Name:

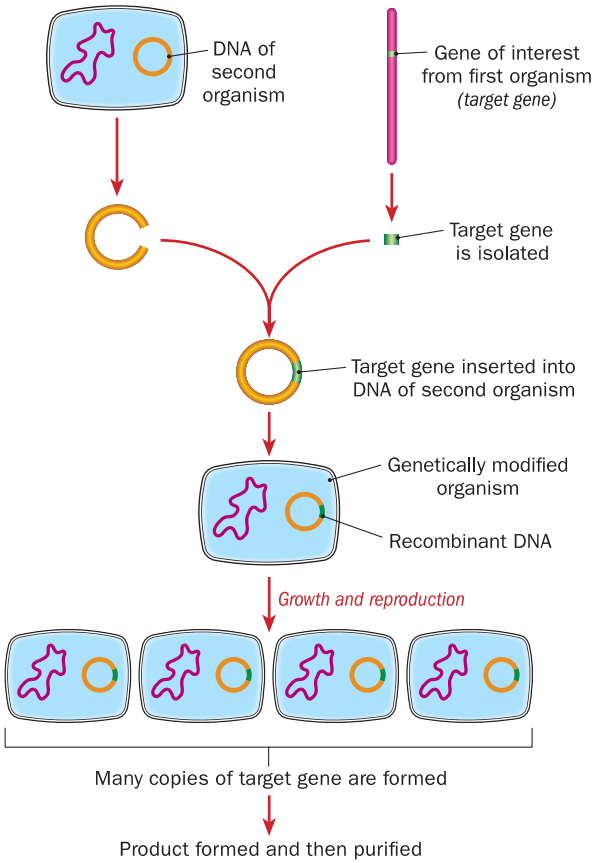
2.5 Genetics	**Objectives**
2.5.9 Genetic Engineering	1. Define Genetic Engineering 2. Understand that GE alters DNA 3. Understand the function of restriction enzymes 4. Be able to explain the following processes isolation cutting insertion transformation expression 5. Discuss three applications of GE 6. Discuss the ethical issues of genetic engineering

GENETIC ENGINEERING

Genetic engineering is a process whereby genes are transferred from one organism to another.

Genetic engineering using bacteria involves:

Isolation of a chromosome (containing the target gene) and a plasmid.
Cutting the chromosome (restriction) and plasmids with a restriction enzyme.
Insertion of the cut sections of the chromosome into the plasmid
Transformation of bacterial cells i.e. getting the bacterial cells to take up the plasmids.
Expression or production of the required protein by the bacteria with the recombinant DNA.



A **cloning vector** is a piece of DNA that can accept the **target gene** and replicate e.g. plasmid in bacteria.
Restriction enzymes cut DNA at specific sites. Genetic 'scissors' that recognises a specific sequence of bases.
DNA ligase is an enzyme that is used to get the foreign DNA to join with the DNA of the cloning vector. Genetic 'glue'.
The altered DNA is called **recombinant** DNA because it recombines after the small section of DNA is inserted into it.
Transgenic organisms are organisms that have been altered using genetic engineering.
GMOs are genetically modified organisms – living things whose DNA has been altered artificially.
'Pharming' is the production of foreign proteins by GMOs.

Applications of genetic engineering: (know 1 plant, 1 animal, 1 m/o)

Plant

Weedkiller-resistant crops

Inserting a bacterial gene for herbicide resistance in to **crop plants**, so that when the herbicide is sprayed it will kill weeds but it will not kill the plant.

Animals

Sheep produce a protein to treat emphysema (collapse of the alveoli because they cannot produce a protective protein in the lungs). A human gene for this protein (AAT) has been inserted inot sheep DNA and they can the produce the protein in their milk.

Microorganisms

Bacteria make insulin

Inserting the gene for human insulin into a **bacterium** which then produces human insulin for use by diabetics. This overcomes the danger of people producing antibodies to the pig insulin.

Ethical issues of genetic engineering

Release of GMOs into the environment.
Use of GMOs as a food source.
Concern that animals will suffer as a result of being genetically modified.
The fear that humans, especially zygotes, may be genetically modified – 'designer babies'.

Genetic engineering

Section A

2009 HL

6. **(**a) What is *genetic engineering*? _____

_____

(b) Name **three** processes involved in genetic engineering.

