Biology 6: Inheritance, Variation, Evolution

Section 1a: Sexual and Asexual Reproduction

1 Sexual Reproduction	Reproduction involving the **fusion of gametes**.
2 Gamete	A **sex cell** that contains **half the genetic information** of a body cell. E.g. **sperm** and **egg** in animals, **pollen** and **ovaries** in plants.
3 Meiosis	The type of **cell division** that **produces gametes**. Four daughter cells are produced from one original cell. Each cell is genetically different. Each daughter cell has half the genetic information of a body cell.
4 Fertilisation	**Fusion of gametes**. Restores the full number of chromosomes.
5 Asexual Reproduction	Reproduction involving **only one parent and no gametes**. No mixing of genetic information so genetically identical **clones** are produced. Only **mitosis** is involved.
6 Mitosis	**Cell division** that produces two identical daughter cells with the full amount of chromosomes.

Section 1b: Mitosis and Meiosis

	Mitosis	Meiosis
7 Number of daughter cells produced	2	4
8 Variation in cells produced	Genetically identical to each other and parent cell	Different to each other and parent cell
9 Purpose	Growth, repair, asexual reproduction	Produce gametes for sexual reproduction
10 Number of chromosomes	Full amount (pairs of chromosomes)	Half (single chromosomes)

Section 1c: Advantages and Disadvantages of Different Types of Reproduction

	Advantages	Disadvantages
11 Sexual Reproduction	Produces **variation**. Offspring are more likely to **survive changes** to the environment and disease.	**Requires a mate**. **Slower** way of producing offspring.
12 Asexual Reproduction	Produce **lots of offspring quickly**. **No mate** needed.	Offspring are **less likely to survive environmental changes** or diseases.

Section 2: Genetic Diseases

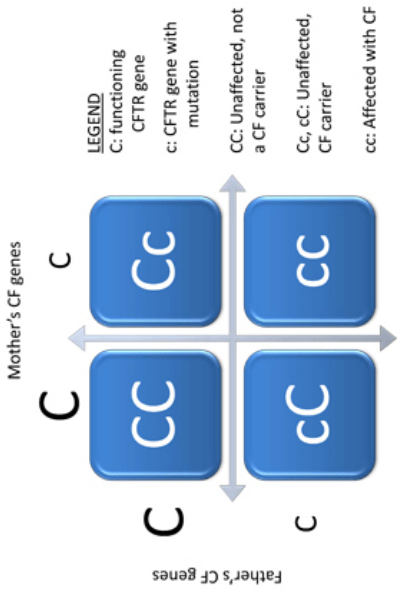
	Polydactyly	Cystic Fibrosis
13 Problem	Extra fingers and toes	Disorder of cell membranes. Causes sticky mucus on lungs.
14 Caused by…	**Dominant** allele	**Recessive** allele
15 Genotype of people with disease	PP or Pp	cc
16 Genotype of people without disease	pp	CC or Cc
17 Does the disease have carriers?	No	Yes – genotype Cc

Section 3: Genetics Key Terms

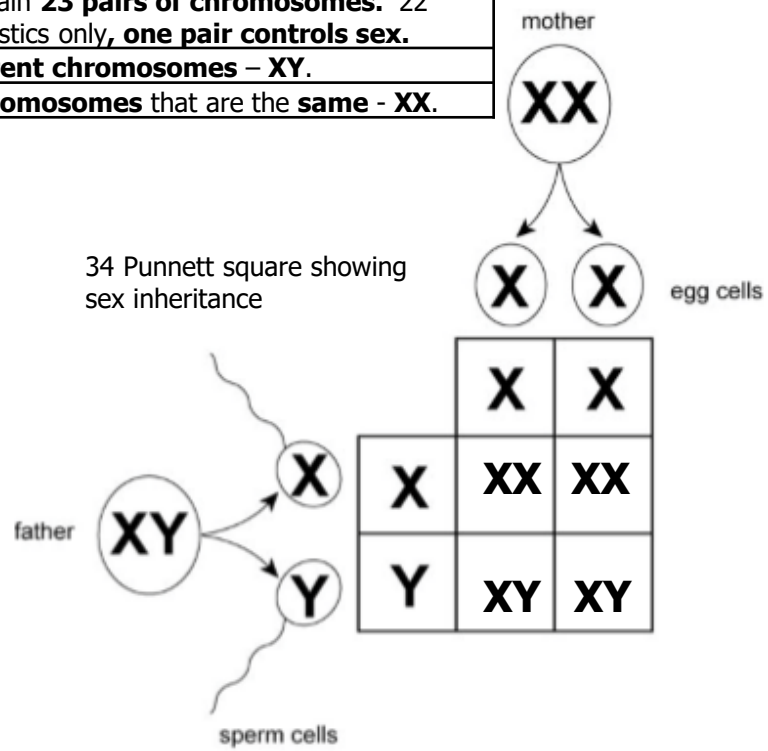
18 DNA	**Genetic material**. DNA is a **polymer** made up of **two strands** forming a **double helix**. The DNA makes up chromosomes.
19 Gene	A gene is a **small section of DNA** on a chromosome. Each gene **codes for a particular sequence of amino acids**, which **make a protein**.
20 Chromosome	A **long coil of DNA**. Found in the nucleus.
21 Genome	The **entire genetic material of that organism**.
22 Allele	**Different versions of the same gene** – dominant and recessive.
23 Dominant	A dominant allele is **always expressed**. Only **one copy** is needed.
24 Recessive	Only **expressed if two copies are present**.
25 Homozygous	**Both alleles** for a gene are the **same** (i.e. both are dominant or both are recessive).
26 Heterozygous	**Both alleles** for a gene are **different** (i.e. one is dominant, the other is recessive).
27 Genotype	The **alleles present** for a **particular gene**.
28 Phenotype	The **physical feature** expressed for a **particular gene**.
29 Single gene characteristics	Some characteristics are controlled by only one gene e.g. fur colour in mice, colour blindness in humans.
30 Multiple gene characteristics	Most characteristics are controlled by many genes e.g. height.

