

The Biotechnology Enterprise

The State of the Industry

Edward Penhoet, Ph.D.

**Dean, School of Public Health
University of California at Berkeley
Founder, Chiron Corp.**

November 17, 2000

The Biotechnology Enterprise

The Benefits of Biotechnology

Vital Statistics/Industry Trends

Blurring of the Borders Between Biotech and Pharma

Geographical Clustering

Universities Remain the Driver for Biotechnology

Information and the Customization of Medicine

Healthy Long-Term Outlook

Benefits of Biotechnology

- 4 A virtually safe blood supply
- 4 Cure for anemia
- 4 Reduced spread of hepatitis
- 4 Saving lives after heart attacks
- 4 Slowing the progression of multiple sclerosis
- 4 Better quality of life for diabetics
- 4 Longer life for cancer patients
- 4 Reducing the Debilitating Effects of Rheumatoid Arthritis
- 4 Slowing the Progression of HIV Infection
- 4 Improved outcomes for Chronic Hepatitis C

The Biotechnology Enterprise

The Benefits of Biotechnology

Vital Statistics/Industry Trends

Blurring of the Borders Between Biotech and Pharma

Geographical Clustering

Universities Remain the Driver for Biotechnology

Information and the Customization of Medicine

Healthy Long-Term Outlook

Biotech Industry *Vital Statistics*

4 Market capitalization of the biotechnology industry at the end of 1999 was \$312 billion

4 1999 estimated sales of all biotech products — \$18 billion

4 1999 sales by biotech industry — \$13.4 billion

4 \$9.9 billion spent on research in 1998

4 Top five biotech companies spent \$121,400 per employee on R&D compared with \$30,600 at the top five pharma companies

Source: Biotechnology Industry Organization.

Biotech Industry *Vital Statistics*

4 U.S. continues to dominate

4 1,283 biotechnology companies

4 373 publicly-traded biotechnology companies

4 Total employees: Greater than 150,000

Source: Biotechnology Industry Organization.

Four Generations of Biotechnology Products

4 Recombinant DNA

- Insulin, hGH, EPO, α -, β - and γ -interferon, IL-2, t-PA, PDGF, vaccines etc.

4 Monoclonal antibodies

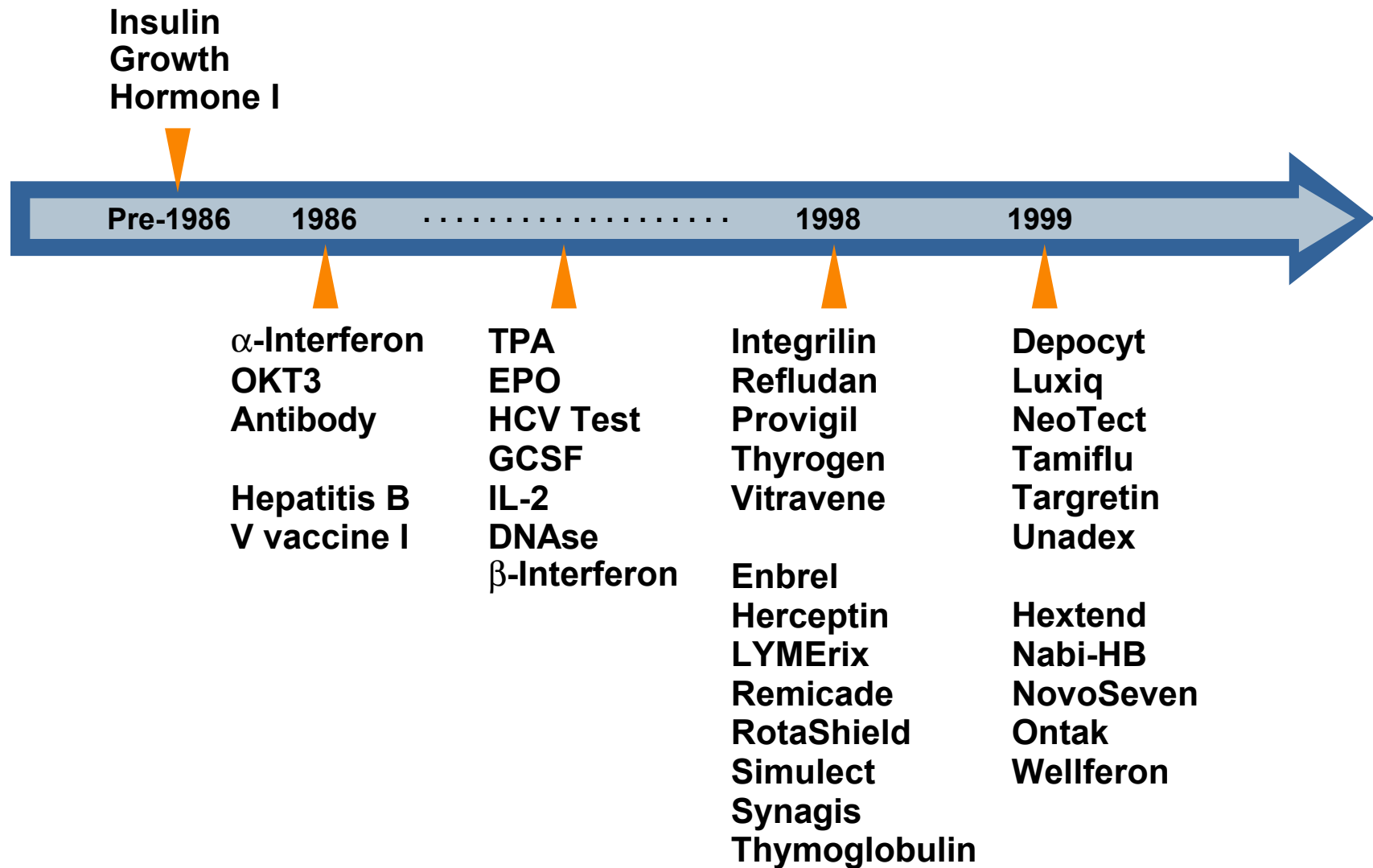
- ReoPro, Rituxan, Herceptin etc.

