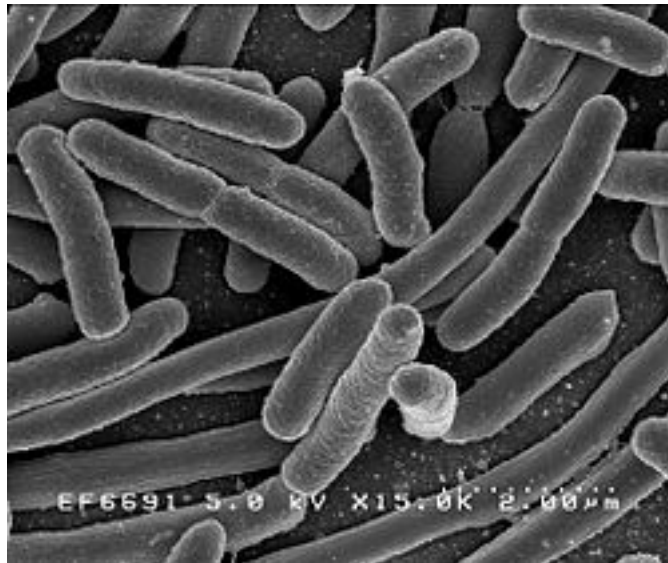
Therapeutic monoclonal antibodies

- PERJETA (Roche)



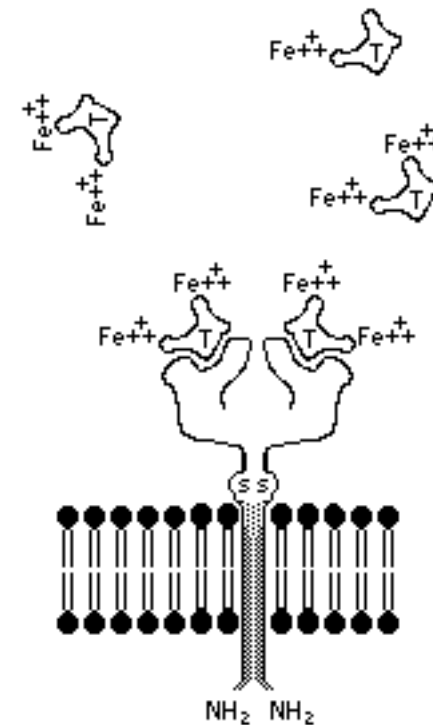
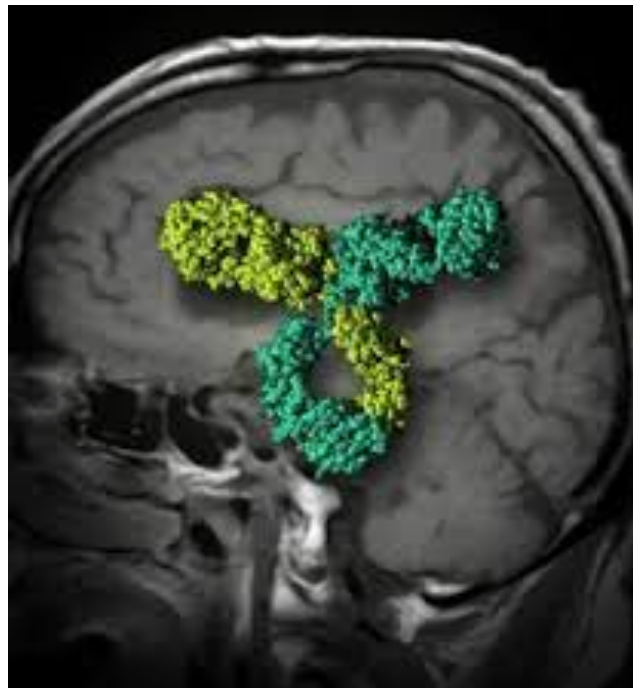
Diabetes