Section 4: Gender Inheritance

31 Human Chromosomes	Human body cells contain **23 pairs of chromosomes.** 22 pairs control characteristics only**, one pair controls sex.**
32 Males	Males have **two different chromosomes** – **XY**.
33 Females	Females have **two chromosomes** that are the **same** - **XX**.



34 Punnett square showing sex inheritance



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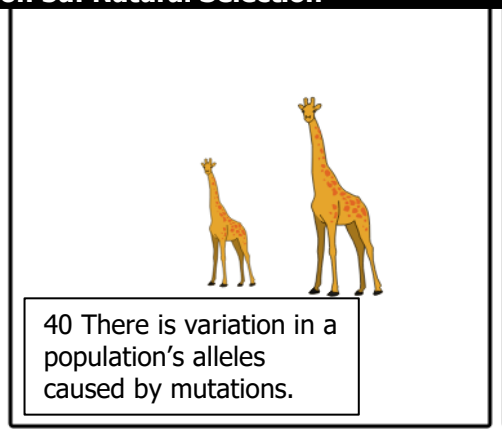
Section 5: Variation and Evolution Key Terms

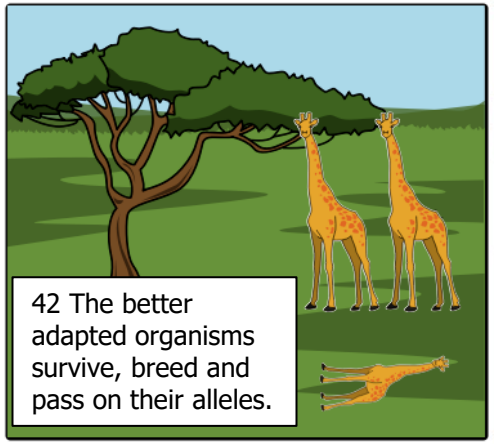
35 Variation	The **differences** between organisms. Can be caused by **genes** (e.g. eye colour), the **environment** (e.g. scars) or **both the environment and genes** (e.g. weight). All variation in genes is **caused by mutations**.
36 Mutation	Mutations are **changes in genes**. **Most have no effect** on the phenotype. Occasionally mutations have a positive effect on phenotype and organisms with these mutations are more likely to survive.
37 Evolution	The **change in the genes of a population over time**. Occurs through natural selection.
38 Natural selection	The process by which the **individuals best adapted to the environment survive** and **pass on their genes**.
39 Speciation	Occurs when **two populations are so different** that they can **no longer breed to produce fertile offspring**. **Two new species** are formed.

