

Introduction to Animal Biotechnology

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Key concepts, applications, and ethical considerations

1. What Is Animal Biotechnology?

Aspect	Description
Definition	The use of biological tools and techniques to modify, improve, or study animals for agricultural, medical, and scientific purposes.
Core	• Molecular genetics
Disciplines	• Cell culture and tissue engineering • Reproductive technologies • Genomics & bioinformatics
Goal	Enhance animal health, productivity, and welfare; generate models for human disease; produce biologically valuable products (e.g., proteins, vaccines).

2. Fundamental Techniques

Technique	Principle	Typical Uses
Recombinant DNA (rDNA)	Insertion of foreign DNA into an animal's genome or cells.	Production of therapeutic proteins (e.g., human insulin in transgenic goats).
Gene Editing (CRISPR, Cas9, TALENs, ZFNs)	Precise cuts in DNA ? targeted insertions, deletions, or base changes.	Knock?out disease genes, improve disease resistance, create livestock with desirable traits.
Somatic Cell Nuclear Transfer (SCNT)	Transfer of a donor nucleus into an enucleated oocyte ? cloned embryo.	Cloning of elite animals, preservation of genetics, research models.
Embryo Transfer (ET)	Harvested embryos are placed into surrogate mothers.	Multiply genetically superior offspring, propagate transgenic lines.

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Technique	Principle	Typical Uses
In?vitro Fertilization (IVF) & Sperm/Egg Cryopreservation	Combine gametes outside the body; store gametes at low temperature.	Genetic banking, controlled breeding programs.
Transgenesis	Integration of a foreign gene that is expressed in the host.	Production of biopharmaceuticals, disease?resistant animals.
RNA Interference (RNAi) & Antisense Technology	Suppression of specific gene expression post?transcriptionally.	Functional genomics, therapeutic knock?down of harmful genes.
Stem Cell & Tissue Engineering	Isolation and differentiation of pluripotent cells; scaffold?based organ construction.	Regeneration of damaged tissues, disease models, cultured meat.

3. Major Applications

3.1 Agriculture & Food Production

- **Improved Growth & Feed Efficiency** – e.g., myostatin?knockout cattle (double?muscle phenotype).
- **Disease Resistance** – transgenic salmon resistant to viral hemorrhagic septicemia; PRRS?resistant pigs.
- **Enhanced Product Quality** – goats producing milk enriched with human lactoferrin; cattle with altered fatty?acid profiles for healthier meat.

3.2 Biopharmaceuticals (“Pharming”)

- **Mammary? gland bioreactors** – goats, cows, and rabbits secreting antibodies, enzymes, or clotting factors in milk.
- **Transgenic chickens** – eggs as a source of recombinant proteins (e.g., influenza vaccine antigens).

3.3 Biomedical Research

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- **Disease Models** – transgenic mice, rats, and larger animals (pigs, sheep) mimicking human conditions (Alzheimer's, cystic fibrosis, muscular dystrophy).
- **Xenotransplantation** – genetically engineered pigs lacking ??gal epitopes to reduce organ rejection in humans.

3.4 Conservation & Biodiversity

- **Genetic Rescue** – cryopreserved gametes or embryos to restore endangered populations.
- **Cloning of Endangered Species**