

Reproduction What is sexual reproduction, and what are the gametes in animals and flowering plants?	Reproduction What is asexual reproduction?
Reproduction Which type of cell division makes identical cells, and which makes non-identical cells?	Reproduction Describe what happens when a cell divides by meiosis.
Reproduction How do meiosis and fertilisation keep the chromosome number the same from one generation to the next?	Reproduction Triple only Give two advantages of sexual reproduction.
Reproduction Triple only Give three advantages of asexual reproduction.	Reproduction Triple only How do malarial parasites reproduce?

Reproduction with only one parent, no fusion of gametes and no mixing of genetic information. Offspring are genetically identical clones. Only mitosis is involved.

The joining (fusion) of male and female gametes: sperm and egg in animals, pollen and egg in flowering plants. Genetic information is mixed, giving variety in the offspring.

Copies of the genetic information are made, then the cell divides twice to form four gametes, each with a single set of chromosomes and all genetically different.

Mitosis makes identical cells. Meiosis makes non-identical cells.

It produces variation in the offspring, which gives a survival advantage if the environment changes. Selective breeding can speed up natural selection to increase food production.

Meiosis halves the number of chromosomes in gametes. Fertilisation restores the full number. The new cell divides by mitosis and, as the embryo develops, cells differentiate.

Asexually in the human host, but sexually in the mosquito.

Only one parent needed; more time and energy efficient (no mate needed); faster; many identical offspring when conditions are favourable.

Reproduction **Triple only**

Give an example of a fungus and a plant that reproduce both sexually and asexually.

Reproduction

Describe the structure of DNA.

Reproduction

What is a gene?

Reproduction

What is the genome?

Reproduction

Give three reasons why understanding the human genome is important.

Reproduction **Triple only**

What is a nucleotide?

Reproduction **Triple only**

What are the four bases in DNA, and how many code for an amino acid?

Reproduction **Triple only** **Higher tier**

Which bases pair together on complementary DNA strands?

A polymer made of two strands forming a double helix, contained in chromosomes in the nucleus.

Many fungi: asexual by spores, sexual to give variation. Plants: seeds (sexual); runners in strawberry plants or bulb division in daffodils (asexual).

The entire genetic material of an organism.

A small section of DNA on a chromosome that codes for a particular sequence of amino acids, to make a specific protein.

The repeating unit of DNA: a common sugar and phosphate group with one of four bases attached to the sugar. The strands have alternating sugar and phosphate sections.

Searching for genes linked to disease; understanding and treating inherited disorders; tracing human migration patterns from the past.

C always links to G, and T always links to A.

A, C, G and T. A sequence of three bases codes for a particular amino acid. The order of bases controls the order of amino acids.

Reproduction **Triple only** **Higher tier**

Give a simple description of protein synthesis.

Reproduction **Triple only** **Higher tier**

What happens when a protein chain is complete?

Reproduction **Triple only** **Higher tier**

How can a mutation change a protein?

Reproduction **Triple only** **Higher tier**

What is the role of non-coding DNA?

Reproduction

Define allele.

Reproduction

What is the difference between a dominant and a recessive allele?

Reproduction

What do homozygous and heterozygous mean?

Reproduction

What is the difference between genotype and phenotype?

It folds up to form a unique shape, which lets it do its job, for example as an enzyme, a hormone or a structure such as collagen.

Proteins are made on ribosomes according to a template. Carrier molecules bring specific amino acids to add to the growing chain in the correct order.

Non-coding parts of DNA can switch genes on and off, so variants there may change how genes are expressed.

It changes the base order, so the amino acid order may change. A few mutations alter the protein's shape, so an enzyme may not fit its substrate or a structural protein loses strength.

A dominant allele is always expressed, even if only one copy is present. A recessive allele is only expressed if two copies are present.

A different form of the same gene.

Genotype is the alleles present. Phenotype is how the characteristic is expressed.

Homozygous: two alleles the same for a trait. Heterozygous: two different alleles.

Reproduction

Give two examples of characteristics controlled by a single gene. Are most characteristics like this?

Reproduction

What ratio of phenotypes do you expect from a cross between two heterozygous parents?