Section 5a: Natural Selection

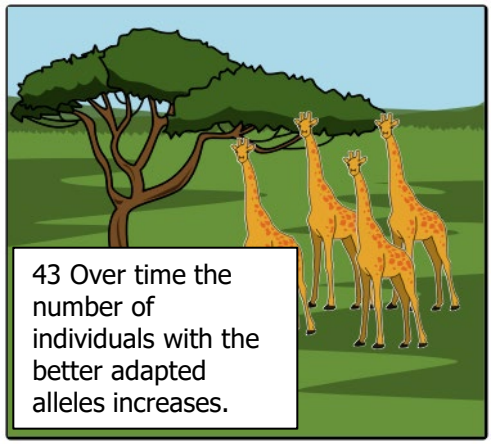


40 There is variation in a population's alleles caused by mutations.

41 There is competition between individuals e.g. for food.



42 The better adapted organisms survive, breed and pass on their alleles.



43 Over time the number of individuals with the better adapted alleles increases.

Section 6: Selective Breeding

44 Selective Breeding (Artificial Selection)	The process by which **humans breed plants and animals for particular genetic characteristics.**
45 Inbreeding	Selective breeding can lead to 'inbreeding' where some breeds are particularly **prone to disease or inherited defects**.

46 Process of selective breeding:

1. Choose parents with correct characteristics from the population.
2. Breed them together.
3. Choose the offspring with the desired characteristics and breed them together.
4. Continue over many generations.

47 Examples of desired characteristics:

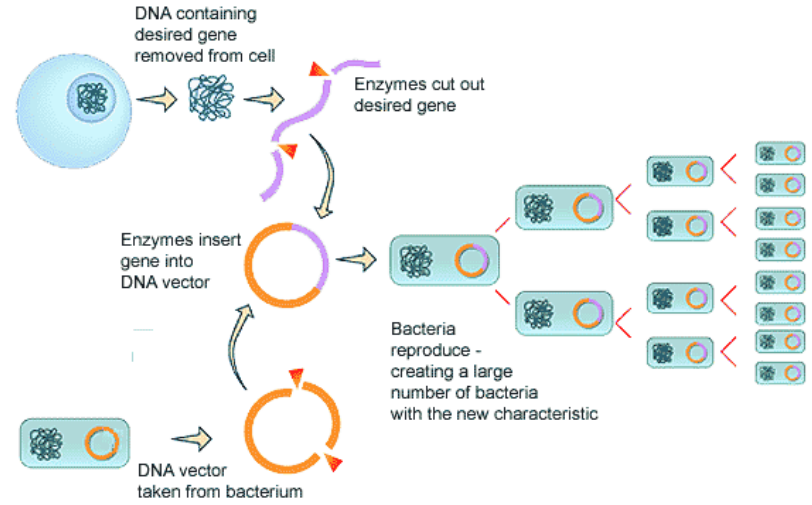
- Disease resistance in food crops.
- Animals which produce more meat or milk.
- Domestic dogs with a gentle nature.
- Large or unusual flowers.

Section 7: Genetic Engineering

48 Genetic Engineering	A process which involves **modifying the genome** of an organism by **introducing a gene** from another organism to give a desired characteristic.
49 GM Crop	Crops that have been produced by genetic engineering.
50 Vector	Something that can **carry a gene into another organism** e.g. **bacterial plasmid** or **virus.**

51 Process of genetic engineering:

1. **Genes** are **cut out** by **enzymes**.
2. The gene is **inserted into a vector** (either a bacterial plasmid or virus).
3. The vector is used to **insert the gene** into the required cells
4. 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.



52 Examples of genetic engineering:

- Bacterial cells have human **insulin gene** inserted into them so that they produce insulin for diabetics.
- Plants that have had genes inserted that make them **resistant to disease, insects** or **herbicides**.

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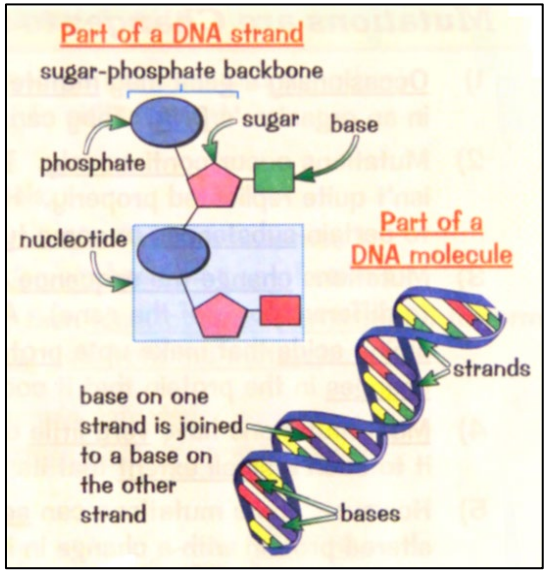
Section 8: Evidence for evolution	
53 Fossil	The preserved remains of an organism from many thousands of years ago. Formed by either gradual replacement by minerals, casts/impressions or preservation in places where there is no decay like amber
54 Resistance bacteria	Bacteria can evolve and become antibiotic resistant. Bacteria sometimes develop random mutations, allowing them to survive an antibiotic, they reproduce increasing the population size of antibiotic resistant bacteria