- Insulin production in E. coli



Engineered recombinant proteins

- Bispecific antibodies/Genentech



Gene Therapy



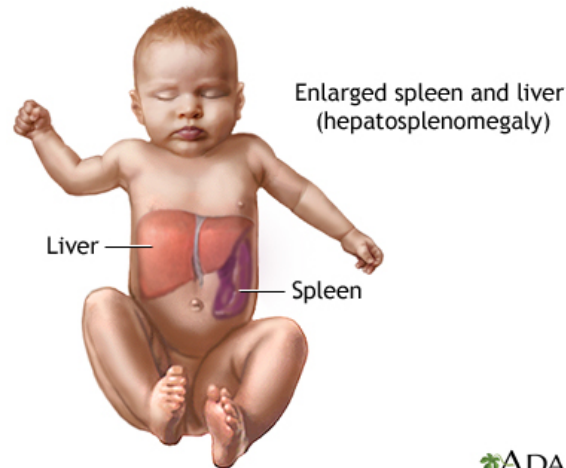
Elelyso (Pfizer + Protalix BioTherapeutics): First plant-made recombinant biological approved

- Approved by FDA 2010
- Genetically engineered carrot cells

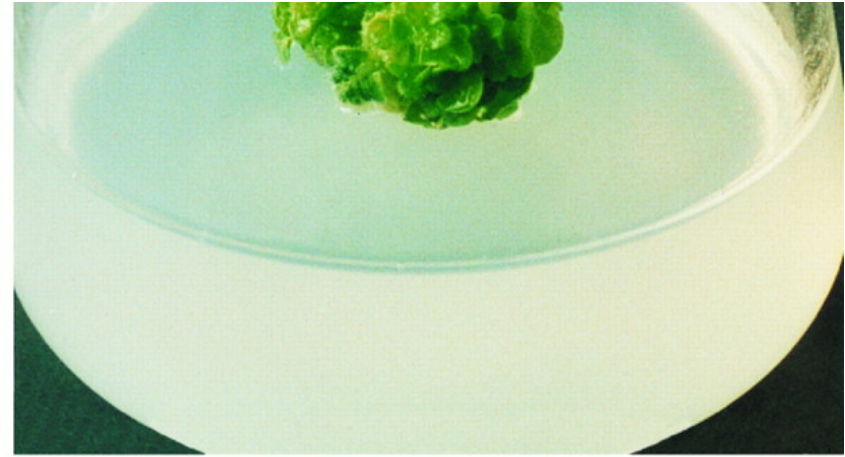
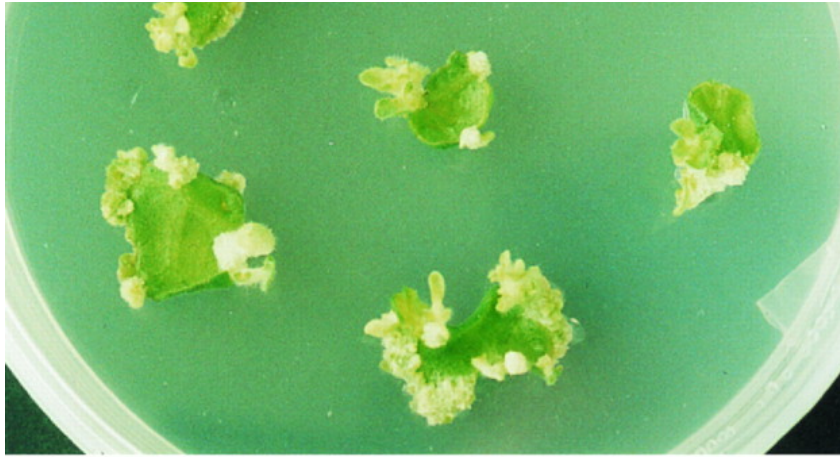


Transgenic carrot cells produce a recombinant protein for treating type 1 Gaucher's disease

- Rare genetic disease (some 10, 000 patients worldwide have Gaucher's disease)
- Patients fail to produce the enzyme **glucocerebrosidase**
- ElELYso, a recombinant form of human glucocerebrosidase which is injectable replaces the missing enzyme and thus prevents lipids from accumulating and damaging liver and spleen.