4 Small molecule compounds

- Viracept, Agenerase etc.

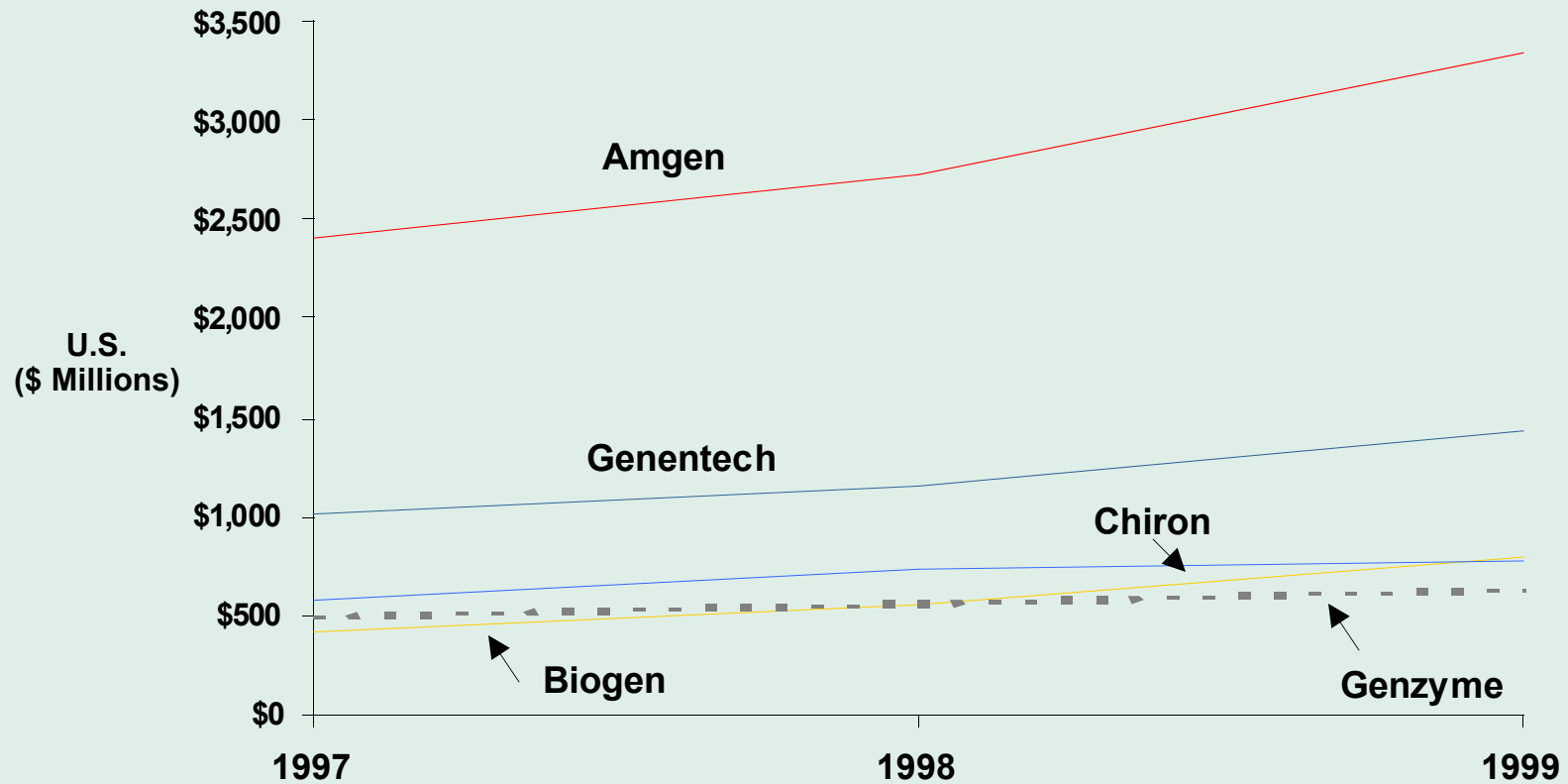
4 Gene therapy

