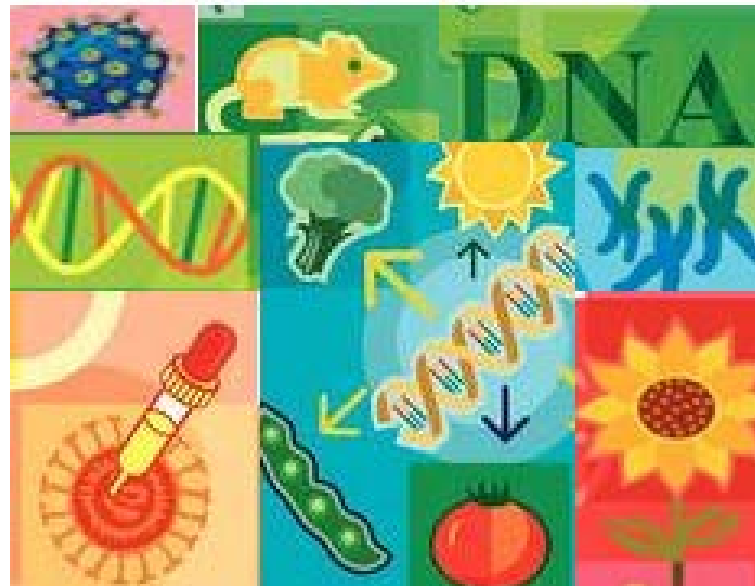


Genetic Engineering

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Lesson Objectives

At the end of this lesson you should be able to

1. Define Genetic Engineering
2. Outline the process of genetic engineering involving some or all of the following:
isolation, cutting, transformation, introduction of base sequence changes and expression
3. Know three applications: one plant, one animal, one micro-organism

Genetic Engineering

The simple addition, deletion, or manipulation of a single trait in an organism to create a desired change.

