**20. Biotechnology & genetic engineering**

**20.1 Biotechnology & genetic engineering**

**State that bacteria are useful in biotechnology and genetic engineering due to their rapid reproduction rate and their ability to make complex molecules**

**Discuss why bacteria are useful in biotechnology and genetic engineering, limited to:**

* **lack of ethical concerns over their manipulation and growth**
* **genetic code shared with all other organisms**
* **presence of plasmids**

**20.2 Biotechnology**

**Describe the role of anaerobic respiration in yeast during production of ethanol for biofuels**

**Describe the role of anaerobic respiration in yeast during bread-making**

**Investigate and describe the use of pectinase in fruit juice production**

**Investigate and describe the use of biological washing powders that contain enzymes**

**Investigate and explain the use of lactase to produce lactose-free milk**

**Describe the role of the fungus *Penicillium* in the production of the antibiotic penicillin**

**Explain how fermenters are used in the production of penicillin**

**20.3 Genetic engineering**

**Define *genetic engineering*** - changing the genetic material of an organism by removing, changing or inserting individual genes

**State examples of genetic engineering:**

* **the insertion of human genes into bacteria to produce human insulin**
* **the insertion of genes into crop plants to confer resistance to herbicides**
* **the insertion of genes into crop plants to confer resistance to insect pests**
* **the insertion of genes into crop plants to provide additional vitamins**

**Outline genetic engineering using bacterial production of a human protein as an example:**

* **isolation of the DNA making up a human gene using restriction enzymes, forming sticky ends**
* **cutting of bacterial plasmid DNA with the same restriction enzymes, forming complementary sticky ends**
* **insertion of human DNA into bacterial plasmid DNA using DNA ligase to form a recombinant plasmid**
* **insertion of plasmid into bacteria (specific detail is not required)**
* **replication of bacteria containing recombinant plasmids which make human protein as they express the gene**

**Discuss the advantages and disadvantages of genetically modifying crops, such as soya, maize and rice**