

# 中国生物工程学的挑战 and 机会

## Challenges and Opportunities of Biotechnology in China

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# Challenges and Opportunities of Biotechnology in China

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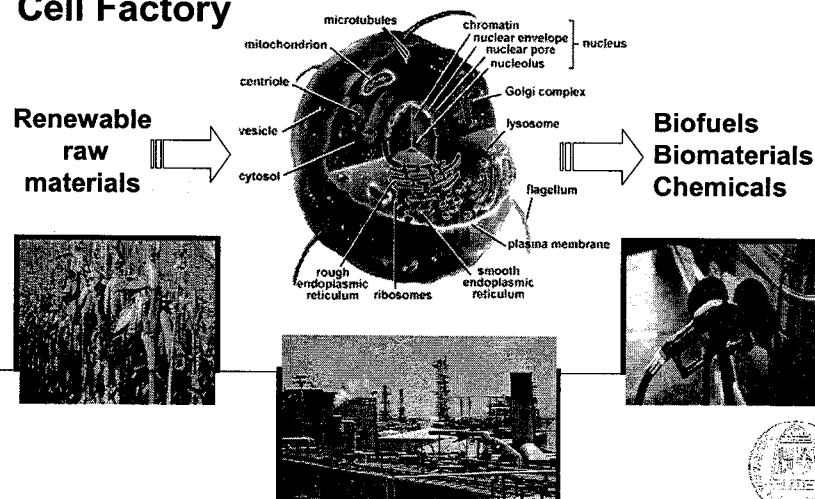
## Biotechnology and development

- Three waves in modern Biotechnology
- The first wave: Pharmaceutical Biotechnology
  - related to *Health Care*, since 1980's
- The second wave: Agricultural Biotechnology
  - related to *Agro-Food*, since 1990's
- The third wave: Industrial Biotechnology
  - related to *Sustainability*, since 2000's



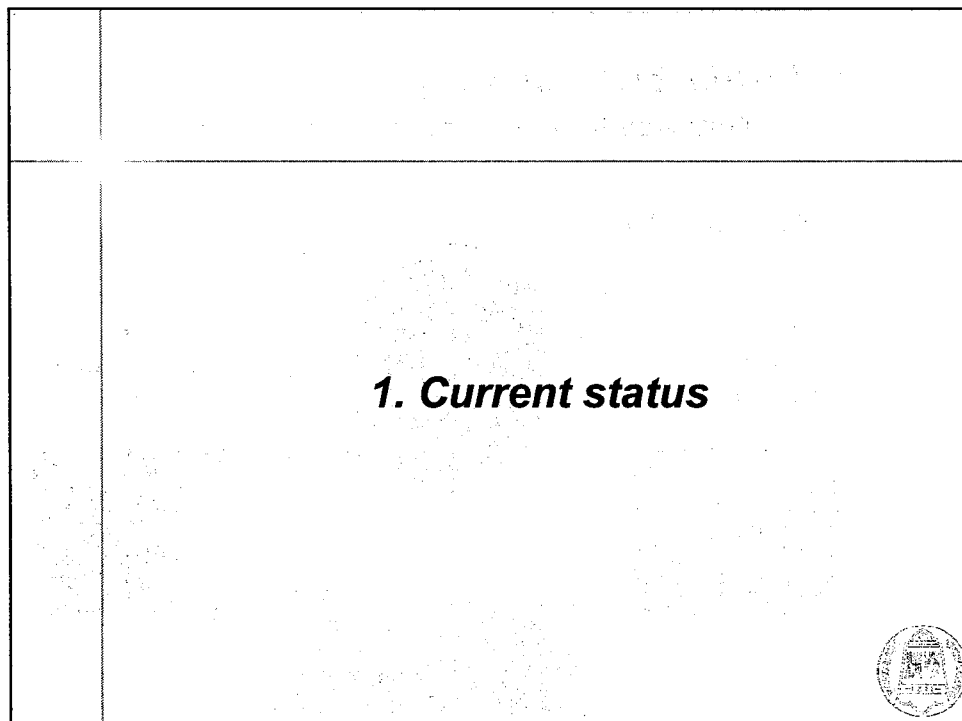

## Industrial biotechnology: Gateway to a more sustainable future

### Cell Factory



### Outline

- **Progress: current status of industrial biotechnology in China**
- **Problems: : what is the major difference between China and the developed countries?**
- **Strategy and goal**

