DNA Technology & Genetic Engineering in Microbiology

Main Question: How DNA technology revolutionized research, medicine & industry

DNA technology: methods to modify DNA

Genetic engineering: changing genes to give new traits

Recombinant DNA: combining DNA from different organisms

Uses microbes as tools

KEY TOOLS

Restriction enzymes

cut DNA

Vectors

carry genes (plasmids)

Transformation

inserting plasmid into bacteria

PCR

amplify DNA

CRISPR-Cas

gene editing

APPLICATIONS IN MICROBIOLOGY

- Protein production (insulin, hormones)
- Vaccines and medicines
- Diagnostic tools (PCR for pathogens)
- Bioremediation
- CRISPR came from bacteria

PRINCIPLES

1. Isolate gene

2. Insert into vector

3. Insert into host

4. Gene cloning

5. Expression of product

RESEARCH IMPACT

Gene function studies

Understanding how genes work and their roles in cellular processes

Genome sequencing

Mapping complete genetic information of organisms

Protein studies

Analyzing protein structure and function

Microbes as model organisms

Using microorganisms to understand biological principles

ADVANCES

1. Industrial biotechnology
2. Medical biotechnology
3. Environmental biotechnology
4. Food biotechnology

Key technologies enabling these advances

1. recombinant DNA technology: combining DNA from different sources
2. Gene cloning: creates multiple copies of a gene
3. CRISPR-Cas9: powerful & precise gene-editing tool
4. Other techniques: restriction enzymes digestion and PCR

Industrial uses of genetically modified microorganisms (GMMs)

1. Pharmaceutical production

Vaccines and therapeutic proteins, Antibiotics, Enzymes

2. Food and beverage processing

vitamins and amino acids, Enzymes Food additives

3. Bioremediation and environmental applications

pollutant degradation, Bioremediation, Agricultural applications

4. Other industrial uses

Biofuels, industrial enzymes

Analysis considerations

1. Genetic engineering techniques

analyze specific techniques such as CRISPR-Cas9 or recombinant DNA techniques

2. Production efficiency and cost

Evaluate the advantages GMMs, lowerBiosafety and ethical concerns

3. Safety and risk assessment

potential risk such as gene transfer to other organisms, creation of toxic products or allergenic reactions

Biosafety concerns

1. **Accidental release:** unintentional escape of microorganism
2. **Unpredictable ecological effects:** disrupting the natural balance of microbial communities
3. **Horizontal gene transfer:** creating superbugs or new pathogens
4. **Bioterrorism potential:** could be misused by malicious actors

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Ethical concerns

1. **Environmental responsibilities:** Raises question about consequences
2. **Informed consent:** involving human associated microbes
3. **Unintended consequences:** genetic modification can have unforseen side effects
4. **Blurring the lines between therapy and enhancement:** line lies between treating disease and non therapeutic enhancement

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Hypothesis: enabling faster and more precise Research methods

Research significance: connects microbial genetics to real world Production cost