Biotechnologies in Livestock, Poultry, Fisheries & Aquaculture
(in the Asia/Pacific Region)

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Main Areas of Application in Animals & Animal Products

o **Genetics, breeding and conservation**
o **Reproduction**
o **Nutrition & feeds**
o **Disease diagnosis, epidemiology & vaccines**
o **Product technologies**
o **Emerging technologies (applications in many areas):**
  o **Stem cell technologies**
  o **Metagenomics**
  o **Biotherapeutics**
  o **Nanotechnologies**

Biotechnologies in Genetics, Breeding & Conservation: Livestock & Poultry

- **Characterizing genetic variation**
  - DNA polymorphs, Microsats, SNPs, Sequencing
  - Markers used in six Asian countries for genetic distancing
- **Increasing the speed of genetic improvement**
  - QTLs, MAS, MAI, Whole genome selection
  - GAI in sheep :FecB (Booroola) gene
  - MAS used in two Asian countries
- **Transgenic animals**
  - Gene transfer, 'Knock-in', 'Knock-out'
- **Conserving genetic resources and diversity**

Reproductive Biotechnologies: Livestock

- ❖ **Artificial Insemination (AI)**
  India: 34 million AI in 2007
  Asia: AI also used in chickens, camels and ducks
- ❖ **Multiple Ovulation Embryo Transfer (MOET)**
  Eight Asian countries use ET
- ❖ **Harvesting Ova for Embryo Production**
  - ❖ At Slaughter; Ovum Pick Up (OPU)
  - ❖ In Vitro Maturation (IVM) and Fertilization (IVF)
- ❖ **Cryopreservation – Semen, Embryos**
  - ❖ Cattle, buffaloes, goats, sheep
- ❖ **Gender pre-selection (sexing)**
  - ❖ Semen, Embryos
  - ❖ China only developing country where sexing used at field level
- ❖ **Cloning**
  - ❖ Embryo splitting
  - ❖ Embryonic cell nuclear transfer
  - ❖ Somatic cell nuclear transfer (cloned buffalo in India)

Biotechnologies in Animal Health: Livestock, Poultry & Fish

❖ **Disease diagnosis**
  - ❖ Immunoassays (ELISA, RIA), DNA/RNA probes, PCR, DNA microarrays
  - ❖ China, India, Thailand: public sector production of biotech based diagnostic kits for animal diseases
  - ❖ OIE approved Biosafety III referral lab for FMD diagnosis being established in India for the Asia-Pacific region

❖ **Molecular epidemiology**
  - ❖ Nucleotide sequencing of pathogens

❖ **Vaccine development**
  - ❖ Recombinant DNA technology
    Seven Asian countries produce animal vaccines derived from biotechnology

Biotechnologies in Animal Nutrition: Livestock & Poultry`

o **Prebiotics and probiotics**
  - o Inhibit pathogens, increase immunity
o **Growth promoters; Metabolic modifiers**
  - o Recombinant somatotropin, repartitioning agents
o **Immunomodulation**
  - o Enhance endogenous hormones, anabolics
o **Single cell proteins**
  - o Feeds grown in the lab
  - o Amino acids in poultry feed
o **Genetic manipulation of plants**
  - o Increase digestibility, reduce antinutrients
  - o Decrease P & N excretion (phytate, amino acids)
  - o Production of vaccines and antibodies
o **Genetic manipulation of rumen microbes**
  - o Improved fermentation, metabolism, utilization

Biotechnologies for Animal Products: Milk, Meat, Fish & Eggs

- **Food quality**
  - Selective breeding for changes in constituents, consistency, egg-shell quality, etc.
- **Food processing**
  - Fermentation: microorganisms and/or enzymes
  - Dairy products: culture organisms
- **Food safety and testing**
  - Diagnostics, Identify contaminants
  - Traceability of origin
- **Animals as 'Bioreactors'**
  - Recombinant products
  - Proteins, pharmaceuticals, vaccines
- **Animals as organ donors for humans**
  - Xeno-transplantation