Biotech Products *Two Decades of Progress*



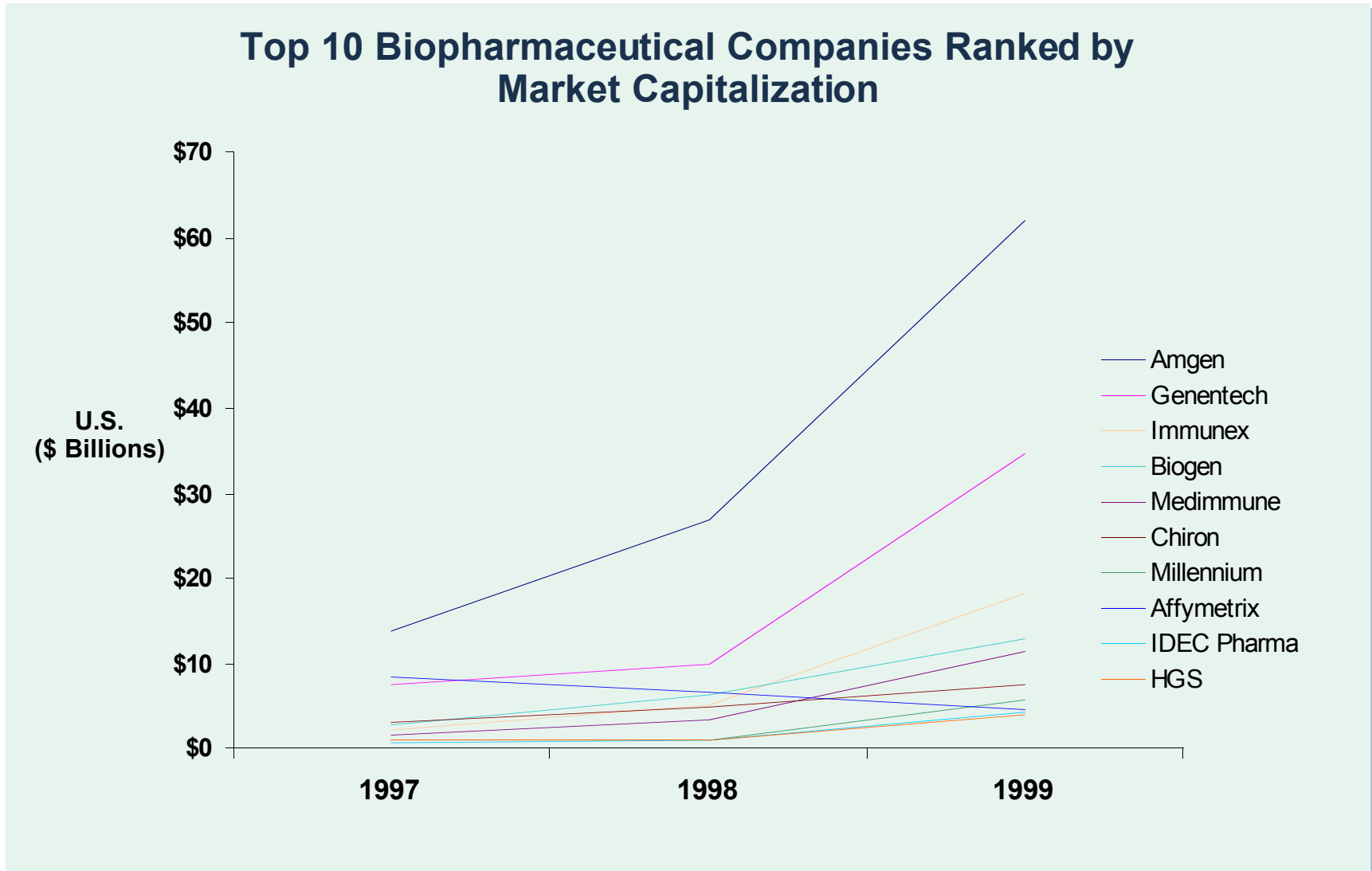
Biotech Industry Trends *Sales Increase*

