

Inheritance, Variation and Evolution Knowledge Organiser – Separate Science Knowledge Organiser

Keywords

allele – An alternative form of a gene.

asexual reproduction – The production of offspring from a single parent by mitosis. The offspring are clones of the parent.

chromosome – Structures that contain the DNA of an organism and are found in the nucleus.

cystic fibrosis – A disorder of cell membranes caused by a recessive allele.

DNA – A polymer that is made up of two strands that form a double helix.

dominant – An allele that is always expressed, even if only one copy is present.

fertilisation – The fusion of male and female gametes.

gamete – Sperm cell and egg cell in animals; pollen and egg cell in plants.

gene – A small section of DNA that codes for a specific protein.

genome – The entire genetic material of an organism.

genotype – The combination of alleles.

heterozygous – A genotype that has two different alleles – one dominant and one recessive.

homozygous – A genotype that has two of the same alleles. Either two dominant alleles or two recessive alleles.

meiosis – The two-stage process of cell division that reduces the chromosome number of the daughter cells. It makes gametes for sexual reproduction.

mutation – A change in DNA.

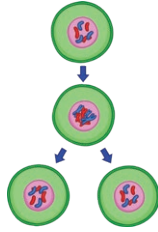
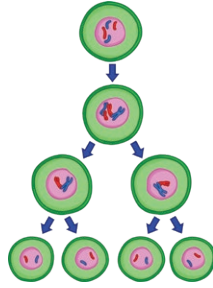
phenotype – The characteristic expressed because of the combination of alleles.

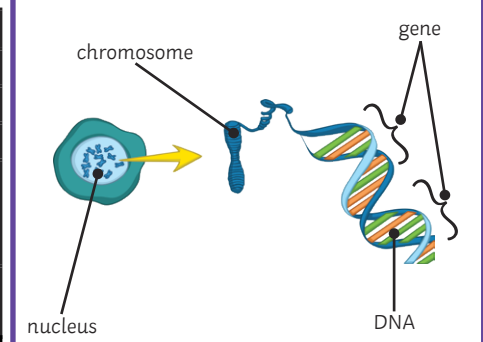
polydactyly – Having extra fingers or toes. Is caused by a dominant allele.

recessive – An allele that is only expressed if two copies of it are present.

sexual reproduction – The production of offspring by combining genetic information from the gametes of two parents. Leads to variation in the offspring.

Mitosis	Meiosis
Produces two daughter cells.	Produces four daughter cells.
Daughter cells are genetically identical.	Daughter cells are not genetically identical.
The cell divides once.	The cell divides twice.
The chromosome number of the daughter cells is the same as the parent cells. In humans, this is 46 chromosomes.	The chromosome number is reduced by half. In humans, this is 23 chromosomes.
Used for growth and repair, and asexual reproduction.	Produces gametes for sexual reproduction.



Sex Determination

Females carry two X chromosomes.

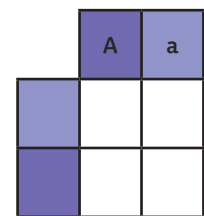
Males carry one X and one Y chromosome.

	mum		
	X	X	
dad	X	XX	XX
	Y	XY	XY

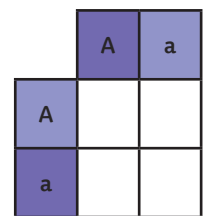
female
male

How to Complete a Punnet Square

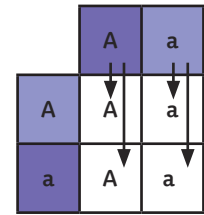
Step 1: Put the two alleles from one parent into the boxes at the top. This parent is a heterozygote. This means they have one dominant and one recessive allele.



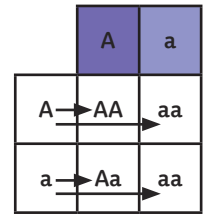
Step 2: Put the two alleles from the second parent into the boxes on the left. This parent is also a heterozygote.



Step 3: Put the alleles from the first parent into the two boxes beneath them.

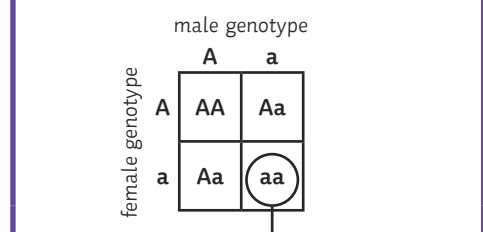


Step 4: Put the alleles from the second parent into the two boxes to the right of them.



Probability

There are four possible combinations of gametes that offspring can inherit.



One of these four has the genotype aa, that's $\frac{1}{4}$, 25% or 0.25.

The recessive phenotype has a ratio of 1:3 because only one combination will show the phenotype, while the other three will not.