Section 9: Extinction	
55 Reasons	Rapid environmental changes, new predators, new diseases, better competitor, catastrophic event e.g. volcanic eruption

Section 10: Classification and evolutionary trees	
56 Classification	Organising living organisms into groups
57 Carl Linnaeus system	Kingdom → Phylum → Class → Order → Family → Genus → Species
58 Carl Woese 3 domain system	Archaea, Bacteria, Eukartota are the main large groups which are then divided into smaller groups using the keyterms above (kingdom etc…)
59 Binomial system	Give a 2 part name in Latin to every organism e.g. *Homo sapiens*
60 Evolutionary trees	Show common ancestors and relationships between species

Section 11: Structure of DNA
61 DNA strands are **polymers** made up of lots of repeating units called **nucleotides**
62 Each nucleotide consists of one **sugar** molecule, one **phosphate** molecule and one **base**
63 The sugar and phosphate molecules in the nucleotides form a **backbone** to the DNA strands. The sugar and phosphate molecules alternate. One of four different bases — **A, T, C or G** — joins to each sugar
64 Each base links to a base on the opposite strand in the helix
65 A always pairs up with T, and C always pairs up with G. This is called **complimentary base pairing**.
66 It's the **order of bases** in a gene that decides the order of amino acids in a protein
67 Each amino acid is **coded for** by a sequence of three bases in the gene
68 The amino acids are joined together to make various proteins, depending on the order of the gene's bases



Section 12: Protein synthesis	
69 Proteins	Examples include enzymes, hormones, structural proteins like collagen
70 Transcription (HT)	The first part of the process of making a protein. It takes place inside the cell nucleus. Transcription involves copying the DNA
71 Translation (HT)	Takes place in the ribosomes that are found in the cytoplasm. This is where the messenger RNA is 'interpreted' and the new protein formed
72 mRNA (HT)	Messenger RNA
73 tRNA (HT)	Transfer RNA

Section 13: Mutations	
74 A mutation	A random change in the DNA
75 Cause?	Exposure to certain substances/some radiation types
76 Types?	Insertions, deletions, substitutions

Section 14: Cloning plants and animals		
77 Clone	A genetically identical (to the parent) organism	
78 Cuttings	Gardeners take cuttings to clone plants. **Quick**, **cheap** but **only one** clone at a time	
79 Tissue culture	Scientists clone plants by taking a few plant cells and growing them in a growth medium with hormones. **Mass production** of clones but quite **expensive** compared to cuttings	
80 Embryo transplants	Sperm taken from a 'champion' male animal, used to fertilise a 'champion' egg. An embryo develops and is split many times before any cells become specialised. Cloned embryos are implanted into host mothers resulting in cloned baby animals	
81 Adult cell cloning	Take an unfertilised egg cell and remove its nucleus. A nucleus from an adult body cell is removed and inserted into this empty egg cell. An electric shock fused the two together and stimulates division. An embryo forms and is implanted into he uterus of a female host. A clone of the original adult cell is produced as it has the same genetic information	
82 Issues	**Negatives**	**Positives**
	• Reduces the gene pool • Animal clones might not be as healthy as the normal ones • Worry of human cloning in the future	• Preserve endangered species • Studying animal clones can lead to better understanding of embryo development

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Section 15: Darwin V Lamarck	
83 Darwin's idea	Evolution by natural selection
84 Controversy at the time	People **did not believe Darwin** at the time because: - It went against religious beliefs - DNA/genes/the mechanism of inheritance was not understood at the time - There was not enough evidence to convince other scientists
85 Lamarck's idea	Evolution by acquired characteristics - Organisms that use a characteristic a lot during its lifetime would become more developed e.g. a rabbit using its legs a lot to run would become longer - Then the organisms offspring would inherit this characteristic e.g. the rabbits offspring would also have longer legs

Section 16: Speciation	
86 Species	A group of similar organisms that can reproduce to give fertile offspring
87 Speciation	The development of a new species

Speciation

88 two ancestral populations get separated by geographical barrier / by land or sea / were isolated

