HSC Biology
Core 2 – Blueprint of Life

Focus 5

- *Current reproductive technologies and genetic engineering have the potential to alter the path of evolution.*

Identify how the following current reproductive techniques may alter the genetic composition of a population:

- **artificial insemination**
- **artificial pollination**
- **cloning**

- Artificial insemination:
  - Injection of male semen into female.
    - Commonly used by;
      - Animal breeders.
        - Cows.
        - Sheep.
    - Sperm collected from male with desirable characteristics.
    - Can be transported large distances.
    - Many females fertilised.
      - More offspring produced.
- Artificial pollination:
  - Plants pollinated by hand.
    - Dusting fertile stigmas with pollen from plants with desirable characteristics.
    - Allow genetic changes quickly widespread within populations.
- Cloning:
  - Produce genetically identical organisms.
    - Genes, cells, organisms may be cloned.
    - All asexual reproduction produces clones.
    - Cloning of plants by cutting/grafting used for years.
      - Produce identical crops/gardens.
    - Tissue culture techniques used to produce clones of plants with required characteristics.
    - Animal cloning offered challenge to scientists.
      - Large domestic animals prove hardest challenge.
    - Dolly cloned by nuclear transfer technology.

- In all reproductive methods, donor gametes/body cells carefully selected for predetermined characteristics.
  - Leads to genetic variation being reduced over generations.

Outline the processes used to produce transgenic species and include examples of this process and reasons for its use.

- Genetic engineering:
  - Producing a transgenic species.
- Transgenic species:
  - Contain a gene from another species.
- **Isolating genes.**
  - Useful gene identified, isolated by cutting out of DNA strand.
  - Restriction enzymes or **endonucleases** used for this.
    - A.K.A. gene scissors.
    - Found in bacteria, 800+ types known.
    - Each enzyme cuts sequence of nucleotides at a specific point.
    - Cut ends known as 'sticky ends'.

- **Recombinant DNA.**
  - DNA strands from 2 different organisms cut with same enzyme mixed.
  - Matching sticky ends connect
    - Annealing.
    - Ligases sealing & strengthening enzymes.
      - Found in all living organisms.
      - Make & repair DNA.
      - Seal & strengthen annealing DNA fragments.
        - Producing recombinant DNA.
- **Producing transgenes.**
  - Genes contain a code for a specific protein.
  - When new protein required:
    - mRNA only copies the code.
  - DNA strand contains control/promoter sequences.
    - Switch gene 'on' or 'off'.
    - Regulate production of protein.
      - When.
      - How much.
      - Where (which cell) it will function.
    - An isolated gene cannot function alone.
      - Requires promoter sequence.

- **Copying genes.**
  - Genetic engineering on a large scale:
    - Multiple copies of genes produced.

- Polymerase chain reactions (PCR) do this.
  - DNA molecule with required gene.
  - Large amount of nucleotide bases.
    - Adenine.
    - Thymine.
    - Guanine.
    - Cytosine.
  - DNA polymerase.
  - Primers.
    - Short nucleotide sequences.
    - Initiate process.

  mixed together.
  - Mixture heated.
  - Separates double stranded DNA molecule.
- Cooled.
  - Primers anneal to ends of DNA strands.
- DNA polymerase synthesises complementary DNA strands.
- Doubles number of DNA molecules in 2 minutes.
- Repetition of heating, cooling rapidly produces large quantities of DNA.

- **Inserting gene into bacteria.**
  - Plasmids.
    - Small circular pieces contained by bacteria.
    - Used as vectors (carriers).
      - Transfer transgenes to bacteria.
    - Inserted into bacteria.
      - Bacteria treated with cold calcium chloride, then heat.
        - Softens bacterial wall, easier penetration.
  - Bacteria rapidly clone isolated gene.
    - Human insulin & HGH genes inserted into bacteria.
    - Bacteria cultured.
    - Hormones produced harvested, used to treat people.
  - Bacteriophages.
    - Viruses infecting bacteria.
    - Used to insert genes.