1. _____

2. _____

3. _____

(c) Give an example of an application of genetic engineering in each of the following cases:

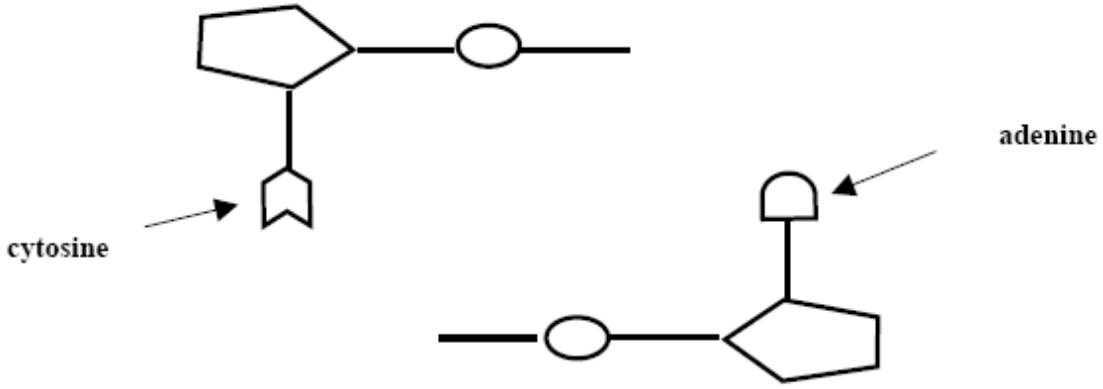
1. A micro-organism. _____

2. An animal. _____

3. A plant. _____

Section C
2004 HL

13. (a) Copy the diagram into your answer book and then complete it to show the complementary base pairs of the DNA molecule. Label all parts not already labelled. **(9)**



(b) The genetic code incorporated into the DNA molecule finds its expression in part in the formation of protein. This formation requires the involvement of a number of RNA molecules. List these RNA molecules and briefly describe the role of each of them. **(24)**

(c) Read the following passage and answer the questions that follow.

Dolly, the most famous sheep in the world, was cloned in the Roslin Institute in Scotland in 1996. When this was announced in February 1997 it caused a sensation, because until then many scientists thought that such cloning was impossible. Such cloning is the production of one or more animals that are genetically identical to an existing animal. This cloning technique is based on the fact that, with the exception of the sperm and the egg, every cell in the body contains in its DNA all of the genetic material needed to make an exact replica of the original body. During the normal development process from embryo to fully-fledged animal, all of the cells in the body are differentiated to perform specific physiological functions.

Before Dolly, the majority view was that such differentiated cells could not be reprogrammed to be able to behave as fertilised eggs. Dolly was produced by a process known as "adult DNA cloning", which produces a duplicate of an existing animal. The technique is also known as "cell nuclear replacement". During adult DNA cloning, the DNA is sucked out from a normal unfertilised egg cell, using a device that acts somewhat like a miniature vacuum cleaner. DNA that has already been removed from a cell of the adult to be copied is then inserted in place of the original DNA. Following this stage, the cell containing the inserted DNA is implanted in the womb of an animal of the same species, and gestation may begin.

To make Dolly, a cell was taken from the mammary tissue of a six-year-old sheep. Its DNA was added to a sheep ovum (egg) from which the nucleus had been removed. This artificially fertilized cell was then stimulated with an electric pulse and implanted in an ewe.
{Adapted from www.biotechinfo.ie}

(i) What is the difference between a nucleus of an egg cell and that of a somatic (body) cell of an animal?

(ii) Suggest an advantage of producing genetically identical animals.

(iii) Suggest a disadvantage of producing genetically identical animals.

(iv) "Every cell in the body contains in its DNA all of the genetic material needed to make an exact replica of the original body". Comment on this statement.

(v) What is the precise meaning of the term "implanted" in the extract above?

(vi) Suggest a purpose for stimulating the fused egg with an electric pulse.
(vii) What do you think is meant by the phrase "artificially fertilised cell"? (27)

2005 HL

10. (a) (i) What is meant by genetic engineering?
(ii) State two applications of genetic engineering, one involving a micro-organism and one involving a plant. **(9)**

(b) Cystic fibrosis is a serious condition that affects the lungs and digestive system. The condition results from
the inheritance of a single pair of recessive alleles.
(i) Explain each of the underlined terms.
(ii) Suggest why a person with a heterozygous allele pair does not suffer from the condition.
(iii) If both parents are heterozygous what is the percentage chance that one of their children may inherit the condition? Explain how you obtained your answer.
(iv) What is meant by genetic screening?
(v) Parents who are suspected of being carriers of disease-causing alleles may be advised to consider a genetic test. Suggest a role for such a test after *in-vitro* fertilisation.