Biotechnologies in Aquaculture: Genetics & Breeding

- **Identify advantageous genes**
  - Improved growth, early maturity
  - Improved flesh quality (nutritional value, taste, texture and appearance)
  - Increased resistance to stress, pathogens and temperature changes
- **Marker-assisted breeding**
- **Transgenics**
  - Injection of DNA in to eggs or somatic cells
- **Conservation of genetic resources**
  - Spermatogonial transplantation
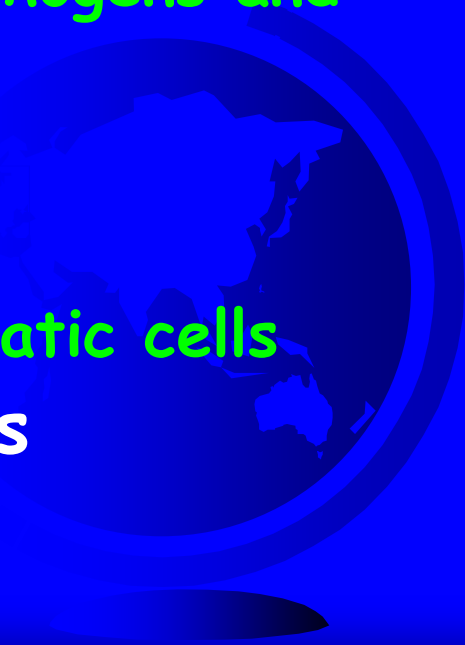
Biotechnologies in Aquaculture: Reproduction

- **Sterile populations**
  - Mono-sex, haploid, triploid
  - Gynogenesis, androgenesis to develop inbred individuals, hybridization
  - Prevent escapees influencing biodiversity
- **Reducing age at maturation**
- **Overcoming seasonality**
- **Improving gamete quality and management**
  - Storage (cryopreservation, vernalization)
- **In vitro fertilization**

Biotechnologies in Fisheries & Marine Organisms

- ❖ **Marine fishery**
  - ❖ Sustainable harvesting; Conservation decisions
    - ❖ Population genetic structure; Evolutionary Significant Units (ESUs); Effective population size (Ne)
  - ❖ Processing
- ❖ **Marine invertebrates**
  - ❖ Food
- ❖ **Macro- and micro-algae**
  - ❖ Food
  - ❖ Pharmaceuticals, Polysaccharides
  - ❖ Bioremediation

Emerging Biotechnologies

- **Stem cell technologies**
  - Embryonic and adult stem cells
  - Therapeutic uses (xeno-transplants, etc.)
- **Metagenomics (Ecogenomics)**
  - Genetic material derived from environmental samples
- **Biotherapeutics**
  - Proteins from transgenic animals and plants
- Nonotechnology
  - Nanomedicine (disease diagnosis, vaccine development)
  - Nanopharmacology (delivery of drugs)
  - Nanotoxicology (toxicity of nanomaterials)

Points to Consider in Increasing Animal Productivity & Quality of Animal Products

✓ **Productivity or yield**
  - ✓ Per animal or Per unit of land or feed
  - ✓ Costs Vs. Benefits

✓ **Sustainable use of natural resources**
  - ✓ Conserving resources and biodiversity
  - ✓ Preserving the environment

✓ **Food security for the poor**
  - ✓ Availability and price

✓ **Demands of increasingly discerning consumers**
  - ✓ Food quality and safety

Issues to Consider in Selecting & Using Biotechnologies

❖ **The needs and livelihoods of the producers**

❖ **For livestock production**

  ❖ Need to also improve management, feeding, breeding and disease control

❖ **For genetic manipulation**

  ❖ What is relevant for a specific production system under the available resources and socio-economic conditions?

  ❖ Are they cost-effective, sustainable and acceptable?

Issues to Consider in Selecting & Using Biotech …

❖ **For transgenics (GMOs) and their products**
  - ❖ Ethics
  - ❖ Hazards
  - ❖ Consumer preferences

❖ **For all Biotechnologies**
  - ❖ Risk assessment
  - ❖ Biosafety
  - ❖ Biosecurity

Issues to Consider in Implementing Biotechnology

❖ **Infrastructure**

　❖ Policies, regulatory framework, institutions, investment

❖ **Human resources**

　❖ Education, training, communication, collaboration, remuneration, recognition, retention

❖ **Equipment and supplies**

　❖ Procurement, maintenance, replacement

❖ **Communication, Collaboration & IPR**

❖ **Monitoring, evaluation, adaptation**

Thank you