Transgenic plants

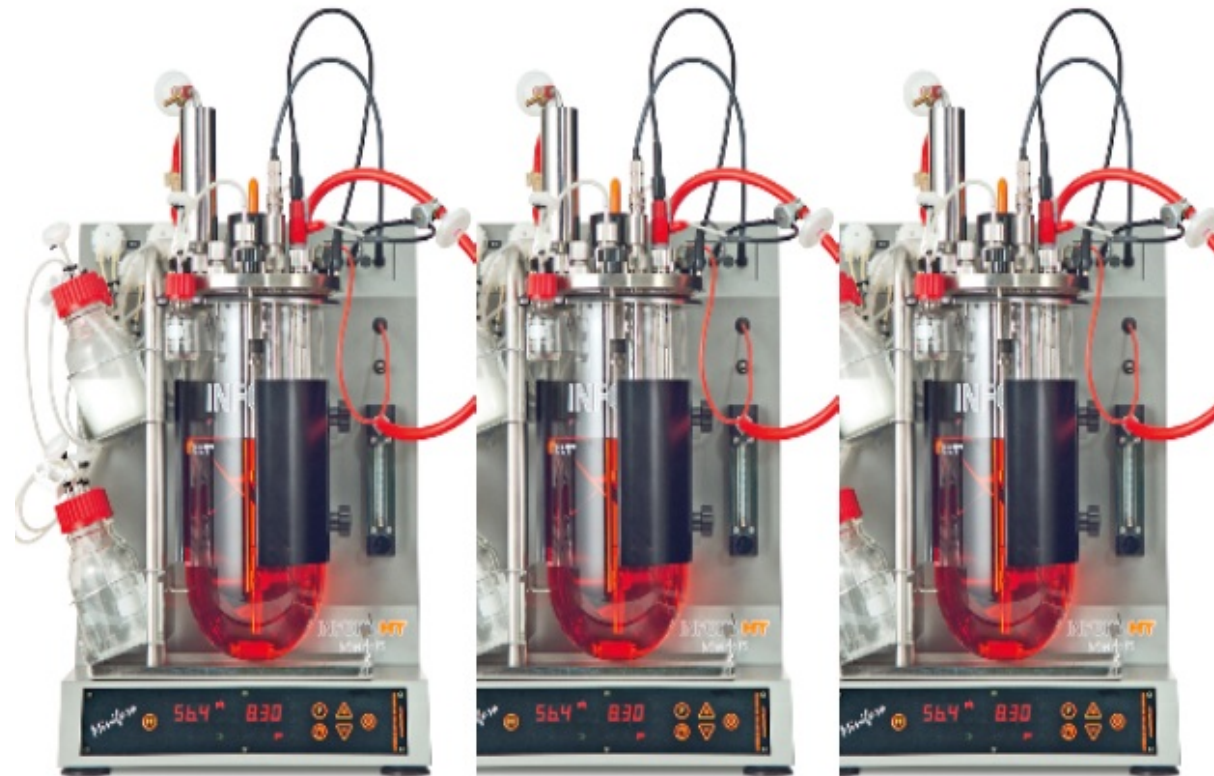


Transgenic animals