Genetic Engineering

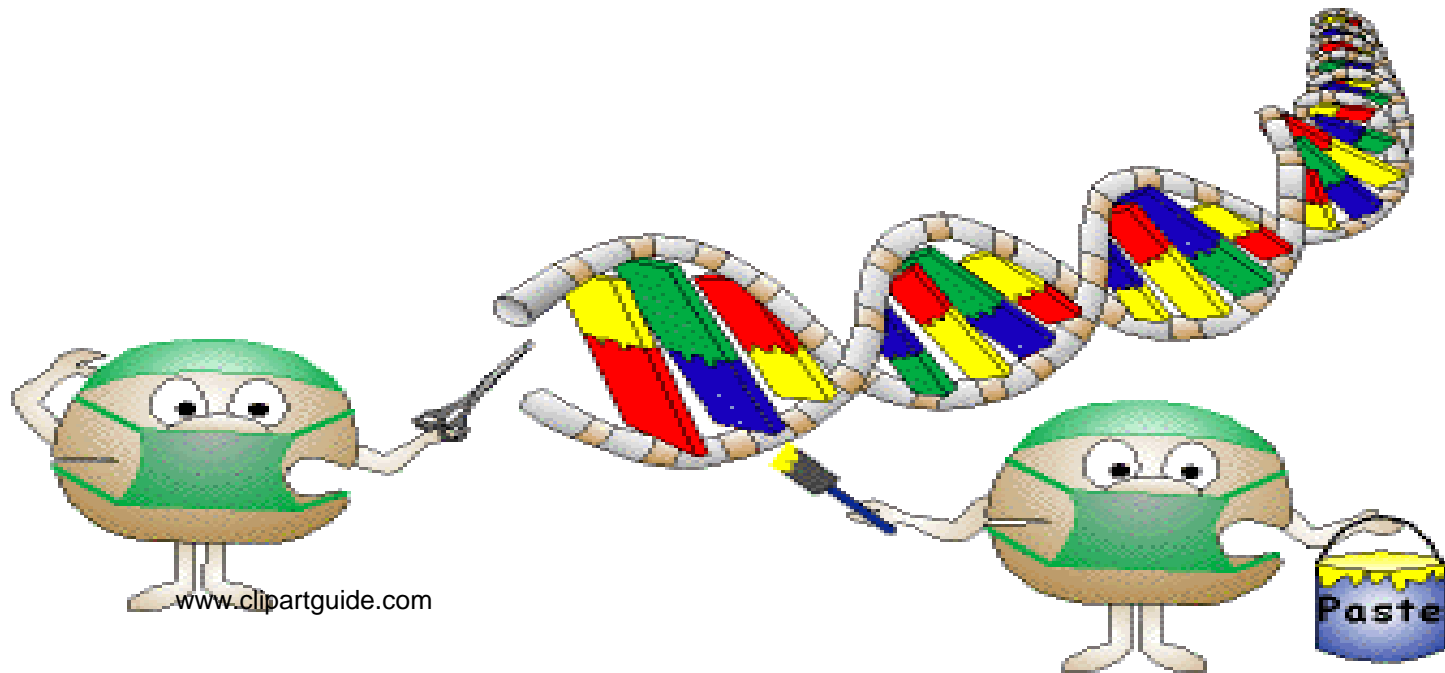
What you need to know

- **Manipulation and alteration of genes**
 - Three applications: one plant, one animal, one micro-organism
- ▣ **Process involving isolation, transformation, and expression**

Genetic Engineering

Is:

Artificially copying a piece of DNA from one organism and joining this copy of DNA into the DNA of another organism



Purpose of Genetic Engineering

It allows genes from one organism to be inserted into a cell of a different organism of a different species.

Examples:

- Human genes can be inserted into a bacterium
- Human genes can be inserted into cells from other animals
- Bacterium genes can be inserted into plant cells

Genetic Engineering

- Genetic engineering means that DNA from different organisms can be combined
- Bacteria can be engineered to produce human proteins
- Human genes can be inserted into other animals

Genetic Engineering - Overview

- ▣ **The altered DNA is called recombinant DNA**
- ▣ **Recombinant DNA is joined to other unrelated DNA in the organism**
- ▣ **This is called gene splicing.**
 - **tiny segments of a gene are taken out and replaced by different genes**

Learning Check

1. What is Genetic Engineering?
2. What is the purpose of Genetic Reengineering?
3. Give three examples of Genetic Engineering
4. What is the difference between altered and recombinant DNA?
5. What is meant by gene splicing?

Transgenic Organisms

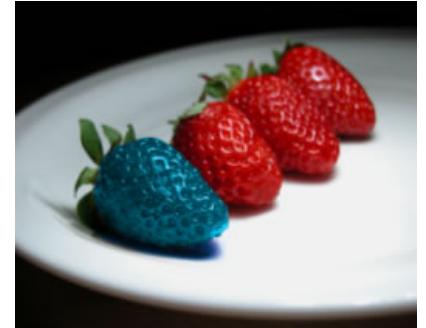
- Organisms altered by genetic engineering.
- Genetic material changed by other than random natural breeding
- Gene transfer
 - moving a gene from one organism to another.

What Transgenic means

- 'Trans-' means 'crossing from one place to another'
- The '-genic' bit means genes
- So it means that bits of genes from different living things have been bolted together and spliced into another organism to make a new one which does something which the scientists want it to do.

Examples of Transgenic Organisms

- GMO- genetically modified organism
- GEO-genetically enhanced organism



For example

Plants that resist a particular type of weed killer

Sheep which make some special substance in its milk.