Top Five U.S. Biopharmaceutical Companies by Worldwide Sales



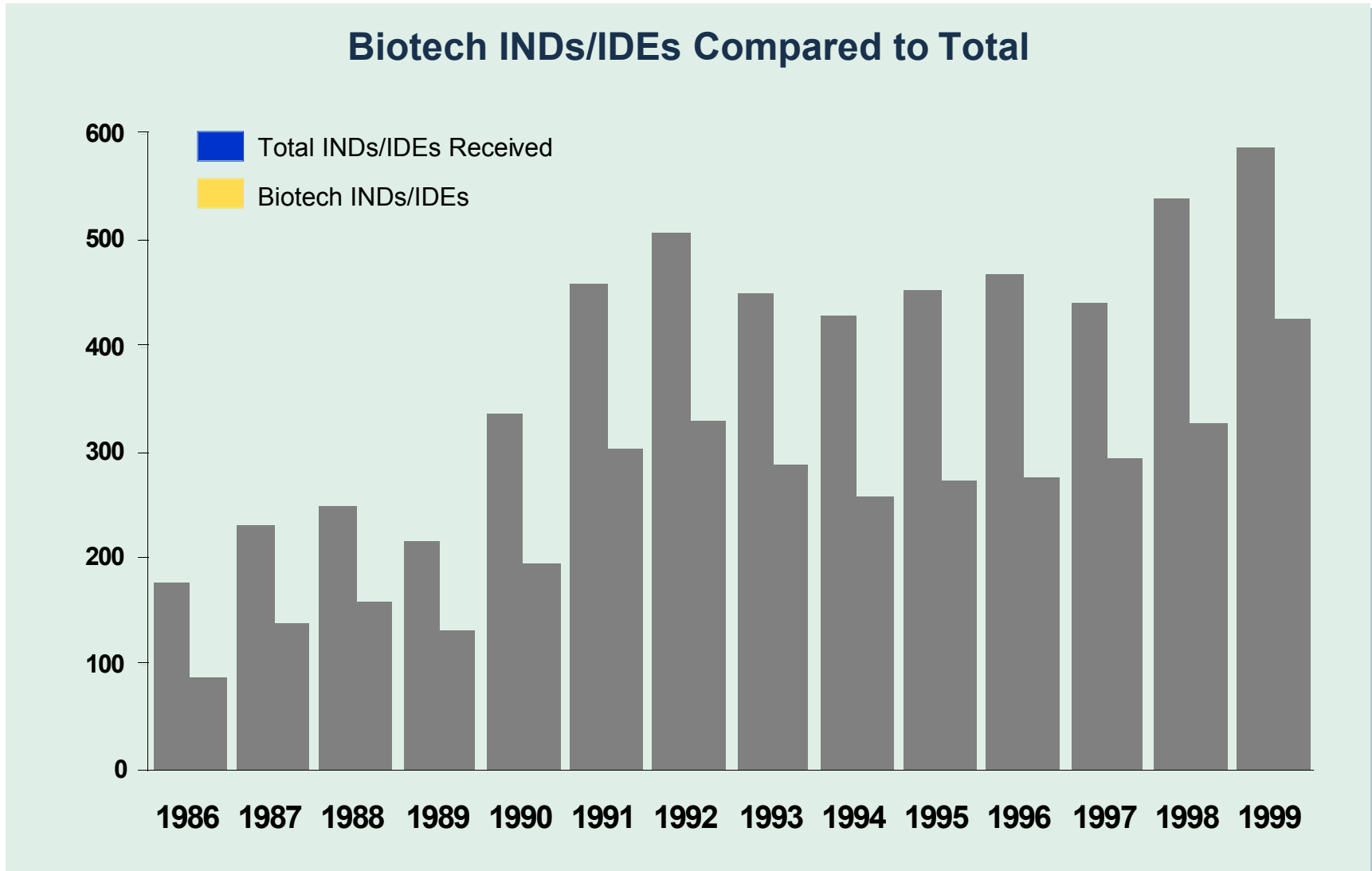
Source: Sales figures; Burrill & Company.

Biotech Industry Trends *Valuations Increase*



Source: Market cap figures; Burrill & Company.

Biotech Industry Trends *Submissions to FDA Increase*



Source: CBER; Burrill & Company.

The Biotechnology Enterprise

The Benefits of Biotechnology

Vital Statistics/Industry Trends

Blurring of the Borders Between Biotech and Pharma

Geographical Clustering

Universities Remain the Driver for Biotechnology

Information and the Customization of Medicine

Healthy Long-Term Outlook

Blurring of the Borders Between Biotech and Pharma

Pharma companies become life sciences companies



AVENTIS PHARMA.
AVENTIS—A new world leader



American Home Products Corporation is a global leader in vaccines, biotechnology, and animal health care.



Answers That Matter.

We are committed to providing answers that matter in medicine, life sciences and healthcare.



Bayer is an international, research-based group active in life sciences, polymers and chemicals.



Novartis is a global leader in the life sciences, committed to improving health and well-being through innovative products and services.