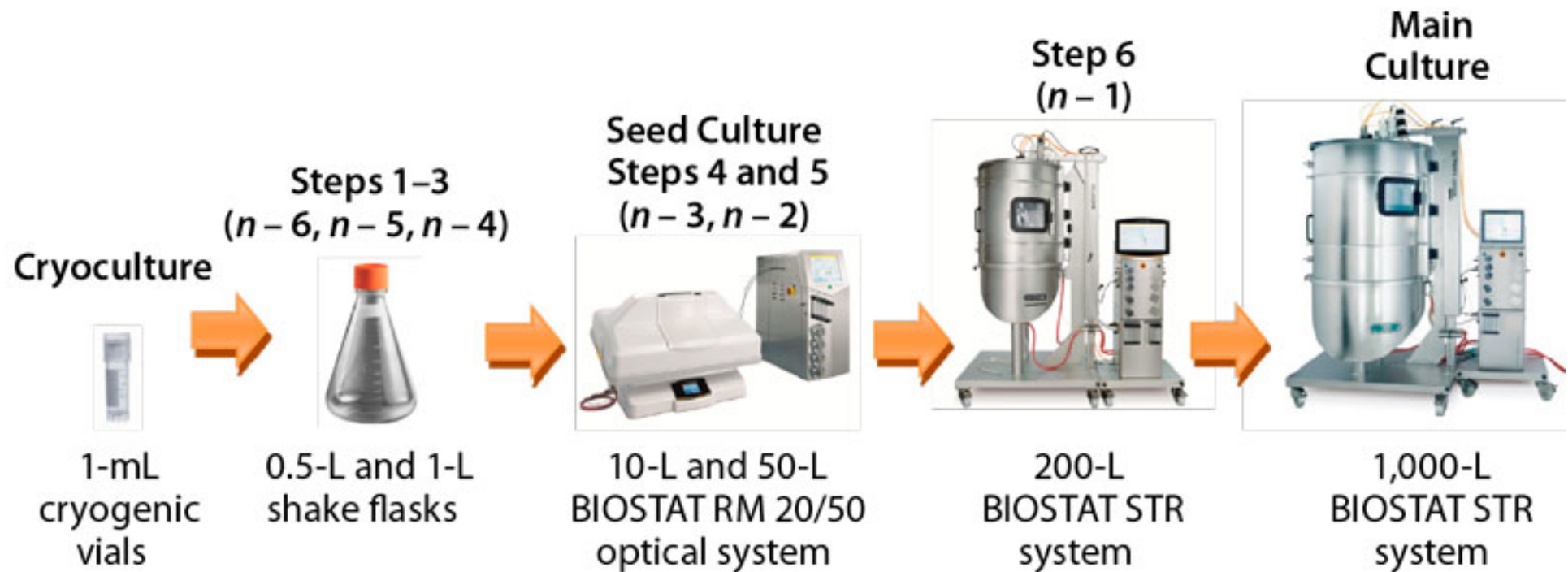


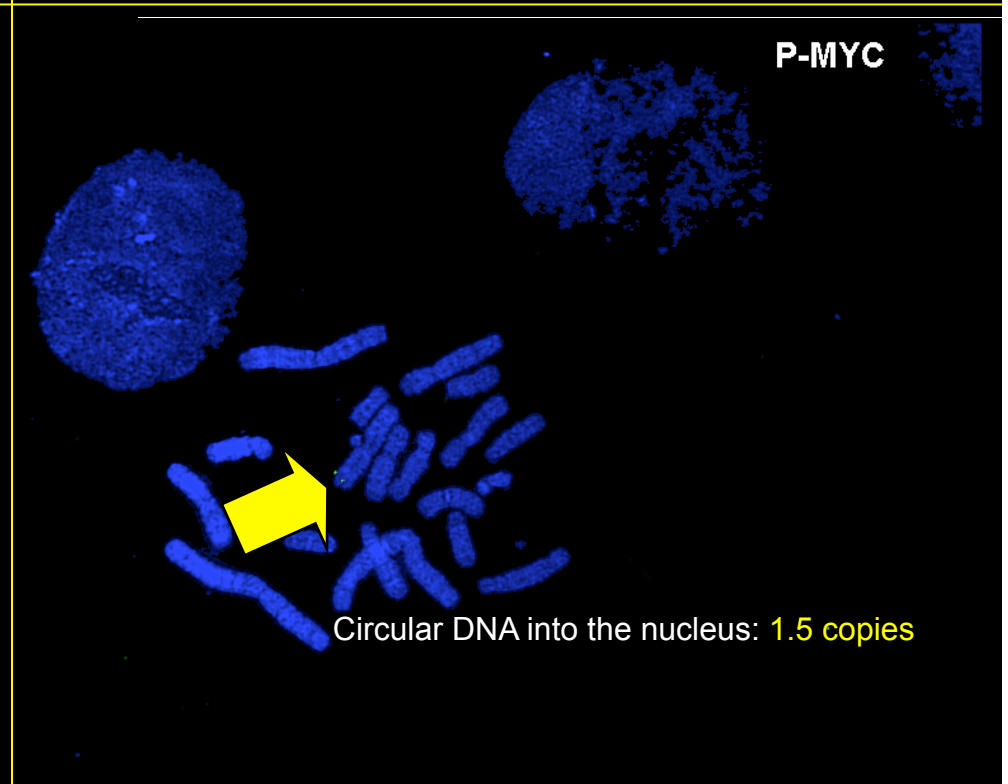
