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UNIT V

Transgenic Plants and Animals

- **Transgenic organisms:** Organisms that have had foreign genes (from another species or synthetic DNA) inserted into their genome using recombinant DNA technology.
- **Purpose:** To introduce new traits, enhance existing traits, or study gene functions.

Transgenic Plants

Definition

- Plants that have been genetically modified to express a gene from a different organism.

Methods of Development

1. **Gene Transfer Techniques:**
 - **Agrobacterium-mediated transformation:**
 - Utilizes *Agrobacterium tumefaciens*, a natural plant pathogen.
 - Transfers the desired gene into the plant via a **Ti plasmid**.
 - **Gene gun (Biolistics):**
 - Shoots microscopic particles coated with DNA into plant cells.
 - **Electroporation:**
 - Uses an electric field to introduce DNA into plant protoplasts.
2. **Selection and Regeneration:**
 - Transformed cells are selected (e.g., using antibiotic resistance markers).
 - Plants are regenerated from the transformed cells through tissue culture techniques.

Applications

1. **Agricultural Improvements:**
 - **Insect resistance:** *Bt crops* (e.g., Bt cotton, Bt corn) produce a toxin from *Bacillus thuringiensis* that kills pests.
 - **Herbicide resistance:** *Roundup Ready* crops resist glyphosate herbicide.
 - **Disease resistance:** Resistance to viral, bacterial, or fungal pathogens.
2. **Nutritional Enhancement:**
 - Example: *Golden rice* enriched with vitamin A.
3. **Pharmaceuticals:**
 - Plants producing vaccines or therapeutic proteins.
4. **Bioremediation:**
 - Plants engineered to detoxify pollutants (e.g., heavy metals).

Transgenic Animals

Definition

- Animals genetically modified to carry genes from other organisms.

Methods of Development

1. **Microinjection:**
 - Direct injection of DNA into the pronucleus of a fertilized egg.
2. **Retroviral Vectors:**
 - Use of modified viruses to introduce genes into animal embryos.
3. **CRISPR-Cas9:**
 - A precise gene-editing tool for inserting, deleting, or modifying genes.
4. **Nuclear Transfer:**
 - Cloning techniques where a nucleus from a genetically modified cell is transferred to an enucleated egg.

Applications

1. **Medical Research:**
 - Model organisms for studying diseases (e.g., Alzheimer's, cancer).
 - Example: *Oncomouse* (genetically modified for cancer research).
2. **Pharmaceuticals:**
 - Animals producing therapeutic proteins in their milk (e.g., human insulin, clotting factors).
3. **Agriculture:**
 - Animals with enhanced growth rates (e.g., transgenic salmon that grow faster).
 - Disease-resistant livestock.
4. **Xenotransplantation:**
 - Transgenic pigs engineered to reduce immune rejection of their organs in humans.

Ethical Considerations

1. **Biosafety:**
 - Risks of gene flow to wild species (e.g., transgenic plants).
 - Allergens or unintended effects on human health.
2. **Animal Welfare:**
 - Ethical concerns about animal suffering during experimentation.
3. **Environmental Concerns:**
 - Impact on ecosystems, such as loss of biodiversity.
4. **Social Issues:**
 - Patenting of genetically modified organisms (GMOs) and its impact on farmers.

Examples of Transgenic Organisms

1. **Plants:**
 - Bt cotton, Golden rice, Flavr Savr tomato (delayed ripening).

2. Animals:

- Glowfish (zebrafish with fluorescent proteins).
- Transgenic goats producing antithrombin protein.

Advantages and Limitations

Advantages:

- Improved agricultural productivity.
- Enhanced nutritional value of food.
- Advances in medical research and treatments.
- Potential solutions to environmental issues.

Limitations:

- High costs of development.
- Ethical and regulatory hurdles.
- Potential long-term risks to health and environment.

Transgenic plants and animals have revolutionized agriculture, medicine, and biotechnology. While their benefits are significant, ethical and environmental considerations must be addressed for sustainable use.