GENETICS
LESSON 12: GENETIC TECHNOLOGIES

Learning Outcomes

- **I can describe different technologies used to manipulate genes.**

Scientific Gene Manipulation

- in addition to using breeding practices to influence the genetic makeup of an individual or species, scientists can now directly modify or change the genetic code of an individual or species

1. Cloning
   - producing an identical copy of an organism
   - involves replacing the entire DNA within an egg with the DNA of the individual to be copied, and then implanting the new egg into a host mother

https://www.youtube.com/watch?v=tELZEPcgKkE

Dolly the sheep.

2. Gene Cloning
   - producing many identical copies of a specific gene in a bacterial host cell
   - these copies can then be used for research or for making transgenic organisms.

3. Transgenic Organisms
   - the introduction of a foreign gene into an organism to introduce a new trait
   - often done using recombinant DNA technologies (i.e., the method used for creating transgenic organisms) – using a vector (often a manipulated virus) to inject the new gene.
   - called Genetically Modified Organisms (GMO's)
     - golden rice – higher vitamin A and iron content
     - tomatoes that can grow in colder climates
     - increased crop resistance to herbicides or infections
     - insulin producing bacteria
     - modifying milk production in goats to produce human medical products (growth hormones, anti-clotting factors, etc.)
     - more compatible pig organs for human transplant operations
     - https://www.youtube.com/watch?v=7TmcXYp8xu4
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4. Reproductive Technologies
   - procedure used to increase the chance of becoming pregnant
   - artificial insemination

        - collection and concentration of sperm cells that are then placed into the female's uterus
        - also used in domestic animals
    - in vitro fertilization (i.e., test tube babies)
        - combining sperm and egg cells in glassware for fertilization, allowing the embryos to start to grow, then implanting the embryo(s) into the mother's uterus
    - intracytoplasmic sperm injection (form of in vitro fertilization)
        - directly injecting the sperm DNA into an egg for direct fertilization
        - embryo is implanted in mother's uterus

5. Gene Therapy
    - replacing a missing or defective gene with a healthy gene to cure a genetic disorder – this is **not** introducing genes from a different species
    - used to increase recognition of diseased cells to the immune system
    - new gene is inserted using a viral vector
    - first approved use in US
        - used to treat a 4 year old girl for ADA-SCID (a severe autoimmune deficiency disorder; called "bubble children")
            - https://www.youtube.com/watch?v=lSz1ZINMwj8
            - SCID video
        - received injections every 2 months – achieved temporary success
    - since then, there have been many clinical trials and some FDA and European Medicines Agency (EMA) approvals for gene therapy treatment
        - successful treatment of ADA-SCID in multiple children
        - treatment of hemophilia
        - treatment of choroidermia – X-linked recessive trait causing hereditary retinal degeneration
        - treatment of spinal muscular atrophy – loss of motor neurons leading to muscle wasting
        - treatment of simian HIV in monkeys
    - donor lungs
        - 80% of potential donor lungs cannot be used due to damage from inflammation during brain death or ICU treatments
        - treating donor lungs with IL-10 gene to reduce inflammation and heal the damage caused by inflammation
        - may improve transplant success rates and make more lungs acceptable for transplants