(c) (i) Define the following terms as used in genetics; linkage, sex linkage.
(ii) Explain why linked genes do not assort independently.
(iii) Red-green colour blindness is a sex (X)-linked condition. Normal red-green vision results from the possession of a dominant allele (**C**). In each of the following cases give the genotypes of the mother and of the father.
1. A family in which one daughter is red-green colour blind and one daughter has normal colour vision.
2. A family in which all the sons are red-green colour blind and all the daughters are carriers (heterozygous).
(24)

2012 HL

10. (a) (i) Nucleic acids are composed of subunits called nucleotides. Each nucleotide is formed from a sugar, a phosphate group and a nitrogenous base.
Name the two **types** of nitrogenous base found in DNA.
(ii) Give **both** of the specific base pairs in DNA structure.
(9)

(b) In the sweet pea plant the texture and colour of the testa (seed coat) are governed by two pairs of alleles, which are not linked. The allele for smooth (S) is dominant to the allele for wrinkled (s) and the allele for yellow (Y) is dominant to the allele for green (y).
(i) State the Law of Segregation **and** the Law of Independent Assortment.
(ii) Using the above symbols, and taking particular care to differentiate between upper case and lower case letters:
1. give the genotype of a pea plant that is homozygous in respect of seed texture and heterozygous in respect of seed colour.
2. state the phenotype that will result from the genotype referred to in 1.
(iii) What phenotype will be produced by the genotype SsYy?
Give another genotype that will produce the same phenotype. Do not use a genotype that you have already given in response to part (ii) 1.

/(iv) If the allele for smooth were linked to the allele for green and the allele for wrinkled were linked to the allele for yellow, give the genotypes of the **two** gametes that parent SsYy would produce **in the greatest numbers**.
(27)

(c) (i) What is meant by the term *genetic engineering*?
(ii) In genetic engineering all or some of the following procedures may be involved.
Isolation;
Cutting (restriction);
Transformation (ligation);
Introduction of base sequence changes;
Expression.
Briefly explain **each** of the above terms in the context of genetic engineering.

(iii) Give **one** application of genetic engineering in **any two** of the following.
1. An animal.
2. A plant.
3. A micro-organism.

(24

2006 OL

11. (a) Explain the following terms, which are used in genetics: allele, homozygous, genotype. **(9)**

(b) (i) Name or draw the sex chromosomes that are present in a human body cell in the case of:
1. A male,
2. A female.
(ii) Use a Punnet square to show that there is a fifty percent chance that fertilization will lead to a male and fifty percent chance that it will lead to a female. **(27)**

(c) (i) What is genetic engineering?
(ii) Give one example of genetic engineering involving an animal and one example involving a plant.

(24)

2012 OL

11. (a) (i) In genetics, what is meant by the term *haploid*?
(ii) What is a chromosome?
(9)

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(b) Read the paragraph below and answer the questions that follow.

The rabbit in the photograph has no pigment in its skin, fur or eyes. This is due to
an inherited condition known as albinism. Such animals are unable to produce melanin, a protein pigment that gives colour to the skin, eyes, fur or hair. This condition makes an animal more likely to be preyed upon.
Albinism is caused by genetic mutation. The gene that causes albinism (lack of pigment) is a recessive gene. If an animal has one gene for albinism and one gene
for pigmentation, it will have enough genetic information to make pigment and

the animal will not have this disorder. However, if both genes are recessive the result is albinism. At least 300 species of animal have albino individuals e.g. rabbits, turtles, squirrels, deer and frogs.

(i) What are the main characteristics of albinism?
(ii) What is meant by the term *recessive* gene?
(iii) What is a mutation?
(iv) Mutations can lead to variation in organisms. Variations that make an organism better adapted to its environment can lead to evolution.
/1. What is meant by *evolution*?
2. Name **one** of the scientists who first explained how evolution occurs by natural selection.
3. Give **one** source of evidence for evolution.
(v) People with albinism should always apply a high-factor sunscreen when going outdoors and must avoid strong sunshine. Suggest a reason for these precautions.

(27)

(c) (i) Genetic engineering is regularly used in animals, plants and micro-organisms. What is meant by genetic engineering?
(ii) List **three** of the main procedures used in genetic engineering.
(iii) Give **two** examples of how genetic engineering is used.

(24)