<https://www.healthproductsguru.com>

Learning Check

1. What the word transgenic mean?
2. What is a transgenic organism?
3. Give examples of transgenic organisms

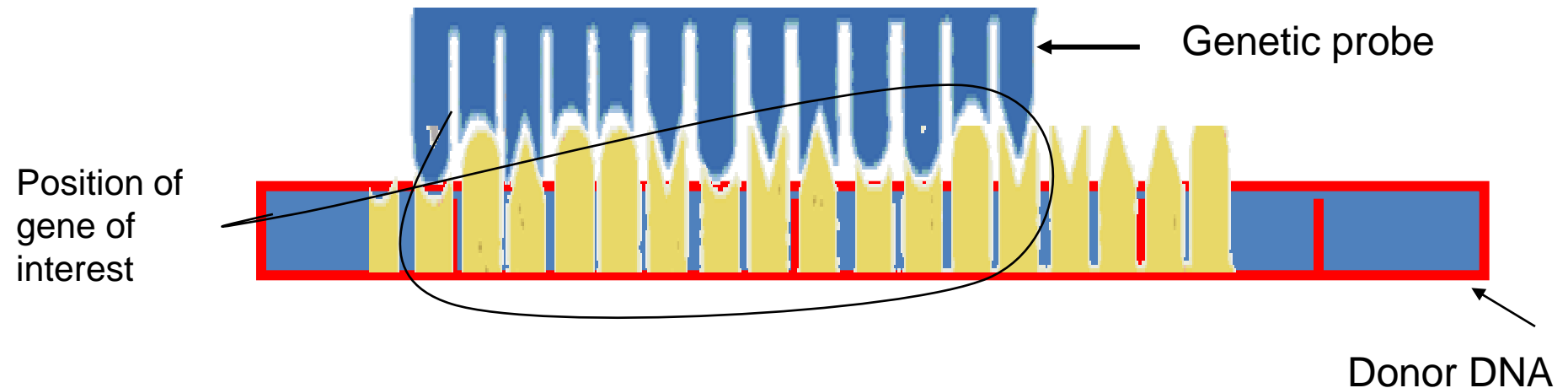