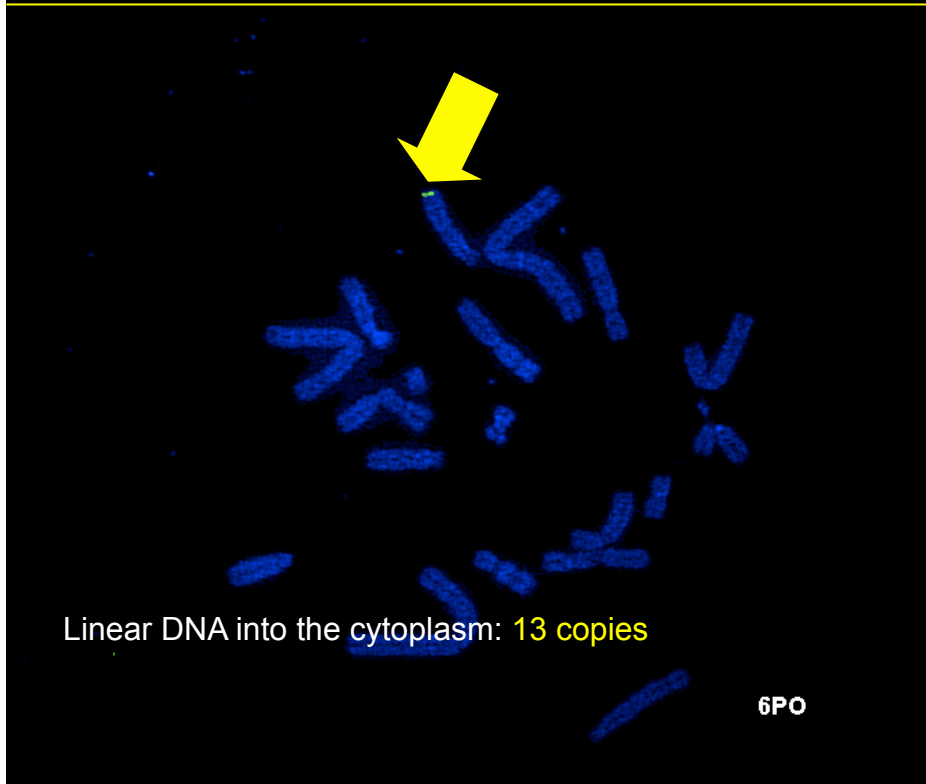
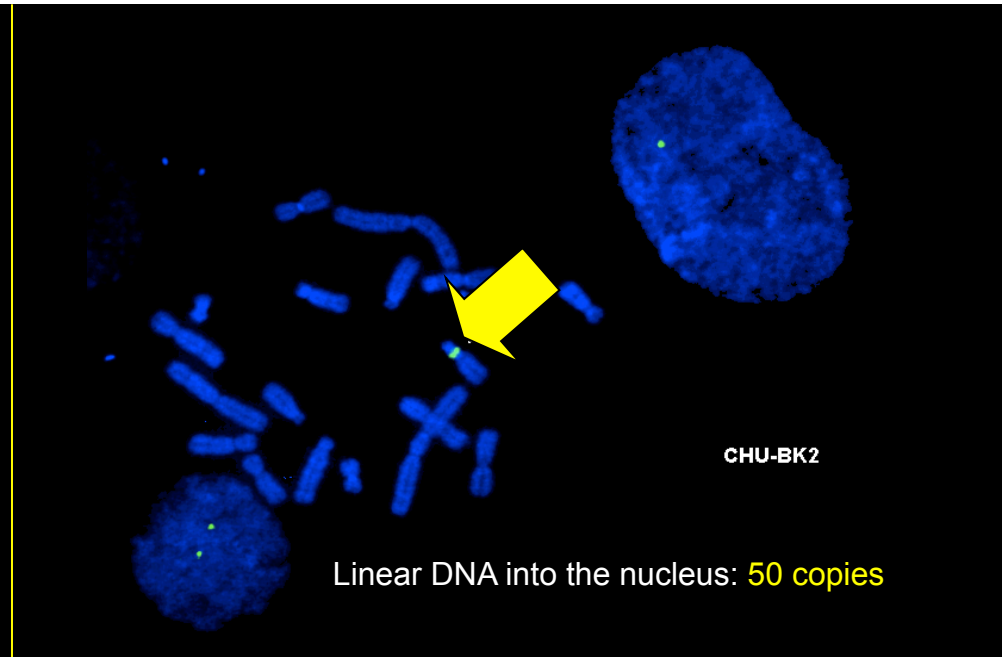