Reproduction **Higher tier**

Construct a Punnett square for $Bb \times bb$. What is the probability of a bb offspring?

Reproduction

In a family tree, two parents without a trait have a child with the trait. What does this show?

Reproduction

Which disorder is caused by a dominant allele: polydactyly or cystic fibrosis?

Reproduction

Give issues to consider about embryo screening.

Reproduction

What are the human sex chromosomes?

Reproduction

What is the chance that a baby is a girl or a boy, and why?

3 dominant : 1 recessive, so a probability of 1 in 4 (25%) for the recessive phenotype.

Fur colour in mice and red-green colour blindness in humans. No, most are the result of multiple genes interacting.

The trait is recessive and both parents are heterozygous carriers.

Gametes B, b and b, b. Offspring Bb, Bb, bb, bb. Probability of bb = 2 in 4 = $\frac{1}{2}$ (50%).

It may alleviate suffering, but embryos are destroyed and there are economic, social and ethical concerns. Gene therapy research also raises ethical issues.

Polydactyly (extra fingers or toes) is caused by a dominant allele. Cystic fibrosis, a disorder of cell membranes, is caused by a recessive allele.

50% each (1 : 1). All eggs carry X; half the sperm carry X and half carry Y.

Females XX, males XY. Humans have 23 pairs of chromosomes; 22 pairs control characteristics only.

Variation and evolution

What causes variation within a population?

Variation and evolution

Where do all variants come from, and how many affect the phenotype?

Variation and evolution

Define evolution.

Variation and evolution

Explain how natural selection leads to evolution.

Variation and evolution

When have two populations formed two new species?

Variation and evolution

When did the first simple life forms develop?

Variation and evolution

What is selective breeding?

Variation and evolution

Describe the steps of selective breeding.

Mutations. Most have no effect on the phenotype, some influence it, very few determine it. Rarely a new phenotype suited to an environmental change causes a relatively rapid change in the species.

Genes inherited (genetic), the conditions in which individuals developed (environmental), or both. The phenotype develops from the genome and its interaction with the environment.

Variants with phenotypes best suited to their environment survive and breed, passing on their alleles. Over generations these characteristics become more common.

A change in the inherited characteristics of a population over time through natural selection, which may result in a new species.

More than three billion years ago. All species have evolved from them.

When they become so different in phenotype that they can no longer interbreed to produce fertile offspring.

Choose parents with the desired characteristic and breed them together. Breed the best offspring together. Repeat over many generations.

The process by which humans breed plants and animals for particular genetic characteristics. It is also called artificial selection.

Variation and evolution

Give four examples of characteristics chosen by selective breeding.

Variation and evolution

What is inbreeding and what problem does it cause?

Variation and evolution

Define genetic engineering.

Variation and evolution

Give examples of genetic engineering in plants and in bacteria.

Variation and evolution

What are GM crops and what are the concerns about them?

Variation and evolution **Higher tier**

Describe the main steps in genetic engineering.

Variation and evolution **Triple only**

What is tissue culture?

Variation and evolution **Triple only**

What are cuttings and embryo transplants?

Breeding closely related individuals. Some breeds become prone to disease or inherited defects.

Disease resistance in crops; more meat or milk from animals; gentle nature in dogs; large or unusual flowers.

Plants: resistance to disease or bigger, better fruit. Bacteria: human insulin to treat diabetes.

Modifying the genome of an organism by introducing a gene from another organism to give a desired characteristic.

Enzymes isolate the gene. It is inserted into a vector (plasmid or virus). The vector inserts the gene into the required cells, at an early stage of development.

Crops with modified genes, for example resistant to insects or herbicides, with increased yields. Concerns: wild flowers and insects, and human health effects not fully explored.

Cuttings: a simple method gardeners use to make identical plants. Embryo transplants: splitting a developing embryo's cells before they specialise, then transplanting the identical embryos into host mothers.

Using small groups of cells from part of a plant to grow identical new plants, to preserve rare species or commercially in nurseries.

Variation and evolution **Triple only**

Describe adult cell cloning.

Variation and evolution **Triple only**

Give a benefit and a risk of cloning.

