

A grayscale, high-contrast image of a large, ornate building, likely a university or research facility, serving as the background for the slide.

# MOL.911

## Molecular Biotechnology I

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**Engineering of Biosystems**

- Cell-Engineering
- Pathway Engineering
- Synthetic Biology
- Protein-Engineering

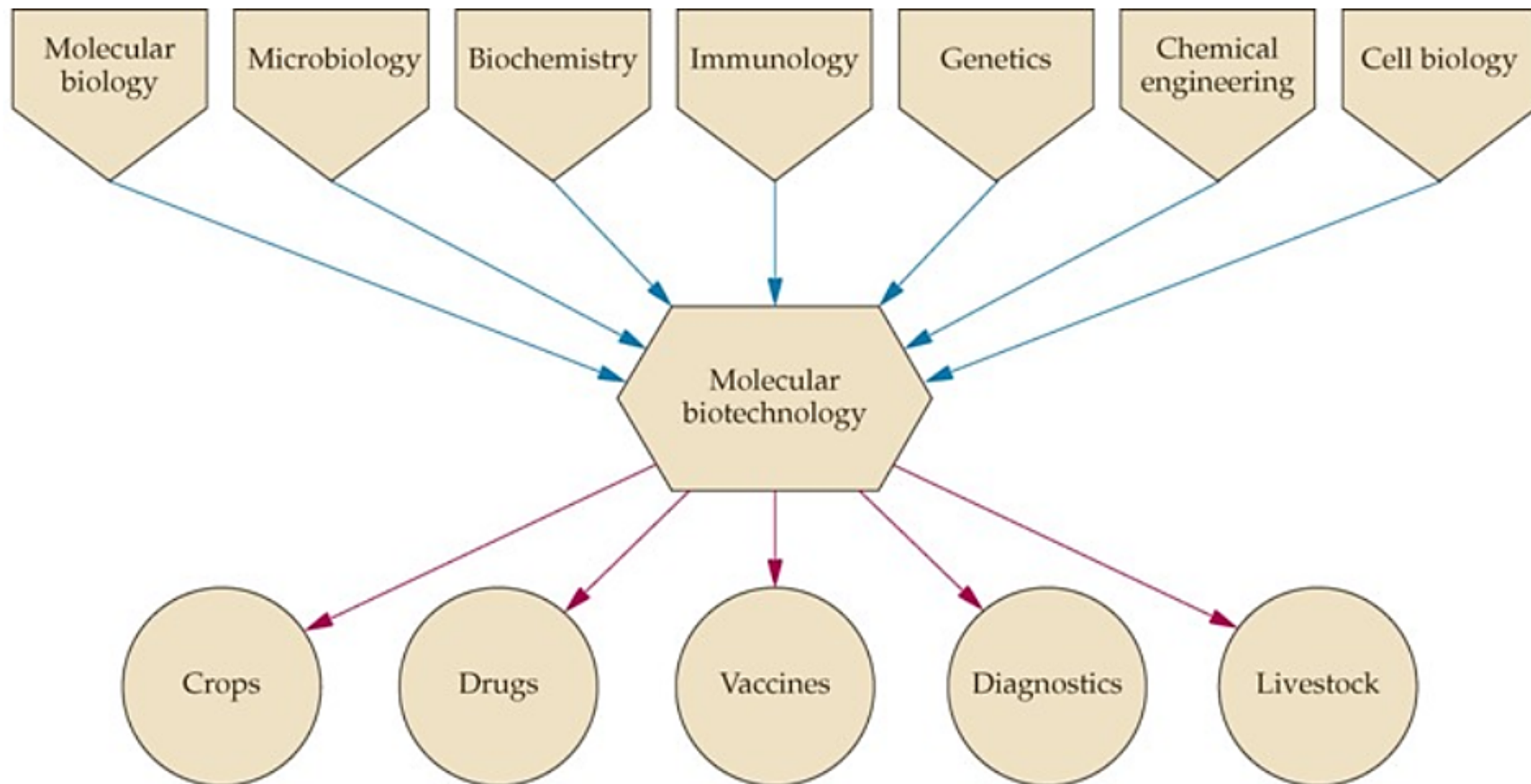
Integrated Technology  
Development

**Engineering of Production Processes**

- Process Development
- Process Monitoring
- Reaction Engineering
- Up- and Downstream Processing

