

AS 90729 version 2
Describe genetic processes
Level 3 Credits 4

This achievement standard involves describing genetic processes.

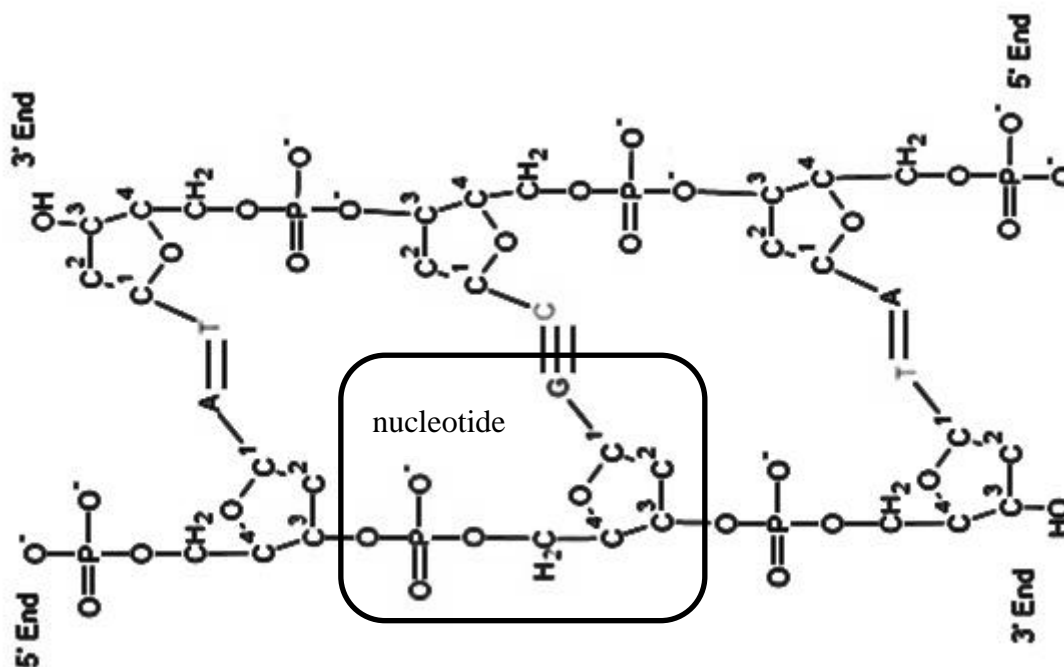
Achievement	Achievement with Merit	Achievement with Excellence
Describe genetic processes.	Explain genetic processes.	Discuss genetic processes.

Genetic processes refer to genetic expression and applications of gene technology. Genetic expression relates to its role in gene technology.

structure of DNA and its role in carrying the genetic code

- double helix
- nucleotides
- base pairing
- triplets
- coding strand

Three bases (triplet code) give 64 combinations, which are enough to code for the 20 amino acids.



structure and function of RNA

- messenger RNA
- transfer RNA
- ribosomal RNA

Messenger RNA (mRNA) is the link (template) between the DNA and the cytoplasm (ribosome). Messenger RNA (mRNA) is a long molecule, which contains the code for producing a polypeptide chain (protein).

Transfer RNA (tRNA) is a short molecule, as it only needs to deliver an amino acid (small) molecule. Transfer RNA (tRNA) has an anticodon coding for a specific amino acid. Each tRNA will match up with three bases (codon) on the one messenger RNA (mRNA) molecule, which carries the code to produce the protein. Messenger RNA (mRNA) contains multiple codons as defined by the length of the gene it transcribes.

Ribosomal RNA (rRNA) assists in the reading of the base sequence.

□ DNA replication

- how DNA replicates
- functions of DNA polymerase
- functions of ligases

Parent strand unzips breaking the original base pairings. The original strand provides a template, which is used to pair complementary nucleotides to it, A with T and C with G. The DNA molecule unwinds and the DNA polymerase binds to the parent strands. It begins moving along it in the 3' to 5' direction, using it as a template for assembling the nucleotide. On the 5' to 3' strand of DNA, the polymerase binds and produces short sections of complementary DNA (called Okazaki fragments). These short sections need to be joined together, so another enzyme, DNA ligase then stitches these together.