[Overview](#) [New Skills](#) [Worldwide](#)



Blurring of the Borders Between Biotech and Pharma

Biotech companies become fully integrated



Blurring of the Borders Between Biotech and Pharma

4 Combinatorial chemistry now deployed broadly

- **Affymax, Alanex etc.**

4 Small molecule capabilities in biotech companies

- **Chiron, Vertex, Biogen, Pharmacopeia, Axys etc.**

4 Pharma companies relying more heavily on biotech partnerships

4 Pharma companies investing in internal protein therapeutics development

4 Pharma companies become life science companies

The Biotechnology Enterprise

The Benefits of Biotechnology

Vital Statistics/Industry Trends

Blurring of the Borders Between Biotech and Pharma

Geographical Clustering

Universities Remain the Driver for Biotechnology

Information and the Customization of Medicine

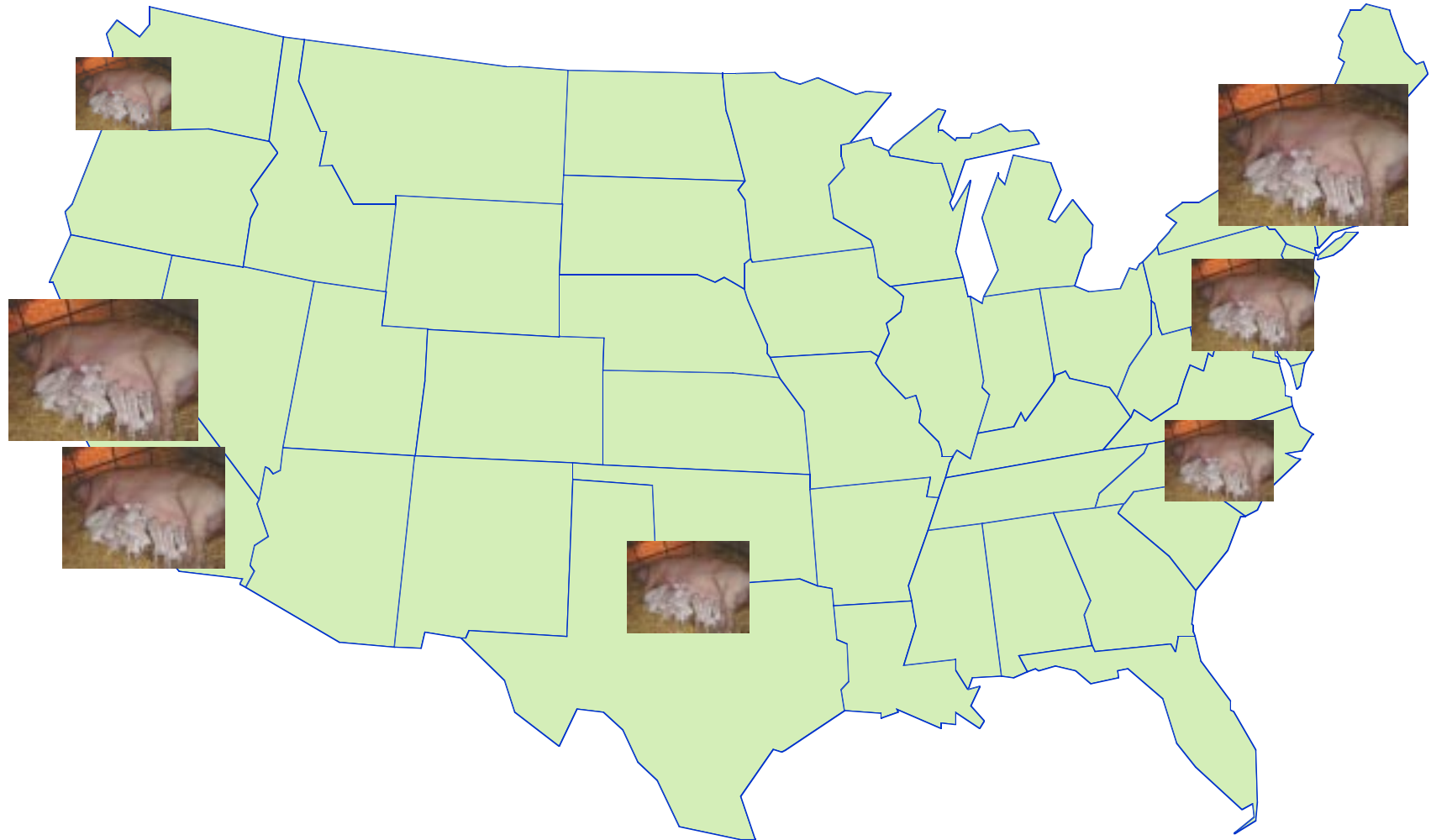
Healthy Long-Term Outlook

Biotechnology Reliant on Local Resources, especially Research Universities



Picture source: <http://www.pigparadise.com/>

Geographical Clustering



California Has Most Developed Cluster of Biotech Companies

- 4 California leads the nation with greater than 33% of all biotechnology companies**
- 4 California biotech companies account for 45,000 highly-skilled jobs at an average salary of \$65,800**
- 4 California universities, federal laboratories, and private institutions account employ an additional 41,000 people**
- 4 80% of California biotech companies plan to expand in the next two years**
- 4 88% of biotech companies anticipating growth intend to grow in California**

