BIOLOGY

Blue Print of Life: Reproductive Techniques and Genetics

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

- **Artificial insemination:** it is the process when sperm is placed inside the female reproductive system with intention to impregnate by using means other than natural insemination such as sexual intercourse. It is commonly used in agricultural breeding of large mammals: e.g. cows, sheep and horses.

  This process means that many offsprings arise from the single male parent, resulting in a reduction in genetic variability over time.

- **Artificial pollination:** Transfer of pollen from the anther to the stigma of a plant, by other means than natural pollination such as self-pollination and via natural pollinators. Such as the way Mendel carried his experiments by pollinating plants by using a cotton bud and removal of anthers to avoid self-pollination. This process also give breeder greater control over offspring characteristic.

  This is particularly useful and easy way of breeding new varieties of plants. Thousands of new breeds of plant have been created by artificial pollination. Artificial pollination can create new hybrid species. As a result, genetic composition is altered as the introduction of hybrid species and their inability to reproduce may cause loss of genes and thus genetic variability.

- **Cloning:** is the process of producing organism/(s) with a set of identical genetic make-up. There are two types of cloning: reproductive (creates genetically identical whole organism) and therapeutic cloning (creation of embryos to extract useful stem cells for repairing damaged adult cells).

  This can be extremely detrimental to a small isolated population, as it will further reduce the genetic variability of organisms. So when the population mates with each other defects will arise as a result.

  In all 3 cases, the gametes have been artificially selected for the characteristics they carry. This causes a great reduction in genetic variability if only a few or one donor's gametes are used within a population, especially a small and/or isolated population.

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

Methodology: method, procedure or technique. It can also mean the theoretical analysis of methods/ procedure or techniques.

Cloning is the generation of genetic identical organisms. Cloning is a fairly recent development in the science of genetics area. The most common is the somatic cell nuclear transfer. This process requires 2 types of cells: one egg and one somatic cell (from the same species).

- The nucleus of the egg is then extracted and discarded (along with its genetic information) and the somatic is then inserted into the egg and fused using electricity.

- The egg is then stimulated and this causes it to divide as if it had been fertilized in natural reproduction. The egg is then placed in a culture medium for several days until a blastocyst (early-staged embryo) is formed.

- After approximately a week, the blastocyst is inserted into the surrogate mother where it continues to develop. After full term gestation period, the surrogate mother will deliver birth to an organism with identical genes to the genetic donor (somatic cell)

Note:

- In plants, cutting and grafting is used to produce clones. This has been used for much longer than animal cloning.

- Cloning (especially animal cloning) can produce organisms with characteristics never seen before (mutations) and this can cause defects in the artificially produced organism.

- Advantage: characteristics can be controlled; disadvantage: genetic variability is reduced and thus less likely to survive sudden environmental change.

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

Transgenic organisms are organisms that contain a gene that is extracted and inserted using recombinant DNA technology. Examples of transgenic species include:

- **Cold strawberries:** a gene from a type of salmon allows the strawberry to survive and grow in cold temperatures. So strawberries can grow in cold climate as well, giving places the ability to grown strawberries all year long.

- **Transgenic sheep:** given a plant gene which enables then to produce an insecticide that attacks insects such as blowflies and lice.

Process of production of transgenic species:

1. A useful gene and the chromosome it is on is identified.
2. The gene is extracted and 'isolated' or cut out of its DNA strand (through use of restriction enzymes).
3. Ligases are used to repair and strengthen DNA after it has been cut by restriction enzymes.
4. PCR (polymerase chain reaction) is used to produce many copies of the recombinant DNA formed by previous processes.
5. The gene is inserted into cell of another organism.
6. The gene is inserted into the cell of another organism (through microinjection/ Ti plasmid injection, gene gun and electroporation).

Microinjection: a fine glass needle is used to insert the resulting recombined DNA into the nucleus of the host cell.

Ti (tumor inducing) plasmid: a bacterium such as *agrobacterium tumefaciens* is used as they produce crown gall in plants by inserting some of their own DNA into the host plant causing it to grow a gall in which the bacteria live. This ability to insert DNA is used is used in creating transgenic species as desired DNA can be transferred into the host.

Gene gun: blasts small pieces coated with DNA into the nucleus of the host cell.

Electroporation: it uses electric pulses to create small pores in the nuclear membrane through which DNA is inserted.

Analyze 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.

Examples of transgenic species:

- Transgenic tomatoes have longer shelf life in supermarkets.
- 'Super pigs' have about ten extra hormones. These genes are created from artificial DNA copied from human DNA. The 'genes' are activated in the presence of zinc.

There are many ethical issues associating with transgenic species and their use:

- Long term health risks of the transgenic animal.
- Animal cruelty: transgenic pigs grow fast and leaner but are unable to stand due to arthritis; transgenic mice created in labs to automatically develop cancer, cystic fibrosis and muscular dystrophy so that scientists can study the diseases.
- Return if Eugenics: selective breeding to humans to carry on desirable traits. E.g. sterilizing mentally retarded people and atrocities committed by Nazi Germany.
- Concerns over that producing transgenic species can disrupt rate of gene transfer and interfere with evolutionary relationships of organisms and concerns over gene released into the wild doing irreversible damage such as the promoting of strains of drug-resistant diseases.

Discuss the potential impact of the use of reproduction technology on the genetic diversity of species uses a name plant and animal example that have been genetically altered.

Artificial reproduction (artificial pollination, selective breeding, artificial insemination and IVF) have been found in recent years to have the ability to achieve desired characteristics in the offspring. Selection acts on the phenotype and determines which genotypes are passed on, affecting the gene pool. Some of these process increases genetic variability and new phenotypes and genotype combinations. However in the long run, genetic variation will decrease and so will jeopardize the likelihood of the species/ population's survival. This is because natural gene combinations that are not selected will gradually disappear. Cloning may also bring extinct back to life. We can reintroduce the extinct species' genes e.g. Thylacine.

Potential impact on plant example:

The name of the plant: Transgenic rice -"Golden rice"

- It is an important food source in many countries
- It is modified to include beta carotene, the precursor to vitamin A,

Impact:

- It is developed in the goal that it would reduce vitamin A deficiency related diseases such as blindness especially in children and pregnant women.
- This certain type of genetically modified plant claims to be able to save a million children from blindness a year.

Concerns:

- The speed at which the vitamin A would break down once harvested.
- Potential reduction in biodiversity in the event that the genes of the modified crops mingle with the wild species. Causing inappropriate destruction to the balance in the ecosystem.
- It could also be claimed as an intellectual property which prevents certain groups to obtain the information.
- As the genetic diversity of this rice species decrease, it may be able to be wiped out by a change in condition and millions of people may suffer starvation.

Animal:

The name of the animal: gaur – Bos Frontalis

- It is a large wild ox native to India as well as being an endangered species.
- Cloning is used to increase the population of this endangered species.
- Limited gene pool, less variation may wipe out the entire species if disease was to spread within the population or the change of environmental was to occur

Impact:

- increases the population of gaur to slow down the process of eventual extinction
- May disturb the natural ecosystem of where those animals live

Concerns:

- Increasing the population of gaur by cloning restrict its gene pool.
- Interfering with the natural cycle of evolution and their production methods