	<p style="text-align: center;"><b>1. Current status</b></p>  

	<h2 style="text-align: center;">Industrial Biotechnology in China: a glance</h2>
	<ul style="list-style-type: none"> <li>• <b>More than 1500 enterprises; Sales 160 billion RMB</b> <ul style="list-style-type: none"> <li>▪ Bulk fermentation products (enzymes, amino acids, starch sugars, yeast, glutamate, citric acid): <b>20.4 billion RMB</b></li> </ul> </li> <li>• <b>Approx. 20% of total industrial production value</b> <ul style="list-style-type: none"> <li>▪ Created by <i>Industrial Biotechnology</i> and related industries</li> <li>▪ Increasing speed: &gt; 10% per year</li> </ul> </li> <li>• <b>Glutamic acid, VC, beer, and citric acid: in the <i>top place</i> of the world</b></li> </ul> <div data-bbox="1135 1313 1368 1862" data-label="Diagram"> </div>

## Products infrastructure




- **Alcohol/Solvents**
  - Beer, wine; ethanol, acetone, butanol
- **Amino/Organic acids**
  - Glutamic acid, lysine
  - Citric acid, Lactic acid, long-chain dicarboxylic acid
- **Enzymes**
  - Saccharifying enzyme,  $\alpha$ -amylase, alkaline protease
- **Functional foodstuff additives**
  - $\alpha$ -Lactoprotein, single cell protein
  - Oligosaccharide and polysaccharide
  - $\gamma$ -Linolenic acid, lecithin
- **Biomaterials**
  - PHAs, poly-L-lactic acid, chitin
- **Biochemical products**
  - Acrylamide, chiral pharmaceutical precursors
- **Other compounds**
  - Biopesticides, antioxidants, pigments




## Technology development

- **Novel breeding technology**
  - Selecting microorganisms with industrial potential
- **Fermentation optimization technology**
  - Multi-scale process optimization: antibiotics , nucleotide
- **Clean biotechnology**
  - Alcohol production by high gravity fermentation technology
  - High gravity beer fermentation
  - Clean production of glutamic acid
- **Integrated bioreaction and separation technology**
  - Enzymatic production of malic acid



	<h2 style="text-align: center;">Market demand</h2>
	<ul style="list-style-type: none"> <li>• <b>Fine chemicals</b> <ul style="list-style-type: none"> <li>• Acrylamide, chiral compounds, health food</li> </ul> </li> <li>• <b>Biomaterials</b> <ul style="list-style-type: none"> <li>• PLA, PHB, poly amino acids and so on.</li> </ul> </li> <li>• <b>Biofeuls</b> <ul style="list-style-type: none"> <li>• Bioethanol</li> <li>• Biodiesels</li> <li>• Biogas</li> </ul> </li> <li>• <b>Environment protection</b></li> </ul> 

	<h2 style="text-align: center;">2. Problems and challenge</h2> 

## Traditional industry facing challenge!

**Current manufacture routes/modes of industry are NOT sustainable.**

- (1) **Environmental Crisis: Waste Pollution -- Contamination**  
Emission of too many carbon dioxide
- (2) **Resources Crisis: Fossil Resources (Nonrenewable) -- Exhaustion**

**What's the key problem?**

Surviving Crisis!  
Social Crisis!



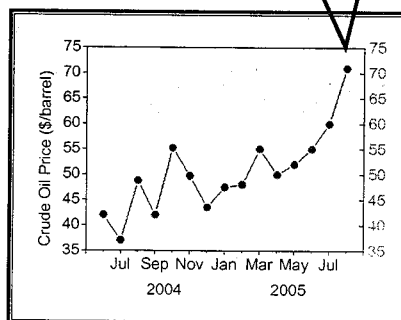
## Raw materials from fossil resources in shortage

**The Exhaustion of Fossil Fuels and Resources:**

<b>Oil:</b>	<b>50~100</b>	<b>years</b>
<b>Coal:</b>	<b>200~300</b>	<b>years</b>
<b>Nature Gas:</b>	<b>75 ~ 120</b>	<b>years</b>

2005.8.30  
70.90 \$/b

• Oil price was  
skyrocketing! Followed  
with bulk chemicals!

