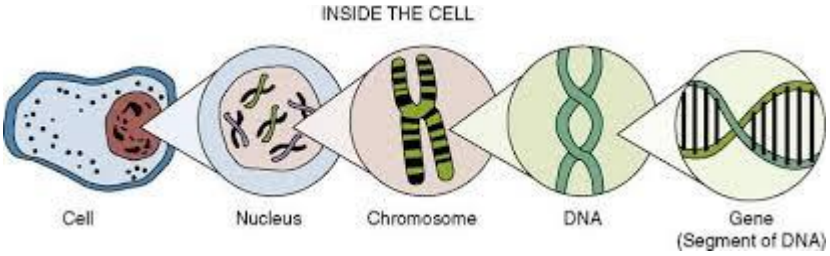
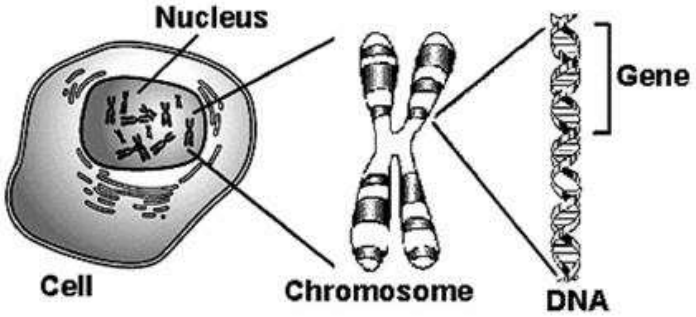
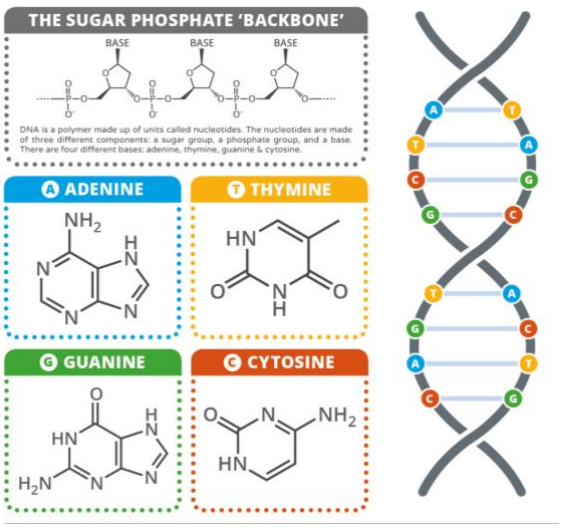
LO: Outline the relationship between DNA, genes and chromosomes





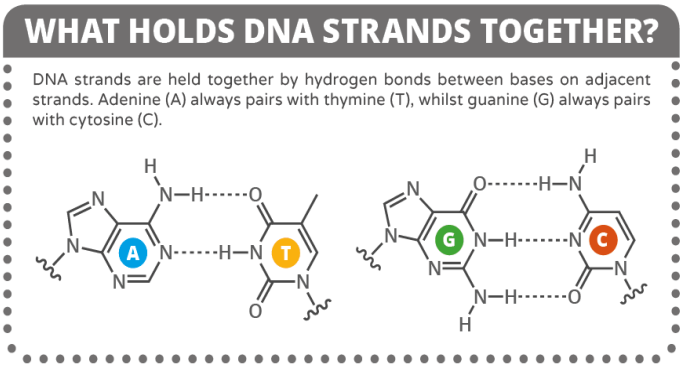
- A chromosome is a rod-shaped structure that is coiled and condensed. It is made up of a deoxyribonucleic acid (DNA) molecule wrapped around proteins (histones).
- DNA is a molecule that carries genetic/ heredity information in the form of genes along its length.
- Genes are small segments of DNA found in a chromosome. Every gene codes for a specific polypeptide, which determines a particular characteristic in the organism.