- **Genes into plants.**
  - Ti (tumour inducing) plasmid insertion.
    - Agrobacterium tumefaciens.
      - Causes a tumour containing transgene to grow in plant.
      - Makes copies as tumour grows.
- **Genes into animal cells.**
  - Microinjection.
    - Uses fine glass pipettes.

- **Insertion using gene/particle gun.**
  - Shoot DNA coated metal pellets into cells of animals or plants.

Eg. Genetically engineered salmon.
  - Inserted with protein BGH (bovine growth hormone).

Eg. Potato plants inserted with gene for lectin from peas.
  - Creates crops resistant to some pests.

Discuss the potential impact of the use of reproduction technologies on genetic diversity of species using a named plant and animal example that have been genetically altered.

- Reproductive techniques;
  - Cloning.
  - Engineering of transgenic species.

  have ability to;
  - Increase genetic diversity.
  - Decrease genetic diversity.
- Moving genes from species to species increases genetic diversity.
  - Rice crops genetically engineered to suit climate & topography, resistance to herbicides used in a region.
  - Transgenic species present larger problems with a
- Cloning reduces genetic diversity, offspring are identical.

Process information from secondary sources to Describe a methodology used in cloning organisms.

- The process of producing genetically identical offspring.
  - In the absence of sexual reproduction.
  - Plants & animals already successfully cloned.
- Plants cloned through tissue propagation.
  - Root tissue taken.
  - Cells separated.
  - Cells cultured in a nutrient rich environ.
    - Become unspecialised.
      - Calluses.
  - Calluses treated with plant hormones.
    - Develop into seedlings.
    - Grow into fully matured plants.
      - Genetically identical to 'parent' plant.

  Eg. Wollemi Pine.
      - Recently discovered in Blue Mountains after believed extinct.
      - Cloned.
        - Offspring sent to botanical gardens, sold to public.
- Animal cloning.
  - Progress not rapid.
  - Requires unfertilised egg as a host for genetic material.
  - Donor egg has nucleus removed.
    - Nucleus from cell of species to be cloned inserted.
    - Electrical stimulus fuses egg with nucleus, initiates cell division.
  - Embryo inserted into surrogate mother, continues to develop.
  - Offspring genetically identical to animal that donated nucleus.
  - First performed 1970's.
    - Tadpoles cloned.
    - Didn't grow into frogs.
  - Dolly 1st cloned mammal 1997.

Analyse Information from secondary sources to Identify examples of the use of transgenic species and Use Available evidence to debate the ethical issues arising from the development and use of transgenic species.

- **Eg.**
  - Transgenic tomatoes.
    - Improved shelf life.
    - Less wasted food, reduce costs to consumers, stores.

  Eg.
  - Transgenic soya beans imported into Australia.
    - Resistant to Roundup (herbicide)
    - More yield from crop.
    - Lower cost to farmer.

- No destroyed plants.

Eg.

- 'Super pig'.
  - 10 extra growth hormones.
  - Genes engineered from human DNA.
  - Genes 'switched on' in presence of Zn.
  - Allows supply of meat to meet its demands.

Eg.

- Transgenic sheep.
  - Able to secrete alpha-1.
    - Protein to treat human lung disease.

- **Ethical issues.**
  - Should something be done just because its possible?
  - Long term effects on transgenic species.
    - Cows treated with genetically engineered BGH, increase milk production.
    - Possible health risk to humans.
    - Risk of mastitis.
      - Infection of nipple.
      - Cows given antibiotics to counter react.
  - Moral questions about creating transgenic species.
    - Raised by animal rights activists.
    - Lab mice bred to automatically develop diseases for scientific study.
      - Cancer, cystic fibrosis, muscular dystrophy.
  - Concern over return of eugenics movement.
    - Strategy applying to selective breeding of desirable traits.
      - Sterilising the mentally retarded.
        - Similar to actions of NAZI Germans.
  - Genetically engineered organisms in environ cause disease.
    - Transgenic species may cause new diseases.
    - Create strains of resistant diseases.
  - Health Risks.
    - Genetically modified foods may cause harm when eaten.