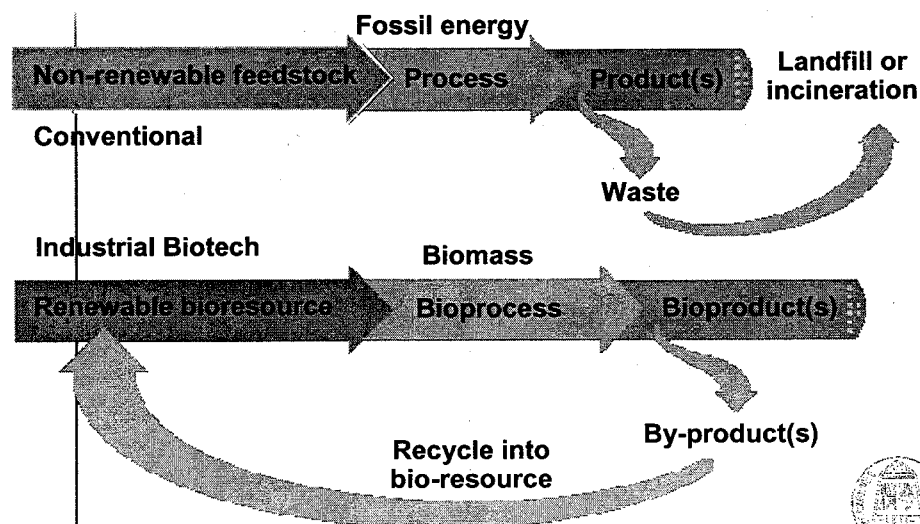


## Present status of China's society


- China: the largest developing country
- The largest country utilizing/processing resources
  - 4 times the average level of the world
- Resource per capita: far less than world average level
- Shortage of energy source (petroleum)
  - $120 \times 10^6$  tons petroleum imported in 2004
  - Importing  $100 \times 10^6$  tons petroleum is predicted in 2010
  - $160 \times 10^6$  tons petroleum: self-exploited in China annually
  - China's petroleum reserves: 2.74 billion tons (only for 17 years)
- Environment pollution, ecological problem
  - Mainly due to use of environment unfriendly process




## Industrial Biotech can solve these problems





	<p style="text-align: center;"><b>3. Strategy and goal</b></p> 

	<p><b>Major problems</b></p>
	<ul style="list-style-type: none"> <li>• Insufficient innovation, small scales of producers, less variety of products</li> <li>• Draggled support technologies and facilities</li> <li>• <b>High cost of production:</b> lacking competition ability <ul style="list-style-type: none"> <li>▪ <i>Low production level:</i> approx. 30% lower than the leading level of the world (in 2000)</li> <li>▪ <i>High consumption of raw materials (low conversion)</i></li> <li>▪ <i>Low yield of recovery:</i> approx. 10-15% lower than the mean level of the world</li> </ul> </li> <li>• Inadequate application exploitation</li> <li>• Serious discharges of waste water, gas and residues</li> </ul> 

## Approaches to overcome these problems


- Government (MOST) has set up many programs to support BT, BI, BE, and BS
  - 973 program: fundamental research aimed at achieving key technology development
  - NSFC of China: support original fundamental research
  - 863 program: commercialize high-technology
  - Five-year key project: commercialize important products
  - Innovative funds: encourage R&D of small enterprises
- Intellectual property right protection
- Introducing capable, innovative scientists





## China's strategy in biotechnology

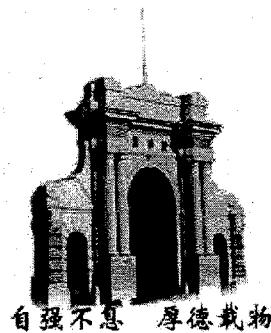
- *Fundamental research in industrial biotech: extremophile, molecular machine etc.*
- *Pharmaceutical and agricultural biotechnology*
- *Industrial biotechnology*
  - Process improvement of traditional products
  - Novel materials and bulk commodity chemicals
  - Novel food (additives), nutraceuticals
  - Enabling and supporting technology
- *Bio-material and bioenergy*
  - Biomaterials
  - Bio-ethanol
  - Bio-gas
  - Bio-diesel oil



	<h2>Conclusions</h2>
	<ul style="list-style-type: none"> <li>• <b>China: <i>great achievements have been made</i> in pharmaceutical, agricultural and industrial biotechnology</b></li> <li>• <b>China's continuous and fast development in industrial biotechnology is <i>driven by market and sustainability</i></b></li> <li>• <b>Compared to the leading countries:</b> <ul style="list-style-type: none"> <li>• major differences still existed in R&amp;D levels</li> <li>• product varieties, production and recovery level: improving</li> <li>• Innovation and sustainability: being the most important</li> </ul> </li> <li>• <b>Industrial Biotechnology provides new opportunities: from a large country to a strong country in biotechnology</b></li> </ul> 

	<h2>Acknowledgements</h2>
	<ul style="list-style-type: none"> <li>• <b>Many data cited from the annual report of Chinese National Biotechnology Developing Centre (CNCBD)</b></li> <li>• <b>Supported by Chinese Society of Biotechnology</b></li> <li>• <b>Many thanks for the experts from Chinese Institute of Food and Fermentation, the Association of Fermentation, professors from many universities, and my graduate students.</b></li> </ul>  

Thanks for your attention!



自強不息 厚德載物

