

DNA replication What is DNA replication?	DNA replication Why is DNA replication needed in multicellular organisms?
DNA replication Semi-conservative replication	DNA replication How does complementary base pairing make replication accurate?
DNA replication Role of helicase	DNA replication General role of DNA polymerase
DNA replication The three PCR stages and temperatures	DNA replication What are primers in PCR?

For reproduction, and for growth and tissue replacement, since every new cell needs a full copy of the genome.

The production of exact copies of DNA with identical base sequences.

Each template base determines the base added (A-T, C-G), so the new strand's sequence is exactly complementary to the template.

Each new DNA molecule contains one strand from the original molecule and one newly synthesised strand.

Links free DNA nucleotides, paired to the template by complementary base pairing, into a new strand.

Unwinds the double helix and breaks hydrogen bonds between bases, separating the strands.

Short single-stranded DNA sequences that bind to the ends of the target sequence and give DNA polymerase a starting point.

Denaturation about 95 °C (strands separate); annealing about 55 °C (primers bind); extension about 72 °C (Taq polymerase builds new strands).

DNA replication Why is Taq polymerase used in PCR?	DNA replication Basis of separation in gel electrophoresis
DNA replication What does DNA profiling compare?	DNA replication Why does using more markers improve DNA profiling?
DNA replication Paternity test rule	Protein synthesis Transcription
Protein synthesis Base pairing in transcription	Protein synthesis Why must DNA templates be stable?

Negatively charged DNA moves towards the positive electrode; smaller fragments move faster and travel further through the gel.

It is from the hot-spring bacterium *Thermus aquaticus*, so it is not denatured at 95 °C and works best at about 72 °C.

It reduces the probability of a false match between two different people, increasing reliability.

Lengths of short tandem repeat (STR) regions, amplified by PCR and separated by gel electrophoresis.

The synthesis of RNA using a DNA template, carried out by RNA polymerase.

Every band in the child's profile must be present in either the mother's or the father's profile.

In non-dividing somatic cells the same sequences are transcribed for the life of the cell, so transcription must not change them.

Template A pairs with RNA U; T with A; C with G; G with C. Held by hydrogen bonds.

Protein synthesis

Why is transcription a key stage of gene expression?

Protein synthesis

Translation

Protein synthesis

Where do mRNA and tRNA bind on the ribosome?

Protein synthesis

Codon vs anticodon

Protein synthesis

How does the polypeptide grow during elongation?

Protein synthesis

Why is the genetic code a triplet code?

Protein synthesis

Degeneracy and universality

Protein synthesis

Start codon and stop codons

The synthesis of a polypeptide from mRNA: the mRNA base sequence is translated into an amino acid sequence.

It is the first stage, so genes can be switched on or off by controlling transcription.

Codon: three bases on mRNA coding for one amino acid. Anticodon: complementary three bases on tRNA.

mRNA binds to the small subunit; two tRNAs can bind simultaneously to the large subunit.

4 bases and 20 amino acids: pairs give 16 combinations (too few); triplets give 64.

A peptide bond links the next amino acid to the chain, then the ribosome moves one codon along the mRNA.

Start: AUG (methionine). Stop: UAA, UAG, UGA.

Degeneracy: more than one codon per amino acid. Universality: the same codons code for the same amino acids in almost all organisms.

Protein synthesis

Sickle-cell mutation

Protein synthesis

Effect of haemoglobin S

Mutation and gene editing

Gene mutation

Mutation and gene editing

Single-nucleotide polymorphism (SNP)

Mutation and gene editing

Why may a base substitution have no effect on a polypeptide?

Mutation and gene editing

Frameshift

Mutation and gene editing

Causes of gene mutation

Mutation and gene editing

Examples of mutagens

At low oxygen it forms long fibres that distort red blood cells into rigid sickle shapes.

Base substitution in the haemoglobin beta-chain gene: codon GAG → GUG, glutamic acid → valine at the sixth amino acid.

A single-base difference between individuals, resulting from a base substitution mutation.

A structural change to a gene at the molecular level: a substitution, insertion or deletion of bases.

Insertion or deletion of bases (not a multiple of three) shifts the reading frame, changing every following codon.

The genetic code is degenerate, so the new codon may code for the same amino acid.

Chemical: benzo[a]pyrene, nitrosamines (tobacco smoke), mustard gas. Radiation: UV, X-rays, gamma rays.

Mutagens (chemicals and radiation) and errors in DNA replication or repair.

Mutation and gene editing

Randomness in mutation

Mutation and gene editing

Germ-cell vs somatic-cell mutation

Mutation and gene editing

Why is mutation essential for evolution?

Mutation and gene editing

Risk of commercial genetic tests

Germ cell: can be inherited by offspring.
Somatic cell: not inherited, but can cause cancer.

Mutations can occur anywhere in the genome (some bases more often); no natural mechanism deliberately changes a base to change a trait.

Without expert interpretation, information on future disease risk could be misunderstood.

It is the original source of all genetic variation (new alleles) on which natural selection acts.