5 Stages involved in GE

1. Isolation
2. Cutting
3. Ligation and Insertion
4. Transformation
5. Expression

1. Isolation

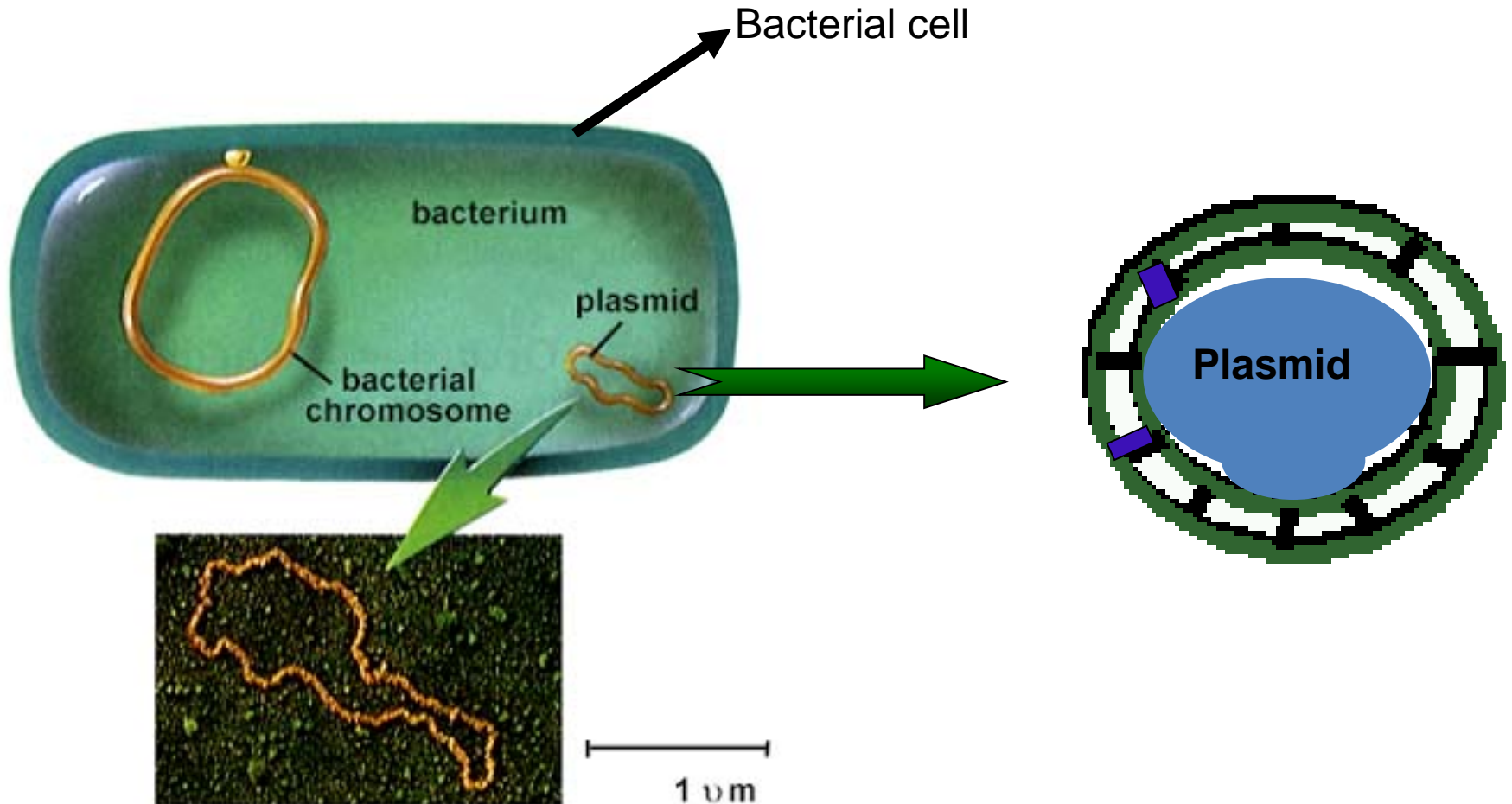
(a) Isolation of a specific gene from donor e.g. human