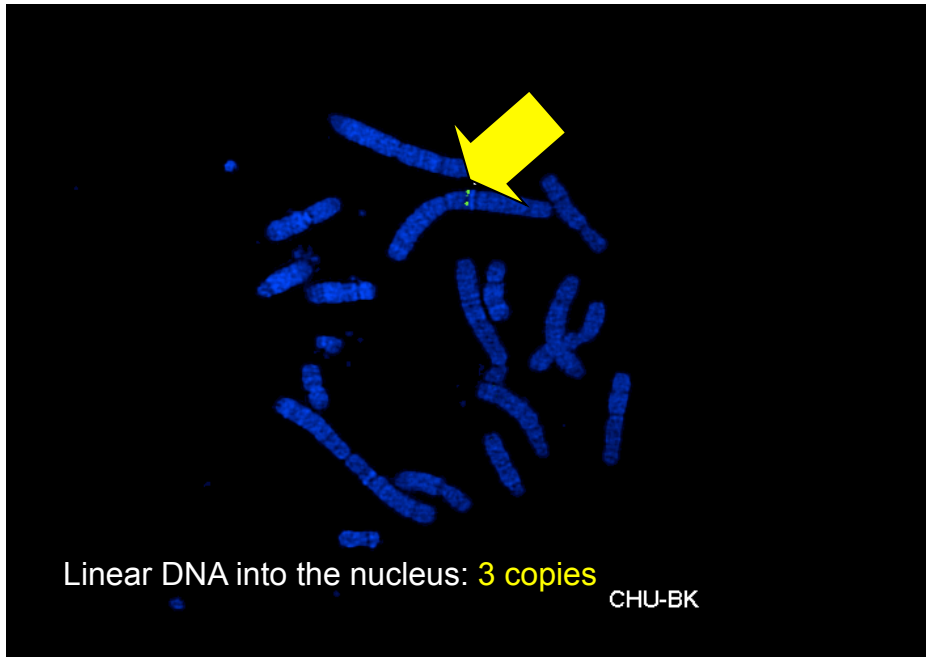
Chapter 3: Bioreactors