LO: State the structure of DNA in terms of the bases, sugar and phosphate groups found in each of their nucleotides

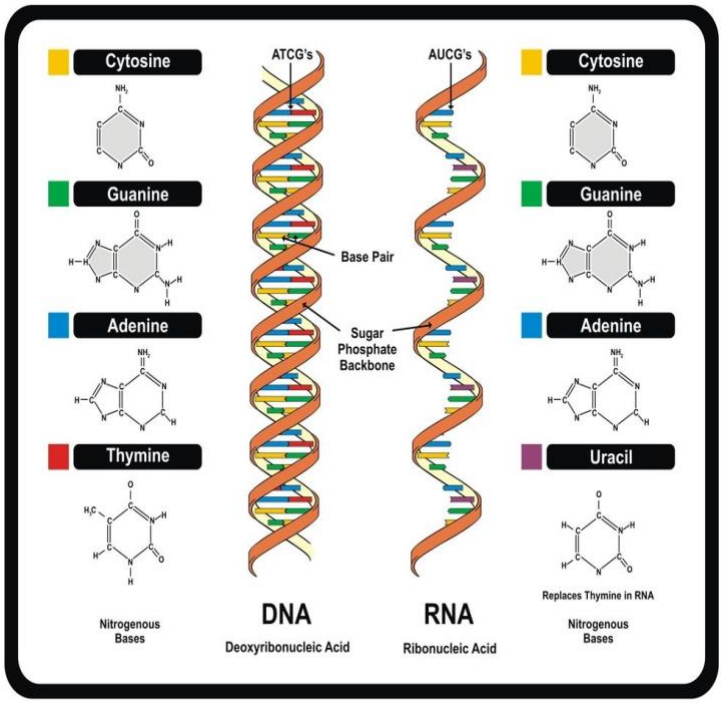


- The DNA molecule is made up of two strands of polynucleotides twisted around each other to form a double helix.
- Each nucleotide forms the basic unit of DNA.
- The nucleotides are joined up by sugar-phosphate bonds.
- Each nucleotide is made up of a deoxyribose sugar, a phosphate group and a nitrogenous base.
- There are four different types of nitrogenous bases: adenine, cytosine, guanine and thymine.