- Cells broken open
- Genetic probe added
- Reveals position of the gene of interest



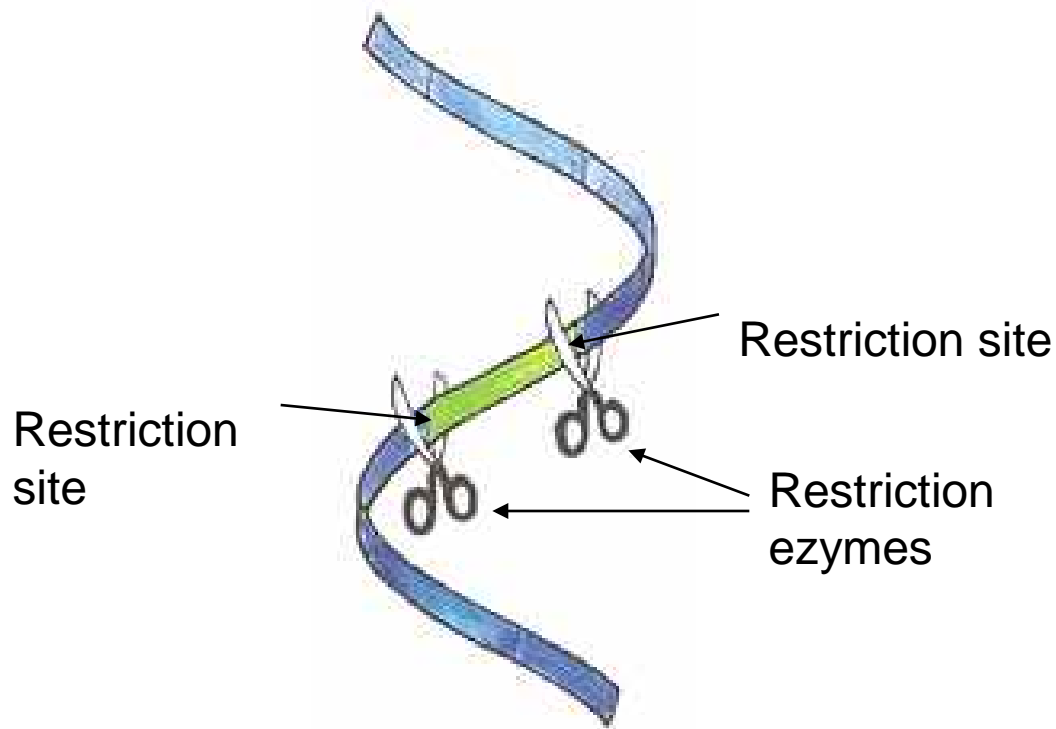
1. Isolation

(b) Isolation of plasmid from a bacterial cell

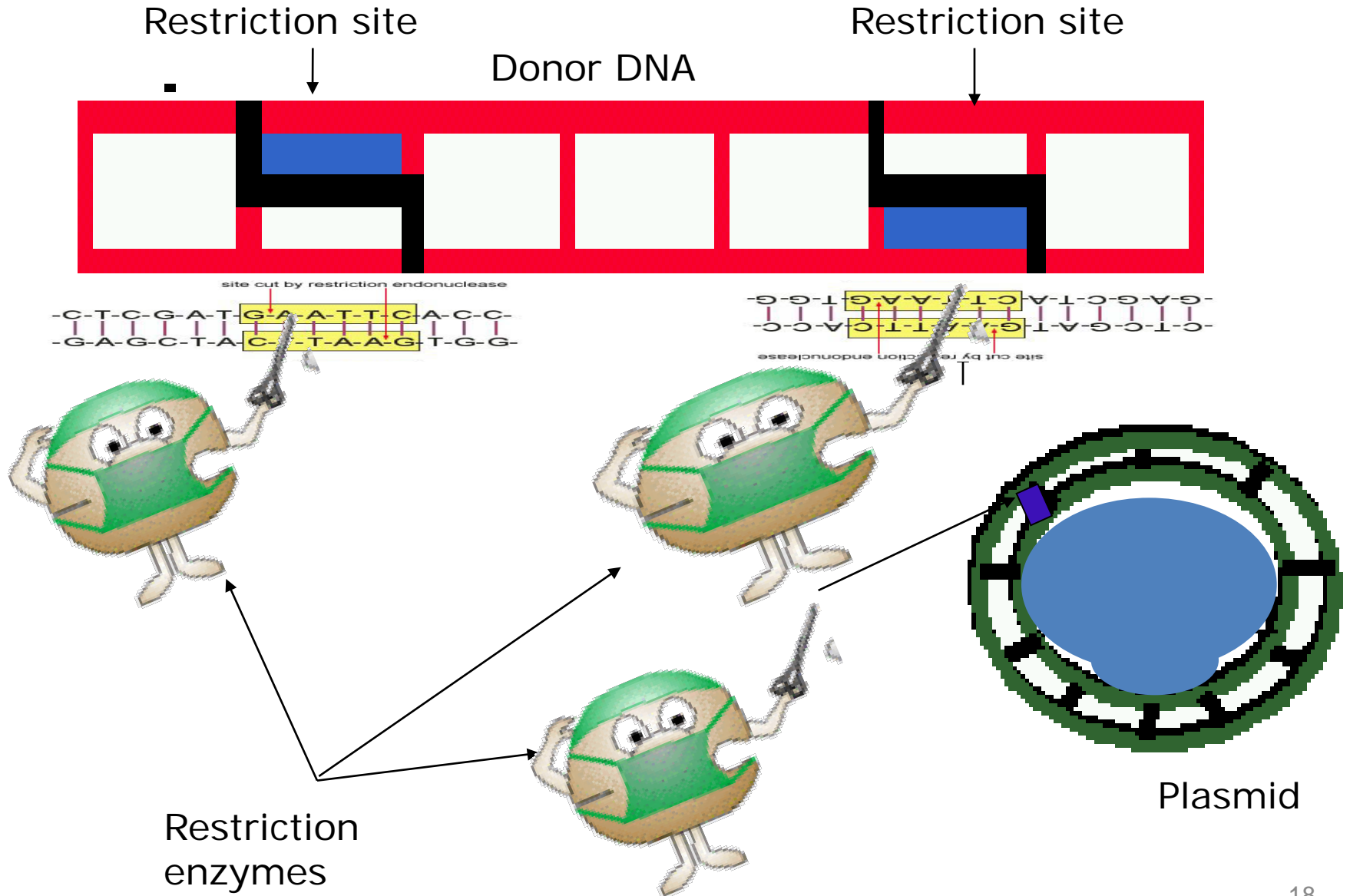