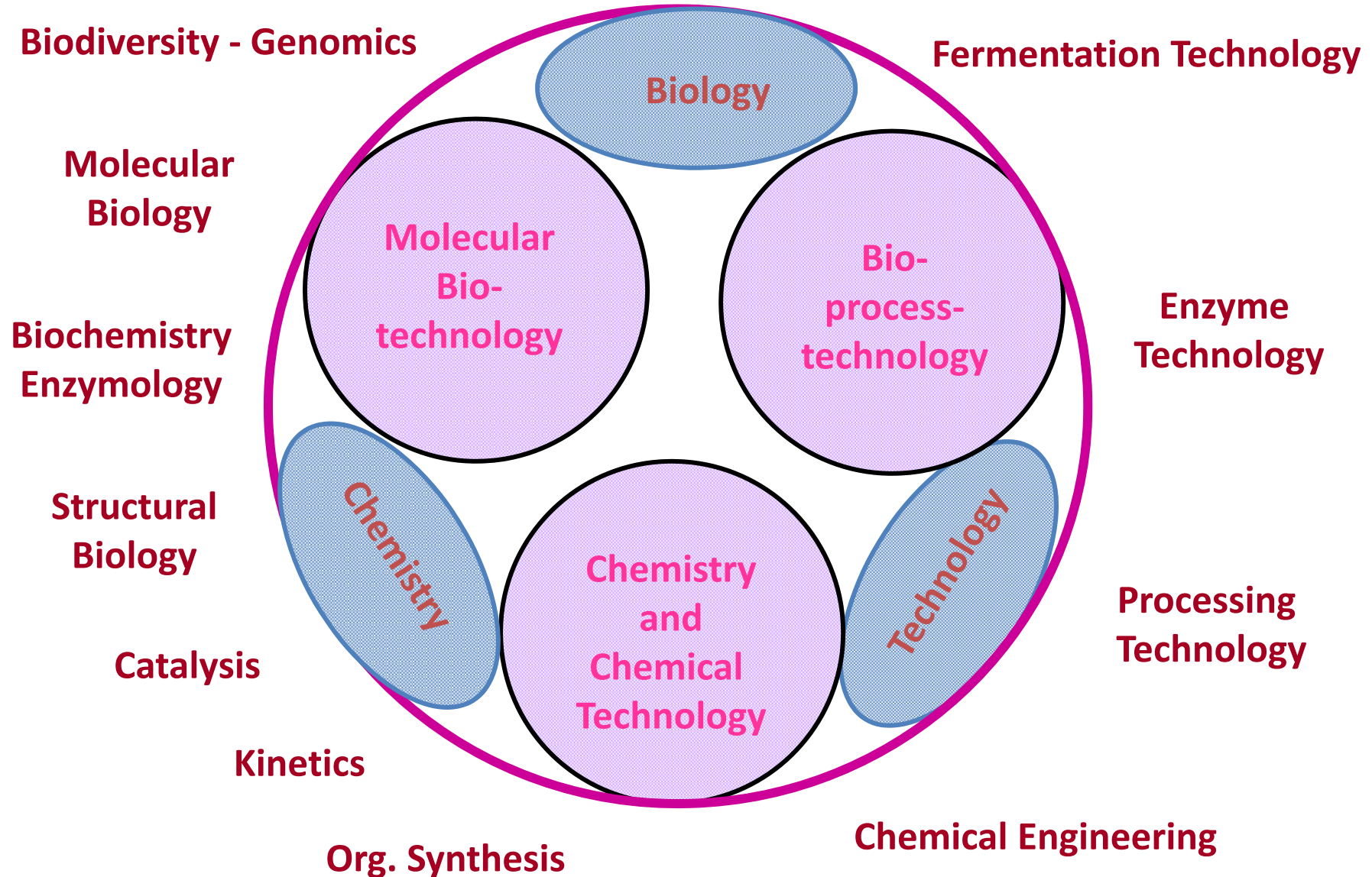


Many scientific disciplines contribute to molecular biotechnology, which generates a wide range of commercial products