LO: State the rule of complementary base pairing

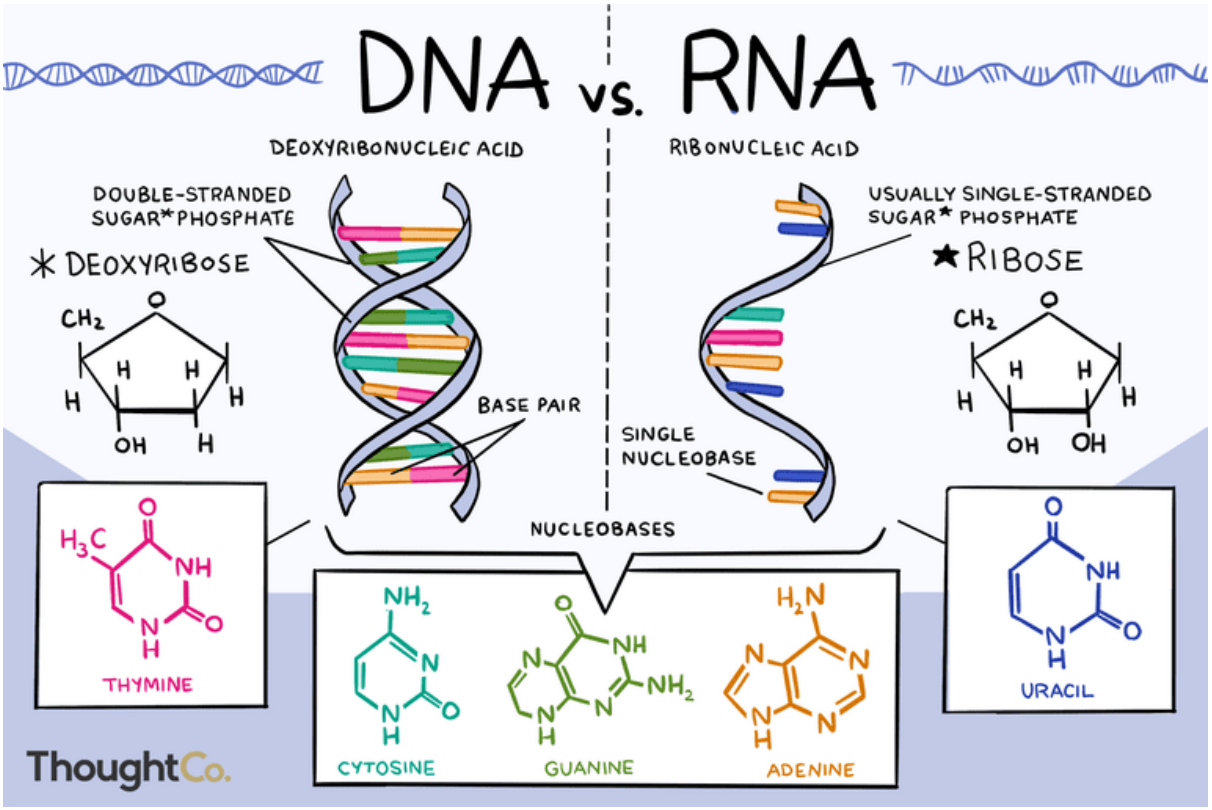


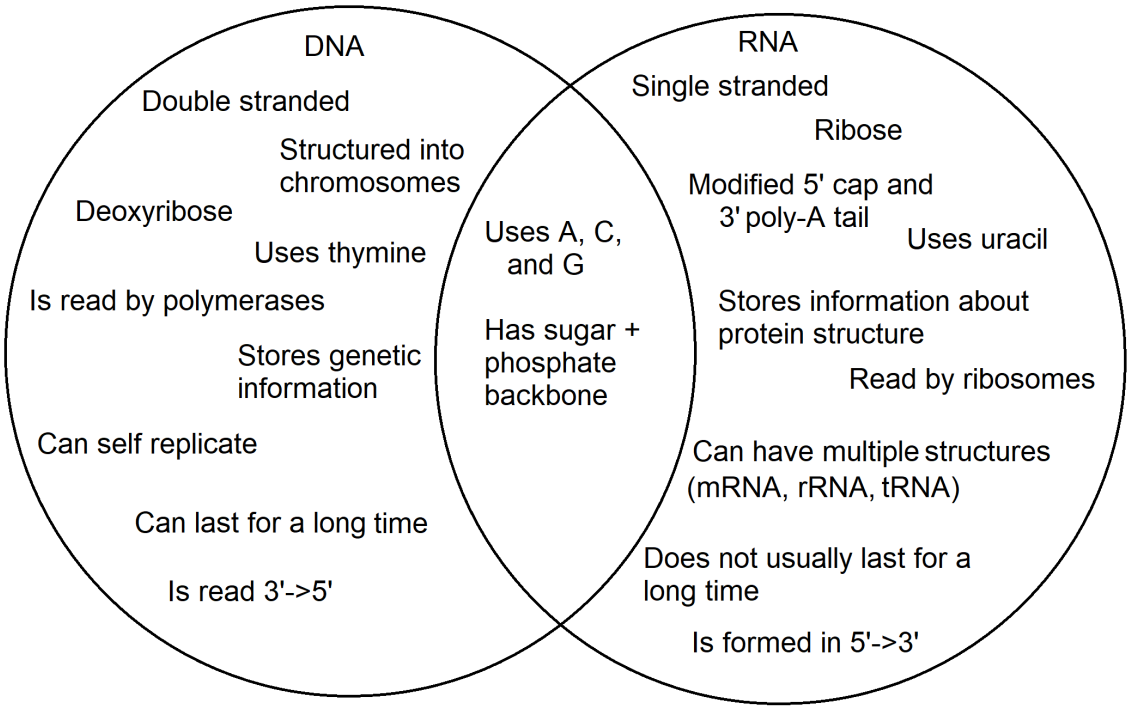
- By complementary base pairing, <u>adenine pairs with thymine</u> and <u>cytosine pairs with guanine</u>.



- Except in mRNA where thymine is replaced by <u>uracil</u>.