2. Cutting

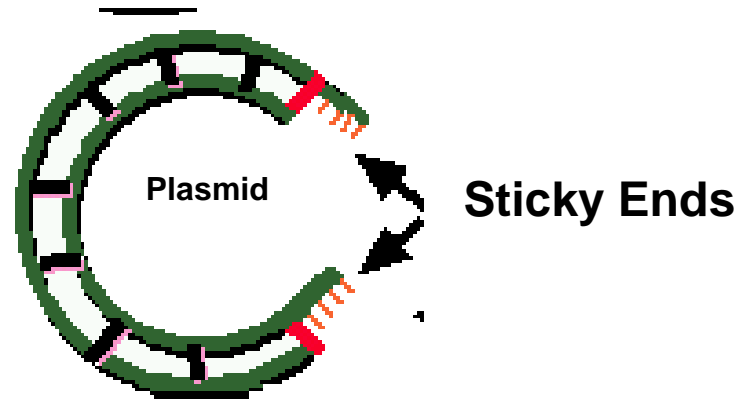
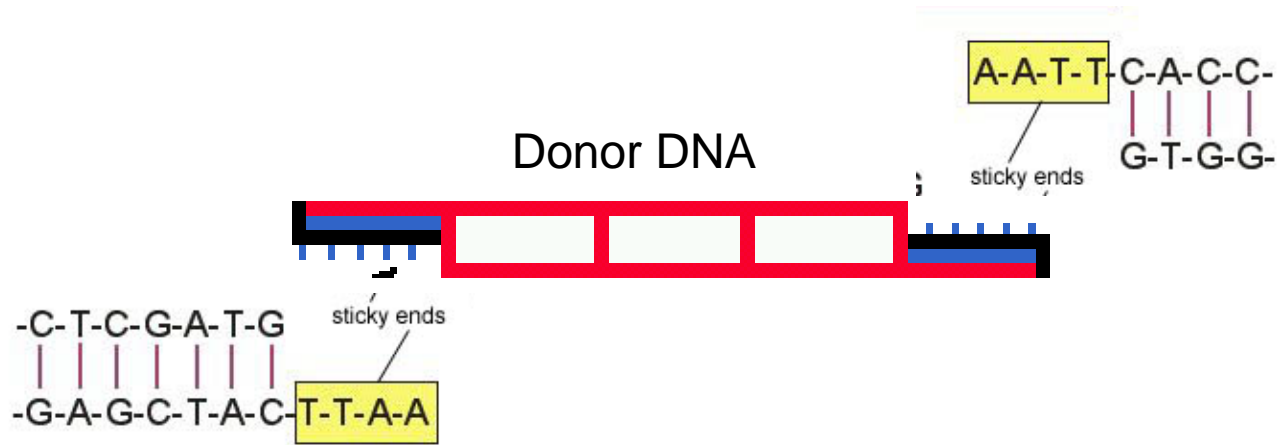
- Restriction enzymes act as molecular scissors and cut DNA at specific sites called restriction sites