- Large scale recombinant protein production



Fed-batch culture





Orbital shaken bioreactors: The future

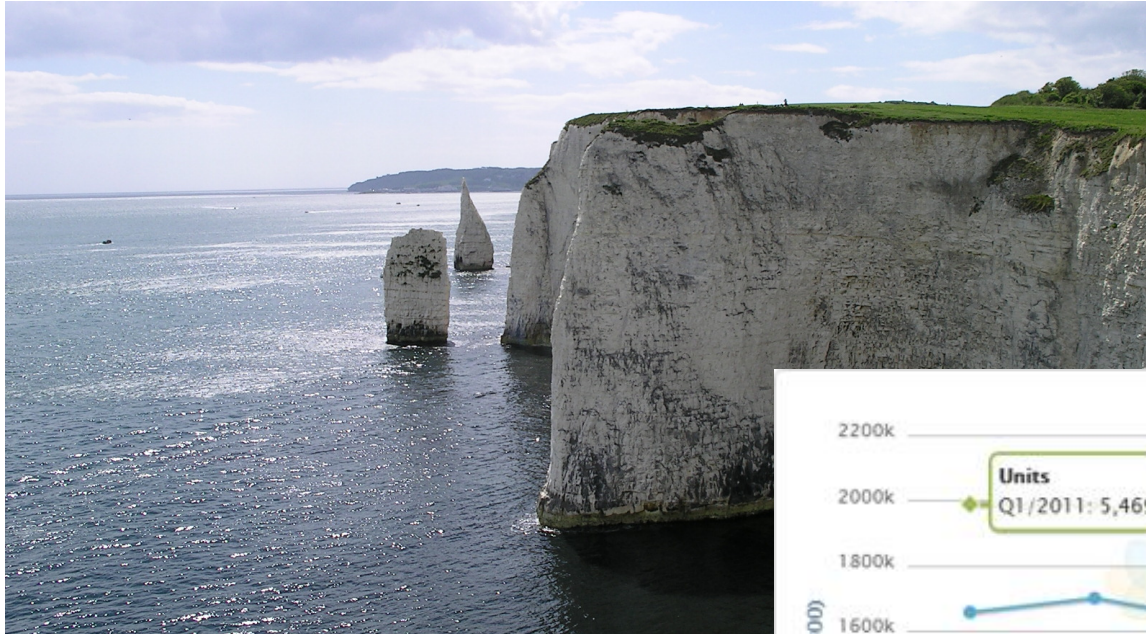


Chapter 4

- Patents

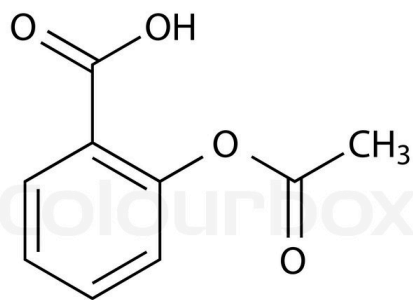


Patent cliff

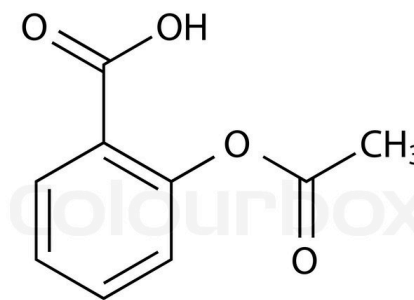


Generic drugs

- Aspirin



Acetylsalicylic acid



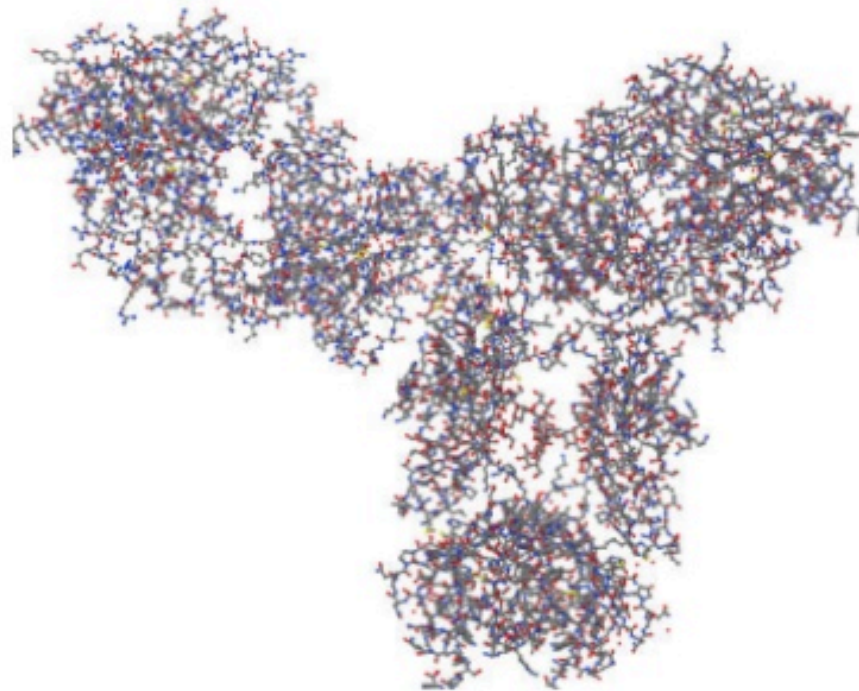
Acetylsalicylic acid