# Molecular Biotechnology

## Industrial Biotechnology - Biocatalysis



Recent Years

Recombinant Antibodies

High Throughput Sequencing

„Omics“

Systems Bio/techno/logy

Synthetic Bio(techno)logy

**Table 1.1** Historical development of molecular biotechnology

Date	Event
1917	Karl Ereky coined the term <i>biotechnology</i>
1943	Penicillin produced on an industrial scale
1944	Avery, MacLeod, and McCarty demonstrated that DNA is the genetic material
1953	Watson and Crick determined the structure of DNA
1961	Journal <i>Biotechnology and Bioengineering</i> established
1961–1966	Entire genetic code deciphered
1970	First restriction endonuclease isolated
1972	Khorana and coworkers synthesized an entire tRNA gene
1973	Boyer and Cohen established recombinant DNA technology
1975	Kohler and Milstein described the production of monoclonal antibodies
1976	First guidelines for the conduct of recombinant DNA research issued
1976	Techniques developed to determine the sequence of DNA
1978	Genentech produced human insulin in <i>E. coli</i>
1980	U.S. Supreme Court ruled in the case of <i>Diamond v. Chakrabarty</i> that genetically manipulated microorganisms can be patented
1981	First commercial automated DNA synthesizers sold
1981	First monoclonal antibody-based diagnostic kit approved for use in the United States
1982	First animal vaccine produced by recombinant DNA technology approved for use in Europe
1983	Engineered Ti plasmids used to transform plants
1988	U.S. patent granted for a genetically engineered mouse susceptible to cancer
1988	Polymerase chain reaction (PCR) method published
1990	Approval granted in the United States for a trial of human somatic cell gene therapy
1990	Human Genome Project officially initiated
1994–1995	Detailed genetic and physical maps of human chromosomes published
1996	First recombinant protein, erythropoietin, exceeds 1 billion dollars (U.S.) in annual sales
1996	Complete DNA sequence of all the chromosomes of a eukaryotic organism, the yeast <i>Saccharomyces cerevisiae</i> , determined
1997	Nuclear cloning of a mammal, a sheep, with a differentiated cell nucleus



**Molecular  
Biotechnology**

**Targeted Engineering of Biosystems**

**Planning in line with engineering practice  
Exact execution according to construction plans**

# Engineering of Biosystems

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## Selection of natural variants

natural diversity

## Mutation - random genetic changes

randomly induced mutagenesis

Induced evolution

## Crosses – genetic Recombination

Sexual crosses

Induced cell fusion

parasexual systems (conjugation, transduction, transformation)

## (Targeted) Gene manipulations – Recombinant DNA

*in vitro* Recombination of DNA*in vitro* site-specific mutagenesis

„designed evolution“

directed evolution

## Systems Biotechnology

Integrated understanding / modeling / ratio-based construction of biosystems/cells

Designed biosystems

## Synthetic Biology

De novo design and construction of complex biosystems/cells

# Engineering of Proteins

## Enzymes

### Functional Proteins – Biopharmaceuticals

Improvement of the Traits of Enzymes and Proteins by  
Rational Design or Directed Evolution

Stability (T., pH, Solvents ...)

Activity ( $v_{\max}$ ,  $K_m$  ...)

