B5.3 Controlling Nature Knowledge Organiser

Science Mastery

Genetics

1. The genetic material in the nucleus of a cell is composed of a chemical called **DNA**
2. DNA is a **polymer** made up of two **strands** forming a **double helix**
3. The DNA is contained in structures called **chromosomes**
4. A **gene** is a small section of DNA on a chromosome
5. Each gene codes for a particular sequence of amino acids, to make a **specific protein**
6. The **genome** of an organism is the entire **genetic material** of that organism
7. The whole human genome has now been studied and this will have great importance for medicine in the future
8. Understanding the human genome is important for:
    - searching for genes linked to different types of disease
    - understanding and treating inherited disorders
    - using in tracing human migration patterns from the past
9. Every chromosome is one of a **pair** so there are two copies of each gene in every genome
10. Different versions of genes are called **alleles**
11. Some characteristics, for example fur colour in mice or red-green colour blindness, are controlled by one gene
12. The set of particular alleles present is called the **genotype**
13. The genotype (e.g. brown allele of the fur colour gene) is **expressed** to make the **phenotype** (e.g. brown fur)
14. A **dominant** allele is always expressed when present even when only one copy is present
15. A **recessive** allele is only expressed when there are two copies of it (i.e. no dominant allele)
16. If the two alleles present are the same, either both dominant or both recessive, then this is described as **homozygous**
17. If one allele is dominant and one is recessive then this is described as **heterozygous**
18. Some disorders are inherited. These disorders are caused by the inheritance of certain alleles
19. **Polydactyly** (having extra fingers or toes) is caused by a **dominant** allele
20. **Cystic fibrosis** (a disorder of cell membranes) is caused by a **recessive** allele

Selective Breeding

21. Selective breeding is also known as **artificial selection**
22. It is the process by which humans breed plants and animals for **particular genetic characteristics**
23. Humans have been doing this for thousands of years since they first bred food crops from wild plants and domesticated animals
24. Selective breeding involves **choosing parents** with the desired characteristic from a mixed population to breed together
25. From the offspring those with the desired characteristic are bred together
26. This continues over **many generations** until all the offspring show the desired characteristic
27. The characteristic can be chosen for usefulness or appearance:
    - Disease resistance in food crops
    - Animals which produce more meat or milk
    - Domestic dogs with a gentle nature
    - Large or unusual flowers
28. Selective breeding can lead to '**inbreeding**' where some breeds are particularly prone to disease or inherited defects

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Genetic Engineering

29. Genetic engineering is a process which involves **modifying the genome** of an organism by introducing a gene **from another organism** to give a **desired characteristic**
30. Plant crops have been genetically engineered to be **resistant** to **diseases** or to produce bigger or better fruits
31. Bacterial cells have been genetically engineered to produce useful substances such as human **insulin** to treat diabetes
32. In genetic engineering, genes from the chromosomes of humans and other organisms can be 'cut out' and transferred to cells of other organisms
33. Crops that have had their genes modified in this way are called **genetically modified (GM) crops**
34. GM crops include ones that are resistant to insect attack or to herbicides
35. GM crops generally show **increased yields**
36. Concerns about GM crops include the effect on populations of wild flowers and insects
37. Some people feel the effects of eating GM crops on human health have not been fully explored
38. Modern medical research is exploring the possibility of genetic modification to overcome some inherited disorders

39. *In genetic engineering:*
    - ***enzymes** are used to isolate the required gene*
    - *this gene is inserted into a **vector**, usually a bacterial plasmid or a virus*
    - *the vector is used to **insert the gene** into the required cells*
    - *genes are transferred to the cells of animals, plants or microorganisms at an **early stage in their development** so that they develop with desired characteristics*

Stem Cells and Therapeutic Cloning

40. A **stem cell** is an **undifferentiated** cell of an organism which is capable of giving rise to many more cells of the same type, and from which certain other cells can arise from differentiation
41. Stem cells from human embryos can be **cloned** and made to differentiate into most different types of human cells
42. Stem cells from **adult bone marrow** can form many types of cells including blood cells
43. **Meristem** tissue in plants can differentiate into any type of plant cell, throughout the life of the plant
44. Treatment with stem cells may be able to help conditions such as diabetes and paralysis
45. In **therapeutic cloning** an **embryo** is produced with the **same genes** as the **patient**
46. Stem cells from the embryo are **not rejected** by the patient's body so they may be used for medical treatment
47. The use of stem cells has potential **risks** such as transfer of viral infection, and some people have ethical or religious objections
48. Stem cells from meristems in plants can be used to produce clones of plants quickly and economically
49. Rare species can be cloned to protect from extinction
50. Crop plants with special features such as disease resistance can be cloned to produce large numbers of identical plants for farmers

Cloning (Biology Only)

51. **Tissue culture** involves using small groups of cells from part of a plant to grow identical new plants
52. This is important for **preserving** rare plant species or commercially in nurseries
53. **Cuttings** involves an older, but simple, method used by gardeners to produce many identical new plants from a parent plant
54. **Embryo transplants** involve splitting apart cells from a developing animal embryo before they become specialised, then transplanting the identical embryos into host mothers
55. In **adult cell cloning**:
    - The **nucleus** is **removed** from an **unfertilised egg cel**l
    - The nucleus from an **adult body cell**, such as a skin cell, is inserted into the egg cell
    - An **electric shock** stimulates the egg cell to divide to form an **embryo**
    - These embryo cells contain the same genetic information as the adult skin cell
    - When the embryo has developed into a ball of cells, it is **inserted** into the **womb** of an adult female to continue its development.

Using Plant Hormones (Biology Only)

56. Plant growth hormones are used in agriculture and horticulture
57. **Auxins** are used as **weed killers**, as **rooting powders**, for promoting growth in **tissue culture**
58. **Ethene** is used in the food industry to control **ripening** of fruit during storage and transport
59. Gibberellins can be used to end seed dormancy, promote flowering, increase **fruit size**