Pharmaceutical Companies Seek to Capitalize on California Biotechnology

4 Novartis founds Novartis Research Institute in San Diego

4 Novartis takes major equity stake in Chiron

4 Roche heavily invested in Roche Biosciences as well as Genentech

4 Pfizer heavily invested in Agouron and Gene Networks through Parke-Davis/Warner Lambert acquisitions

4 Merck acquires Sibia

4 Bayer locates Worldwide Biotech Headquarters in Berkeley

The Biotechnology Enterprise

The Benefits of Biotechnology

Vital Statistics/Industry Trends

Blurring of the Borders Between Biotech and Pharma

Geographical Clustering

Universities Remain the Driver for Biotechnology

Information and the Customization of Medicine

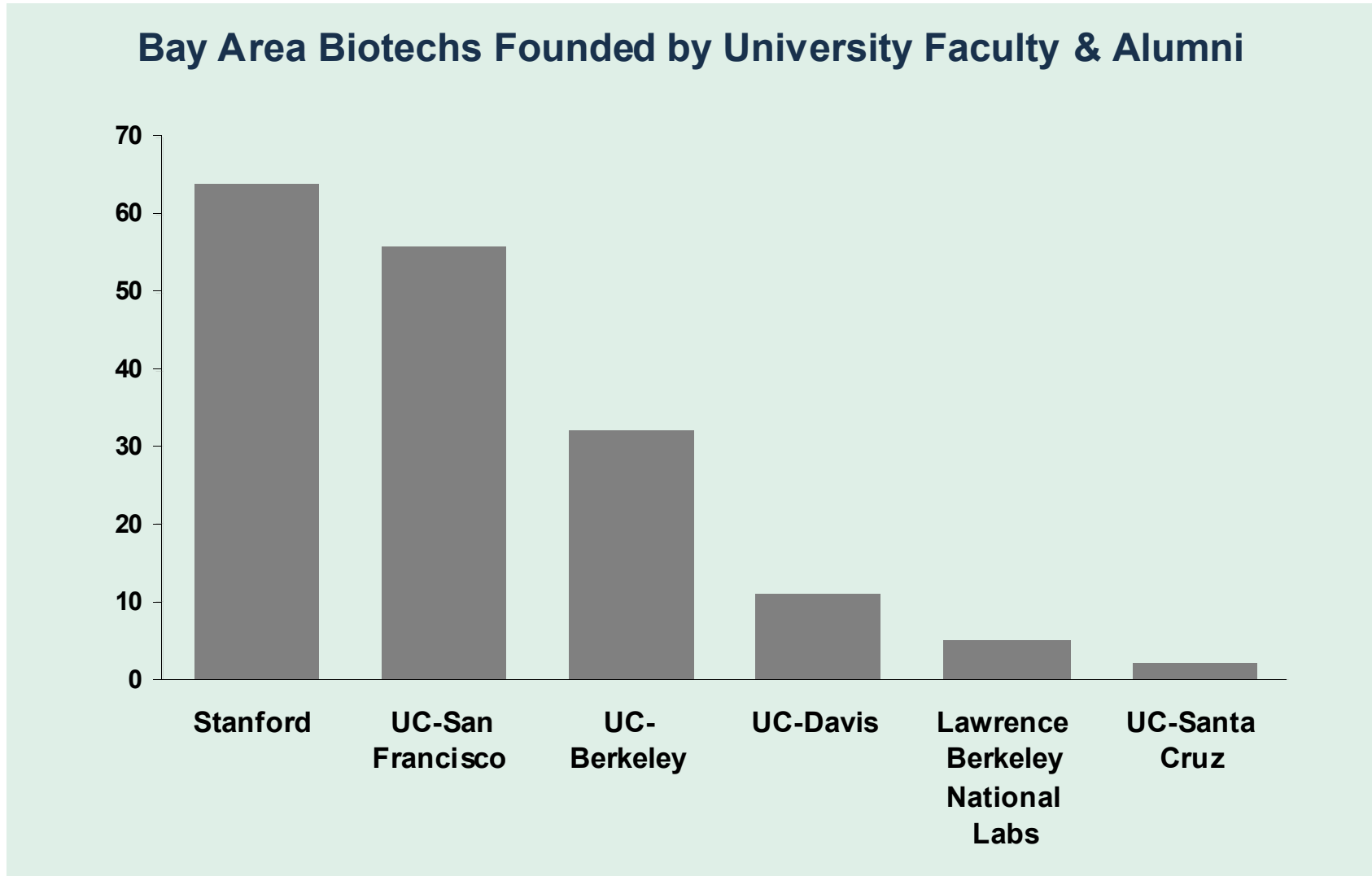
Healthy Long-Term Outlook

Intellectual Assets, Capital, and Infrastructure Drive Biotech Clusters

4 Universities essential for biotechnology growth

- **Nearly one-third of Bay Area biotech companies are spin-offs from academic research institutions**
- **Two-thirds of Bay Area biotech companies have research agreements with California academia**
- **Universities continue to train skilled scientific personnel**