Biologicals versus drugs

- Bigger, more complex



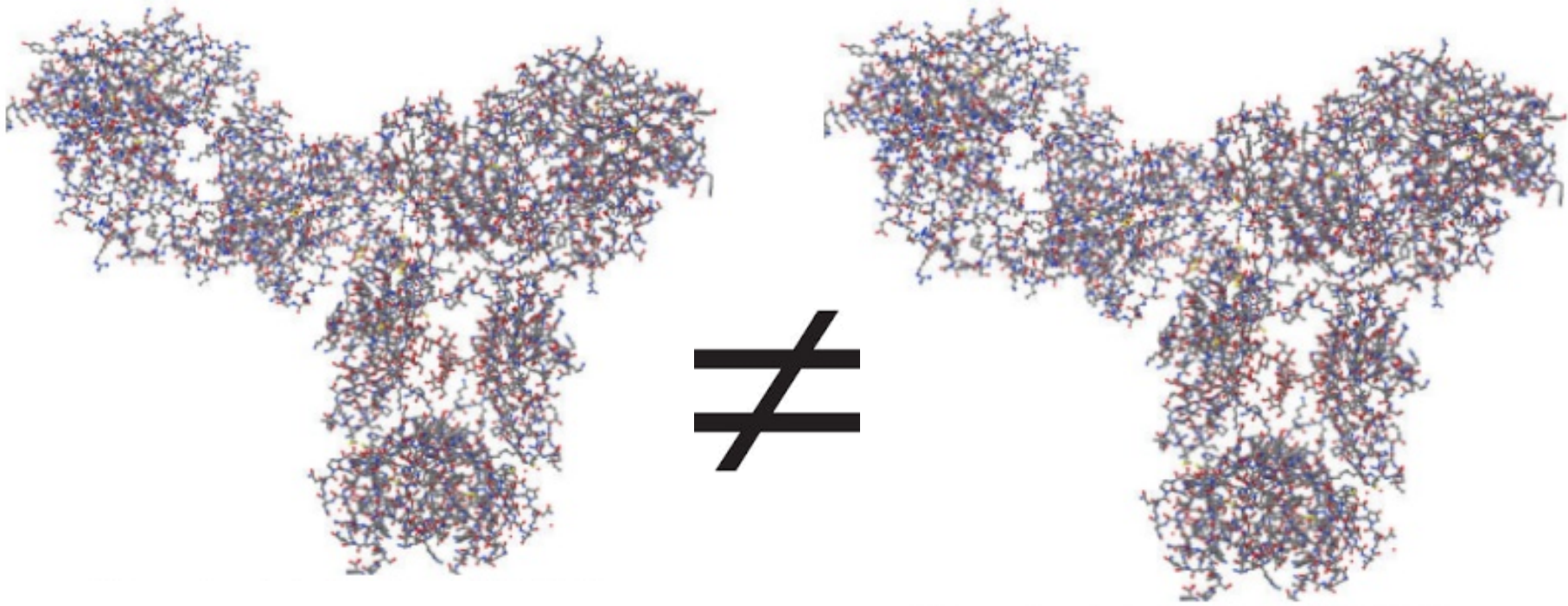
Aspirin 180 Da



Monoclonal Antibody ~150,000 Da

Biosimilars

- Similar but not identical



Evergreening

- Retaining profits from patents

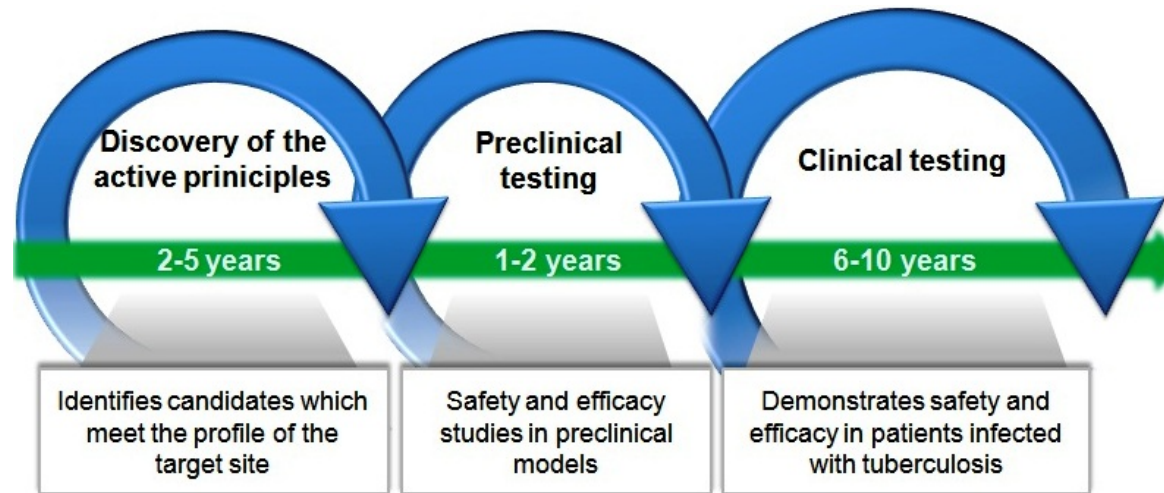


Chapter 4

- Regulatory issues in Pharmaceutical Biotechnology



Stages of clinical trials



Exam

- Test
- Written exam