Substrate specificity

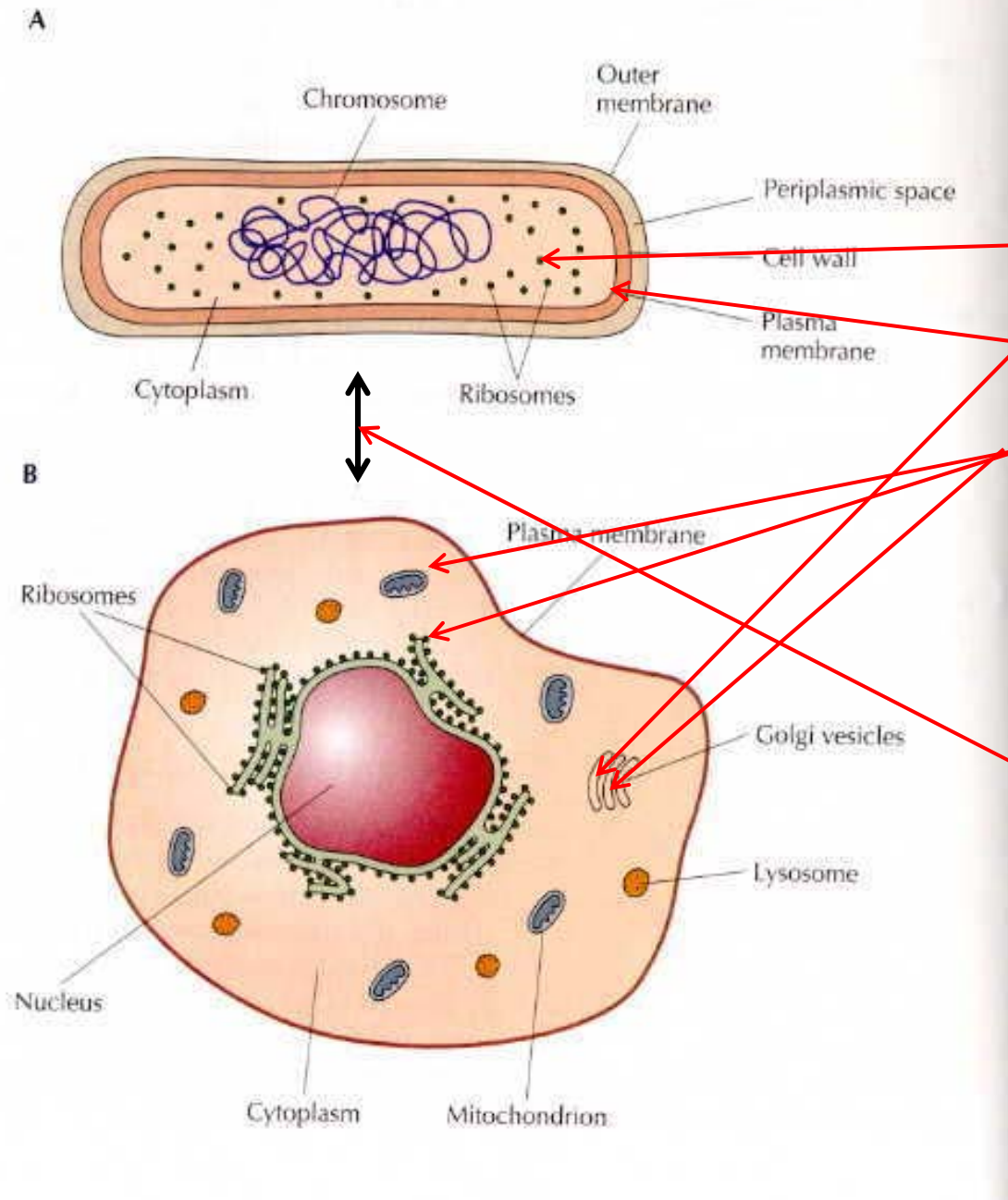
Selectivity (Enantioselectivity, position specificity ..)

Affinity

.... etc.



Figure 2.1 Schematic representations of a prokaryotic bacterium (A) and a eukaryotic animal cell (B).



Important Cell Functions

Metabolism

Transport

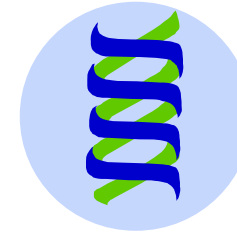
Specialised Compartments

- Protein clusters
- Membranes
- Organelles
- Cytoskeleton

Communication

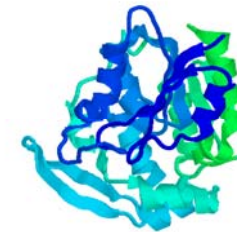
# ORGANISMS

GENOME



TRANSCRIPTOME

PROTEOME



METABOLOME