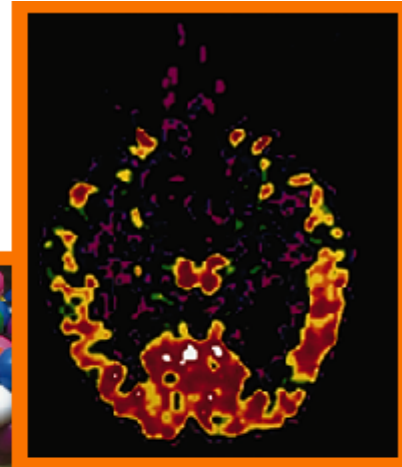
Universities Essential to Biotechnology



Source: California Healthcare Institute; San Jose Mercury News, February 10, 2000.

Molecular Engineering at Berkeley *An interdisciplinary approach*

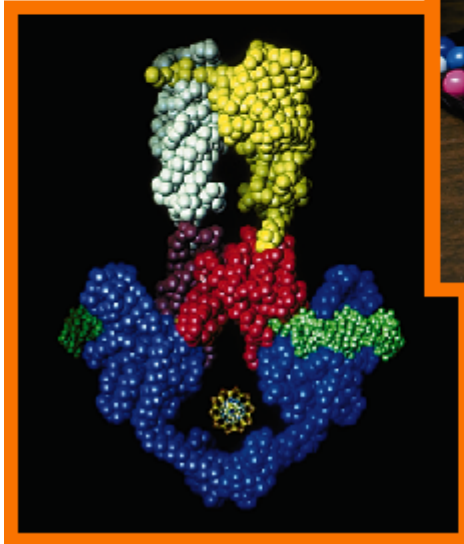
Physics



Bioengineering



Chemistry



Molecular Biology

Biomedical & Health Sciences *An Integrated Approach*

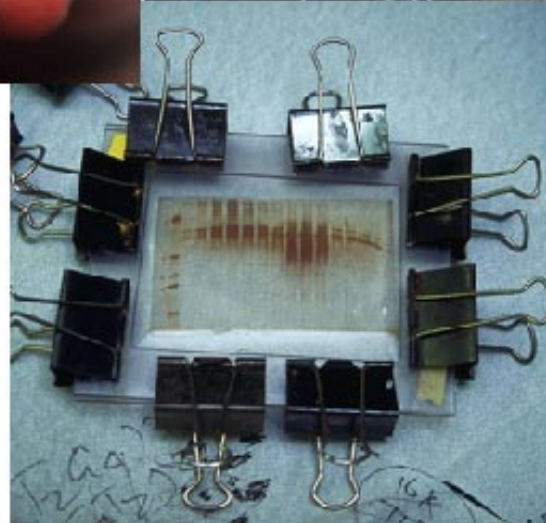
Molecular and Cell Biology



Neuroscience



Public Health



Genomics

Cancer Research

Neuroscience *The Final Frontier of Modern Biomedicine*



Geneticists, psychologists, vision scientists, computer scientists, and other experts working together to understand the brain