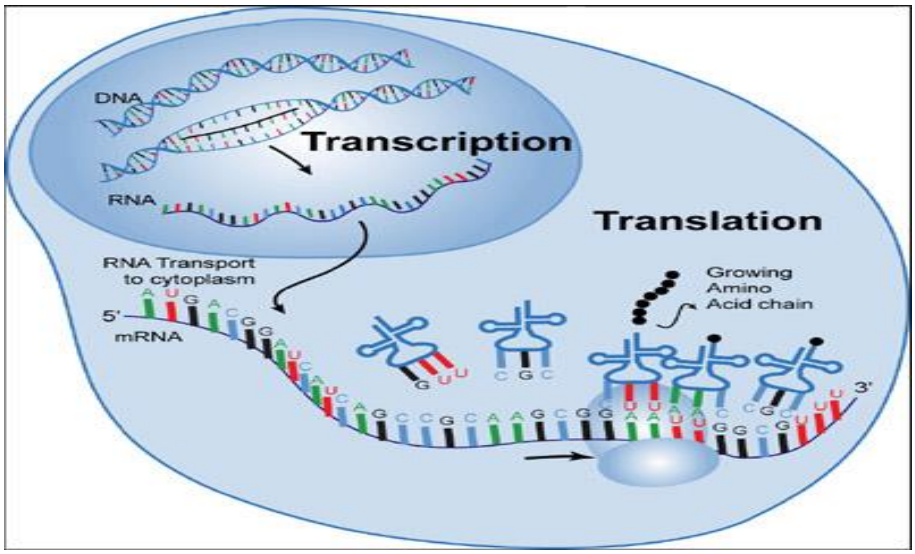
Differences between DNA and RNA





LO: State that DNA is used to carry the genetic code, which is used to synthesise specific polypeptides (details of transcription and translation are not required) and state that each gene is a sequence of nucleotides, as part of a DNA molecule

- DNA is a molecule that carries genetic information in the form of genes.
- Each gene is made up of a specific sequence of nucleotides of DNA that codes for a specific polypeptide.

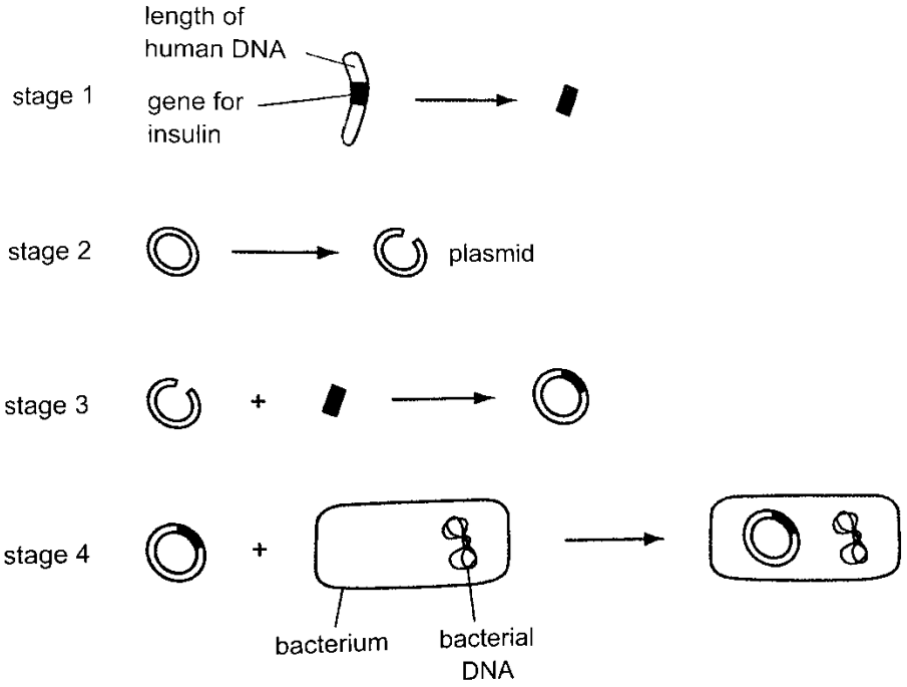


- The genetic code on DNA is transcribed to messenger ribonucleic acid (mRNA) in the nucleus. The process is known as transcription.
- The mRNA is translated into a polypeptide in the cytoplasm with the help of ribosome and transfer ribonucleic acid (tRNA) (with amino acid and anti-codon). The process is known as translation.
- Each amino acid is coded by a specific sequence of three nucleotides on the mRNA known as codon. (For example, AUG stands for the methionine)

LO: Explain that genes may be transferred between cells. Reference should be made to the transfer of genes between organisms of the same species or different species – transgenic plants or animals

- Genes can be transferred between cells of the same species or different species by genetic engineering.
- To transfer genes, a vector is needed. A vector molecule is a DNA molecule e.g. bacterial plasmid
- Transgenic organism is an organism which has been genetically engineered by insertion of a foreign gene, which involves human intervention or through artificial means.

LO: Briefly explain how a gene that controls the production of human insulin can be inserted into bacterial DNA to produce human insulin in medical biotechnology



Stage 1: Insulin gene is isolated from the human cell and cut using a restriction enzyme, producing two sticky ends.
Stage 2: A bacterial plasmid is also isolated from a bacterial cell and cut with the same restriction enzyme, producing two complementary sticky ends.
Stage 3: Human insulin gene is mixed with bacterial plasmid and inserted into the bacterial plasmid and joined together by DNA ligase to form the recombinant plasmid.
Stage 4: Recombinant plasmid and bacteria is mixed and temporary heat or electric shock is applied to open up the pores of the cell membrane of the bacteria to allow the recombinant plasmid to enter, forming transgenic bacteria.