Keywords

embryo screening – Genetic tests carried out on an embryo to see whether it carries a faulty allele.

evolution – A change in the inherited characteristics of a population, over time, through a process of natural selection.

evolutionary tree – A method used to show how scientists believe organisms are related.

extinction – The permanent loss of all members of a species.

fossils – The remains of organisms from millions of years ago which are found in rocks.

genetic engineering – The process by which scientists manipulate and change the genotype of an organism.

natural selection – The process by which organisms that are better suited to an environment are more likely to survive and reproduce.

selective breeding – Humans selecting animals or plants, that have a required characteristic, for breeding.

speciation – The process by which two species evolve from a single original species by natural selection. The two populations have become so different that they can no longer interbreed to produce fertile offspring.

variation - Differences in characteristics of individuals in a population.

Variation

Variation may be due to differences in:

- the genes that have been inherited (genetic causes);
- the conditions in which they have developed (environmental causes);
- a combination of genes and the environment.

Evolution

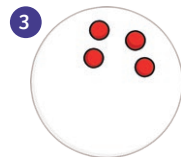
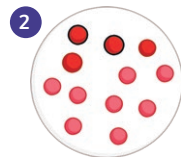
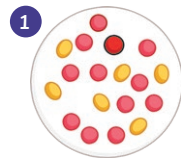
All species of living things have evolved from simple life forms by natural selection.

- If a variant/characteristic is advantageous in an environment then the individual will be better able to compete.
- This means they are more likely to survive and reproduce.
- Their offspring will inherit the advantageous allele.

Resistant Bacteria

To reduce the rate at which antibiotic resistant strains appear:

- Antibiotics should only be used when they are really needed, not for treating non-serious or viral infections.
- Patients should complete their courses of antibiotics, even if they start to feel better.
- The agricultural use of antibiotics should be restricted.



1 There is variation in the bacterial population. One bacterium develops a mutation by chance that means it is resistant to an antibiotic.

2 The antibiotic kills some of the bacteria, the resistant bacterium survives and reproduces.

3 The antibiotic kills the rest of the non-resistant bacteria so the person may start to feel a little better. The resistant bacterium has survived the antibiotic and continues to multiply.

Fossils

Fossils could be:

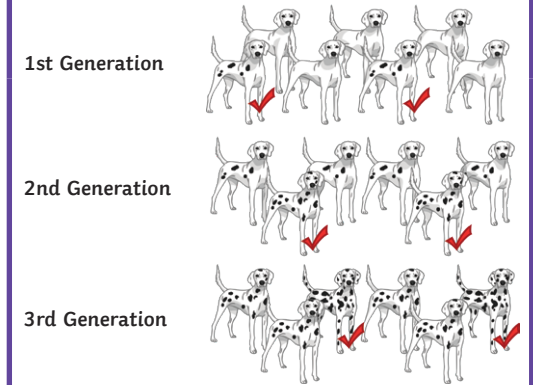
- the actual remains of an organism that has not decayed;
- mineralised forms of the harder parts of an organism, such as bones;
- traces of organisms such as footprints or burrows.

Many early life forms were soft-bodied so have left few traces behind.

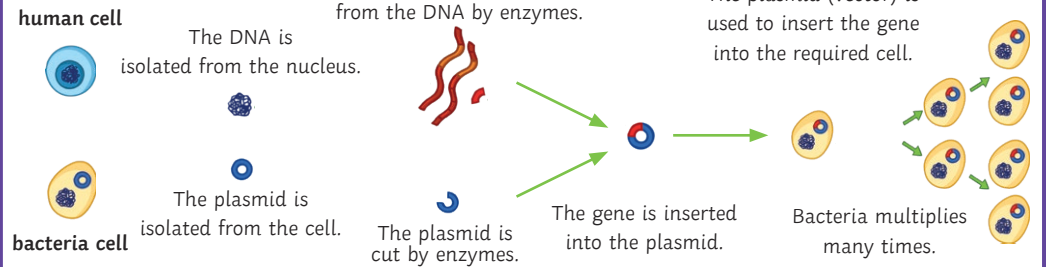
Fossils help us understand how much or how little organisms have changed as life developed on earth.

Selective Breeding

- Choose parents who have the desired characteristic.
- Select the best offspring and breed these to make the next generation.
- These offspring are then bred again and again, over many generations, until a desired result is achieved.



Genetic Engineering



Classification

Linnaeus classified living things into kingdom, phylum, class, order, family, genus and species.

Organisms are named by the binomial system of genus and species.

Due to evidence from chemical analysis, there is now a 'three-domain system' developed by Carl Woese.

Domain	bacteria	archaea	eukaryota			
Kingdom	eubacteria	archaeobacteria	protista	fungi	plantae	animilia

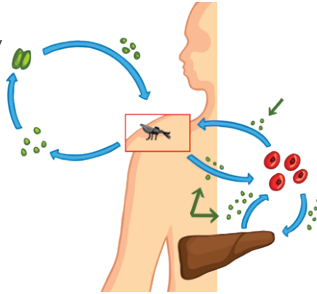
Advantages of sexual reproduction:

- Produces variation in the offspring;
- If the environment changes, variation gives a survival advantage via natural selection;
- Natural selection can be increased by humans in selective breeding to increase food production.