□ stability of DNA

- why DNA needs to be stable
- mechanisms for ensuring DNA stability
- the effect of point mutations on gene expression

DNA needs to be accurately replicated, as it codes for all the polypeptides a cell needs to function. It contains genes, which result in a sequence of amino acids and therefore gives the polypeptides their unique shape / function. The codes must stay the same or the wrong polypeptide will be made.

A method for the accuracy of replication is to carry out a semiconservative replication. The DNA molecule is split in half and complementary nucleotides match the parent strand, making the other half of the DNA molecule. This results in two daughter strands of DNA, each with one new strand and one strand from the original (parent) molecule. Complementary base pairing ensures accuracy of replication, because each of the bases can only bond with one other specific base. C bonds with G and T bonds with A.

A point mutation is when 1 base pair / nucleotide is changed. E.g. Nonsense: codes for a stop codon in the protein, so end up with a truncated protein. Missense: codes for a different amino acid, therefore a different protein produced / shape change / active site not functional. Silent: the mutation produces the same amino acid as some amino acids have several different codes. No change to the protein.

□ protein synthesis

- the role of DNA in determining the structure and function of a protein
- how a protein is produced
 - tRNA
 - mRNA
 - rRNA
 - amino acids
 - RNA polymerase
 - codons
 - anticodons
 - peptide bonds
 - polypeptides
 - transcription
 - translation)

The DNA sequence is made up of sections called genes. Each gene codes for a particular protein to be produced. Polypeptide chains are made by using the DNA code (gene) to create the RNA code, then the polypeptide chain / protein.

The first step is to transcribe the gene into the mRNA inside the nucleus. The mRNA is made by complementary base pairing with the DNA. In the mRNA, there is no T instead it is replaced by U. Once the mRNA is produced, it moves out of a nuclear pore to the cytoplasm, where it is picked up by a ribosome. The ribosome then reads the mRNA in base triplets called codons. The codons code for a particular amino acid that is carried to the ribosome by tRNA. The tRNA has an anticodon that is complementary to the codon. If they match then the amino acid is bonded to the previous amino acids by way of a polypeptide bond. This results in the protein.

☐ **gene technology**

Applications of gene technology will involve a selection from:

- restriction enzymes
- ligation
- polymerase chain reaction (PCR)
- DNA probes
- DNA profiling
- DNA sequencing
- gene cloning
- transgenesis
- gene therapy

PCR: Collect a small sample and amplify with PCR to produce an exact copy and a larger quantity of the DNA. (Note: PCR duplicates any DNA with accuracy and in large amounts. If contaminated with foreign DNA this would mean that any subsequent testing would produce results that are of little use.)

Modification by restriction enzymes: to cut the DNA sample up into various sized smaller pieces so that a DNA fingerprint can be achieved. Restriction enzymes cut the DNA at a specific sequence.

Gel electrophoresis: to get the DNA fingerprint of the suspect by separating out the different sizes of the cut DNA into bands. DNA put into wells in a gel, apply electric current, negative DNA moves to the positive end, smaller lengths move further than larger lengths. Run sample through an electrophoresis gel with all the suspect's DNA fingerprints to make a comparison.

DNA probes are single stranded lengths of DNA between 20–100 nucleotides in length. One type of probe is fluorescently labelled and shows up when illuminated with ultraviolet light. DNA probes are used to identify and label specific DNA fragments e.g. Choosing a gene, detecting pathogenic bacteria, DNA fingerprinting, DNA profiles, • detecting genetic markers for specific genes (eg mutated genes).

Examples:

- matching a small blood sample to a suspect using DNA fingerprinting
- genetically modified lettuce plants to produce human insulin in their cells
- transgenic carrots that produce an enzyme that increases absorption of calcium in humans who eat the carrots, helping prevent diseases such as osteoporosis
- increased production of milk from cows by injecting them with a hormone (a protein) that is produced by genetically engineered bacteria
- research into delivering a copy of the normally-functioning cystic fibrosis gene to the cells lining the lungs within a genetically modified plasmid, delivered to lung cells using a vector such as a virus

☐ **implications of gene technology and associated issues**

Examples:

- random insertion of gene / implications of where the relevant gene is inserted
- cross-contamination
- concern that pollen from these genetically modified plants will spread long distances