The Biotechnology Enterprise

The Benefits of Biotechnology

Vital Statistics/Industry Trends

Blurring of the Borders Between Biotech and Pharma

Geographical Clustering

Universities Remain the Driver for Biotechnology

Information and the Customization of Medicine

Healthy Long-Term Outlook

Explosive Development of New Information

4 Human Genome project

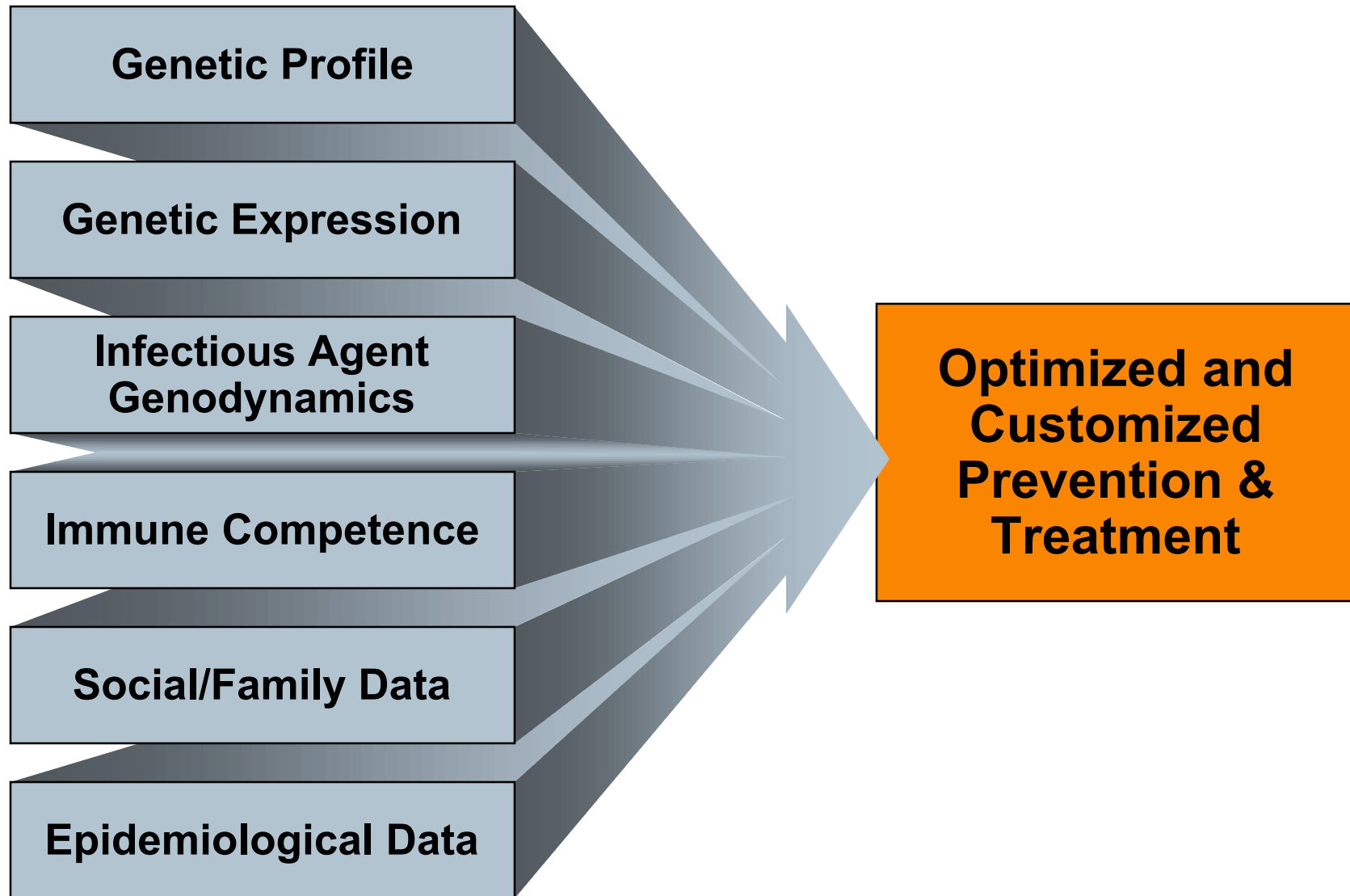
4 Genetic analysis of disease

4 Pathological mechanisms

4 Gene expression in normal and pathological states

- **New metrics**
- **Diagnostic and therapeutic monitoring**
- **Gene therapy**

Individualized Information and Metrics Will Drive Clinical Practice



Data Mining, Informatics, and Information Portals Fuel Better Targeting of Medical Advances

Data Mining and Information

4 Celera, Gene Logic, Incyte, etc.

Bioinformatics Software

4 NetGenics, DoubleTwist, etc.

Tool Companies

4 Affymetrix, Caliper, ACLARA, Orchid, etc.

Pharmacogenomics

4 Millennium, HGS, Axys –PPGx etc.

The Internet

The Biotechnology Enterprise

The Benefits of Biotechnology

Vital Statistics/Industry Trends

Blurring of the Borders Between Biotech and Pharma

Geographical Clustering

Universities Remain the Driver for Biotechnology

Information and the Customization of Medicine

Healthy Long-Term Outlook

Positive Trends for Biotechnology

4 High visibility in Washington

- Expanded funding for NIH
- New FDA guidelines for biologicals
- Continued pressure for accelerated drug approvals

4 Consolidation of healthcare purchasing and testing

- Less infrastructure required for effective marketing

4 Increasing awareness and activism about personal health issues

- Concern over infectious diseases
- Employer recognition for value in prevention
- Premium for reduction of risk
- Third largest use of the Internet

4 Baby boomers have both money and political clout to sustain quality of life

Biotechnologies for the 21st Century

<i>Diagnostics</i>	4 Genetic analysis 4 Expression Analysis	4 Integrated therapies
<i>Immuno Therapy</i>	4 Therapeutic vaccines for cancer and infectious diseases	
<i>Genomics</i>	4 Explosion of new targets for drug discovery	
<i>Pharmaco- genomics</i>	4 Customization of medicine 4 Rational patient selection for clinical trials	
<i>Proteomics</i>	4 High-throughput validation of gene products	
<i>Nucleic Acid Therapy Gene Therapy</i>	4 DNA <ul style="list-style-type: none">• Direct transfer• Vector mediated• Live virus	4 RNA <ul style="list-style-type: none">• Anti-sense• Ribozymes• RNA ligands
<i>Cell-Based Therapies</i>	4 Nervous system repair 4 Immune reconstitution	4 Tissue regeneration

The Biotechnology Enterprise

The State of the Industry

Edward Penhoet, Ph.D.

**Dean, School of Public Health
University of California at Berkeley
Founder, Chiron Corp.**

November 17, 2000