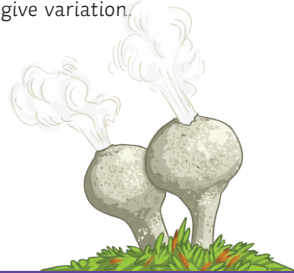
Advantages of asexual reproduction:

- Only one parent needed;
- More time and energy efficient as they do not need to find a mate;
- Faster than sexual reproduction;
- Many identical offspring can be produced when conditions are favourable.

Malarial parasites reproduce asexually in the human host but sexually in the mosquito.



Many fungi reproduce asexually by spores, but also reproduce sexually to give variation.

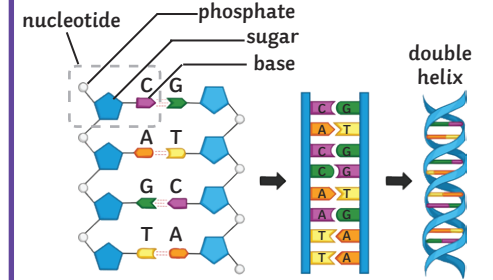


Evolution by Natural Selection

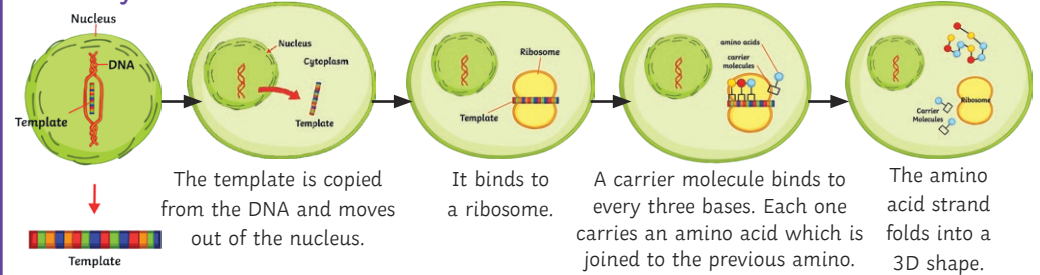
Darwin's theory was only gradually accepted because...

- the theory challenged the idea that God made all the animals and plants that live on earth.
- there was insufficient evidence at the time the theory was published to convince many scientists.
- the mechanism of inheritance and variation was not known until 50 years after the theory was published.

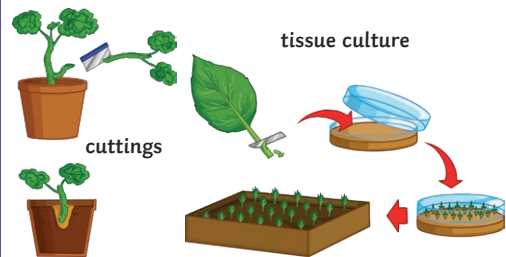
DNA Structure



Protein Synthesis



Cloning in Plants



Many plants produce seeds sexually, but also reproduce asexually by runners such as strawberry plants, or bulb division such as daffodils.



The Understanding of Genetics

1866
Mendel published his results, identifying units of inheritance. His work goes largely unnoticed by other scientists.

1884
Mendel dies.

1900
Boveri provides the first evidence that chromosomes are passed on between generations.

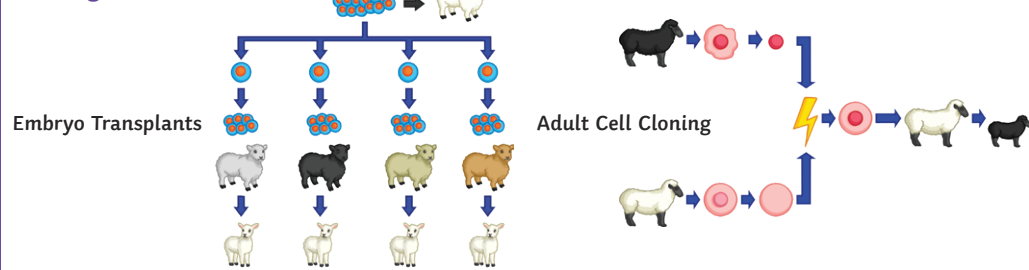
1953
The structure of the double helix is discovered by James Watson and Francis Crick, using data from Rosalind Franklin.

1856
Mendel begins his research.

1882
The 'chromosome dance' of mitosis was observed by Walther Flemming.

1902
Chromosomes are observed separating into gametes in meiosis by Walter Sutton. The connection between chromosomes and Mendel's units is made.

Cloning in Animals



Speciation

isolation – Parts of a population become geographically or environmentally isolated from each other.

conditions – If the conditions in each environment are different, then different characteristics will be advantageous.

natural selection – Organisms with this characteristic are more likely to survive and pass on the allele for it to their offspring.

speciation – Eventually, the two populations are so different they can no longer interbreed to produce fertile offspring.