The development of understanding of genetics and evolution

Triple only

What did Darwin propose, and where did he publish it?

The development of understanding of genetics and evolution

Triple only

Why was Darwin's theory only gradually accepted?

The development of understanding of genetics and evolution

Triple only

What did Lamarck suggest?

The development of understanding of genetics and evolution

Triple only

What was Wallace's contribution?

The development of understanding of genetics and evolution

Triple only

Describe the steps that give rise to new species.

The development of understanding of genetics and evolution

Triple only

What was Mendel's key observation?

Benefit: many identical copies with a useful characteristic, or preserving rare species.
Risk: reduced genetic variation, and some people have ethical objections.

Remove the nucleus from an unfertilised egg cell and insert the nucleus from an adult body cell. An electric shock makes it divide into an embryo, which is inserted into the womb of an adult female.

It challenged the idea that God made all species, there was insufficient evidence at the time, and the mechanism of inheritance was not known until 50 years later.

Evolution by natural selection, in *On the Origin of Species* (1859). Individuals vary; those most suited to the environment survive to breed and pass on their characteristics.

He independently proposed natural selection, published joint writings with Darwin in 1858, and is best known for work on warning colouration and speciation.

That changes in an organism during its lifetime can be inherited. In the vast majority of cases this cannot occur.

In the mid-19th century, his breeding experiments on plants showed that inheritance of each characteristic is determined by 'units' passed on unchanged.

Isolation, genetic variation from mutations, different selection pressures in different environments, alleles passed on, until populations cannot interbreed to produce fertile offspring.

The development of understanding of genetics and evolution

Triple only

Why was Mendel's work not recognised until after his death?

The development of understanding of genetics and evolution

Triple only

Describe how the gene theory developed after Mendel.

The development of understanding of genetics and evolution

What evidence supports the theory of evolution?

The development of understanding of genetics and evolution

What are fossils and how may they form?

The development of understanding of genetics and evolution

Why is the fossil record incomplete?

The development of understanding of genetics and evolution

What is extinction?

The development of understanding of genetics and evolution

How do antibiotic-resistant bacteria arise and spread?

The development of understanding of genetics and evolution

How can the development of antibiotic resistance be reduced?

Late 19th century: chromosome behaviour seen. Early 20th: chromosomes and 'units' behave similarly, so genes are on chromosomes. Mid-20th: DNA structure determined.

When he published, the behaviour of chromosomes had not been observed, so his 'units' could not be linked to anything in cells. Few scientists read or understood his work.

Remains of organisms from millions of years ago, found in rocks. They form when decay conditions are absent, by mineral replacement, or as preserved traces.

Characteristics are passed on in genes, the fossil record, and how antibiotic resistance evolves in bacteria.

When there are no remaining individuals of a species still alive. Factors include new predators, diseases or competitors, environmental change, or a single catastrophic event.

Early life forms were soft-bodied and left few traces, and many traces were destroyed by geological activity.

Do not prescribe antibiotics inappropriately (such as for viral infections), complete the course, and restrict agricultural use.

Mutation produces a resistant strain; antibiotics kill other bacteria, so the resistant ones survive, reproduce and spread because people are not immune.

The development of understanding of genetics and evolution

What is MRSA, and why do new antibiotics not solve the problem?

Classification of living organisms

List the Linnaean groups in order.

Classification of living organisms

What is the binomial system?

Classification of living organisms

Name the three domains in Woese's system.

Classification of living organisms

Why was the three-domain system developed?

Classification of living organisms

What is an evolutionary tree?

Kingdom, phylum, class, order, family, genus, species.

MRSA is resistant to antibiotics. New antibiotics are costly and slow to develop, so unlikely to keep up with new resistant strains.

Archaea (primitive bacteria in extreme environments), bacteria (true bacteria) and eukaryota (protists, fungi, plants and animals).

Naming organisms using their genus and species, for example *Homo sapiens*. The genus has a capital letter; the species does not.

A method showing how scientists believe organisms are related, using classification data for living organisms and fossil data for extinct ones.

Better microscopes showed internal structures, biochemical understanding progressed, and chemical analysis provided new evidence.