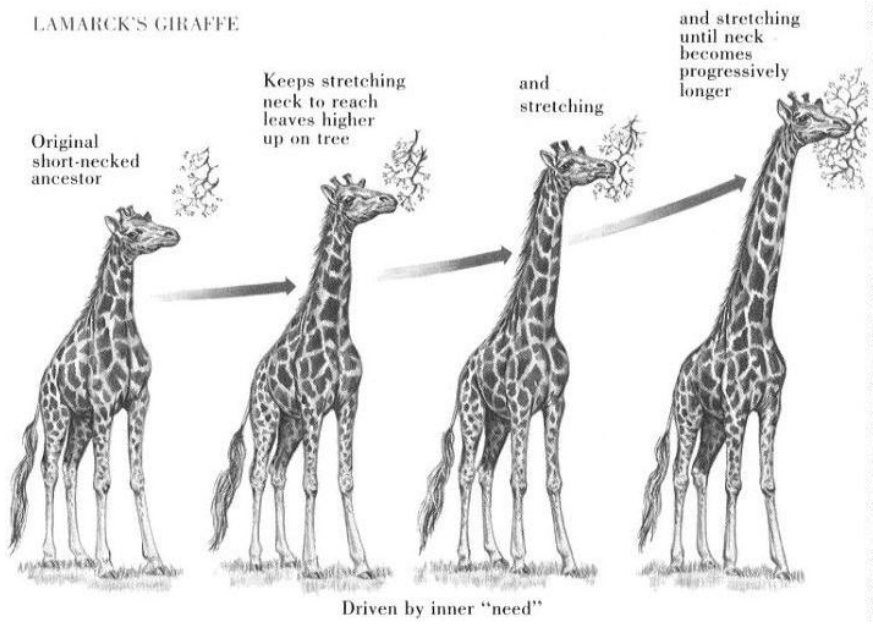
89 genetic variation (in each population) or different / new alleles or mutations occur

90 there are different environments / conditions in these two separate areas

91 natural selection occurs or some phenotypes survived or some genotypes survived

92 (favourable) alleles / genes / mutations passed on (in each population)

93 eventually two types cannot interbreed successfully



Section 17: Mendel	
94 Mendel	A monk who's research led to the foundation of modern genetics

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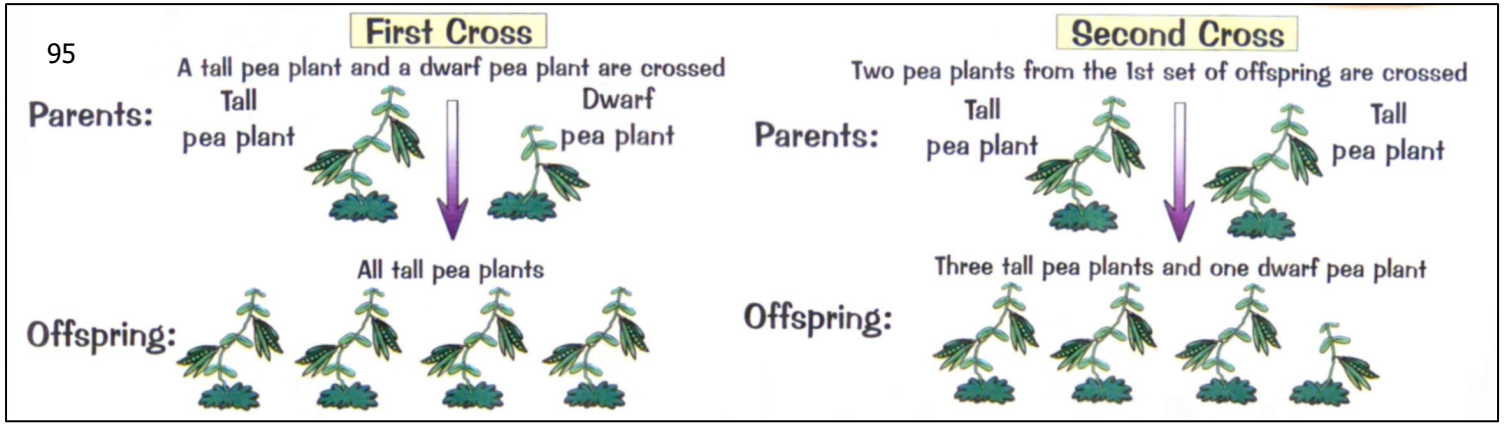

96 Experiments	In the mid-19th century Mendel carried out breeding experiments on pea plants. He observed that the inheritance of each characteristic is determined by 'units' that are passed on from parents to offspring
97 Rejection	Mendel's work was rejected at the time because: - he was just a monk (not a scientist) - chromosomes / DNA / genes not seen / discovered / known at the time - other theories accepted at the time