- Transgenic bacteria are cultured in large-scale fermenters with nutrient broth, optimum pH, optimum temperature and optimum concentration of oxygen to produce large amounts of insulin.
- Transgenic bacteria will be able to produce insulin.
- The bacteria cells are then burst to release the insulin.
- Insulin is extracted and purified (modified).

LO: Discuss the social and ethical implications of genetic engineering, with reference to a named example

Social

- Genetic engineering may lead to class distinctions.
- Possible increased in the economic inequality
  - The price of genetically modified seeds may be more expensive due to patenting.
  - The poorer farmers may not be able to buy the seeds
  - Widen the gap between the rich and the poor.

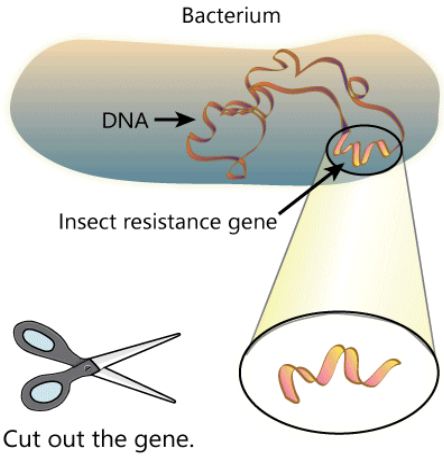
Ethical

- Some religions do not approve of genetic engineering as it may not be appropriate to alter the natural genetic make-up of organisms.
- Genetically modified / GM foods may cause allergy when consumed by some people.
- Genes that code for an antibiotic resistance may accidentally be incorporated into bacteria that cause human diseases
- Some people may deliberately create new combination of genes for use in chemical or biological warfare.

Others

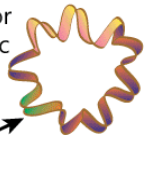
- Reduced effectiveness of pesticides
- Gene transfer to non-target species
- Unintended harm to other organisms, loss of biodiversity

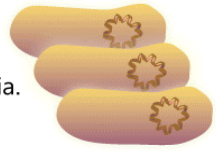
Creation of an Insect Resistant Tomato Plant



1. Cut out the gene.

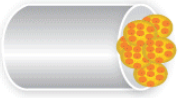
2. Insert gene into a vector with a selectable antibiotic resistance marker gene.





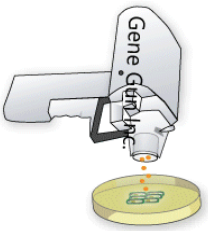
3. Copy vector in bacteria.

4. Coat tungsten or gold particles with DNA vectors.

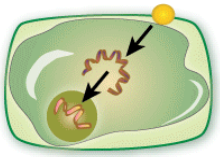


5. Load vector-coated particles onto teflon bullet.

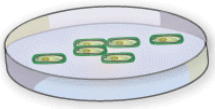
6. Load bullet into gene gun.



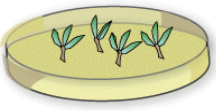
7. Shooting the gene gun releases the particles at a high velocity penetrating the plant cells.



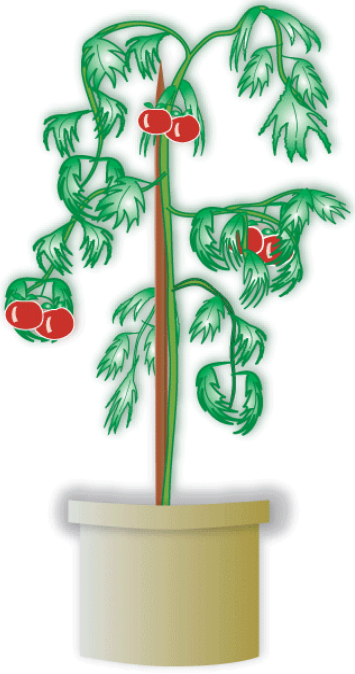
8. The vector enters the cell. The genes are incorporated into the plant genome.



9. The cells are plated on a selective antibiotic media. Only cells that have incorporated the vector will grow.



10. These cells are transferred to medium containing plant growth factors.



Insect resistant tomato plant