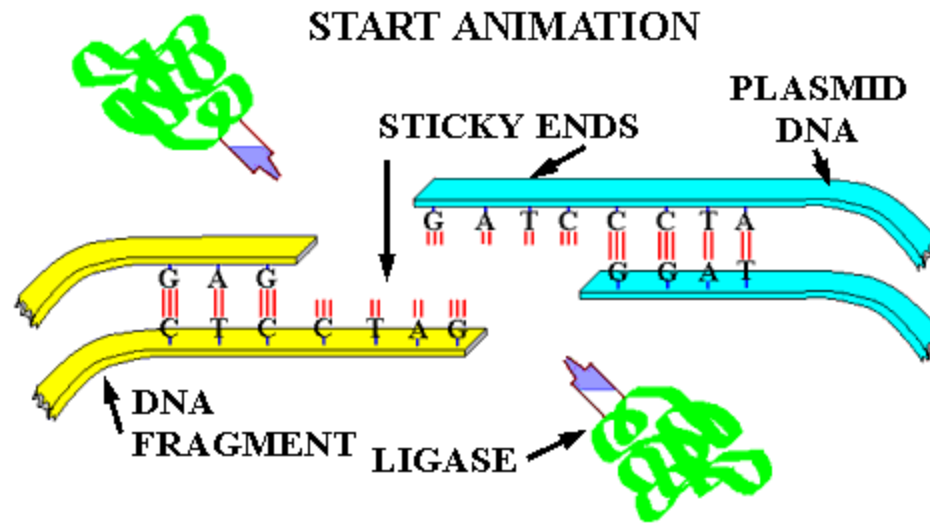
2. Cutting



Cutting



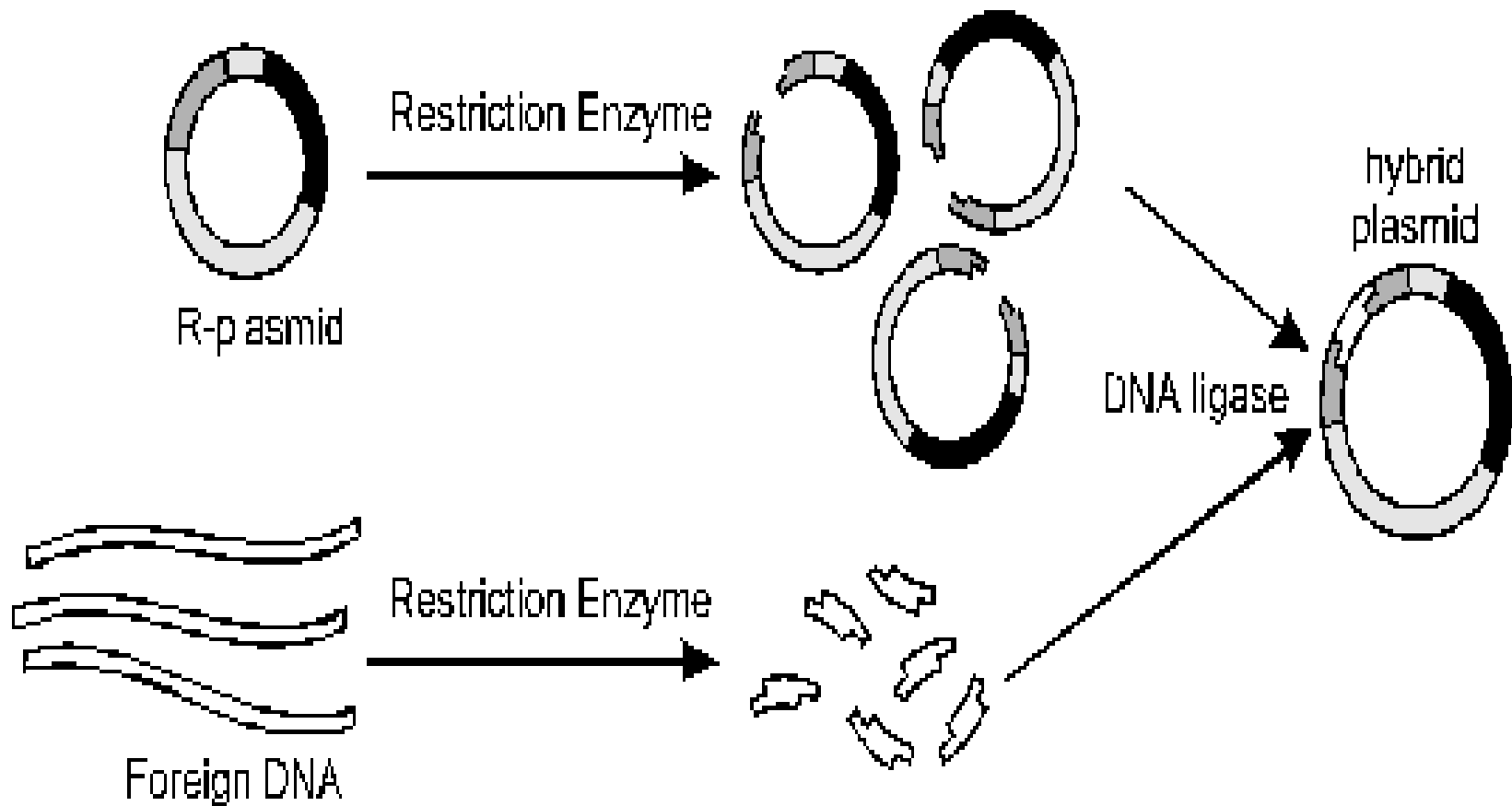
DNA Ligase



http://www.slic2.wsu.edu:82/hurlbert/micro101/pages/Chap10.html#Sticky_ended_cut

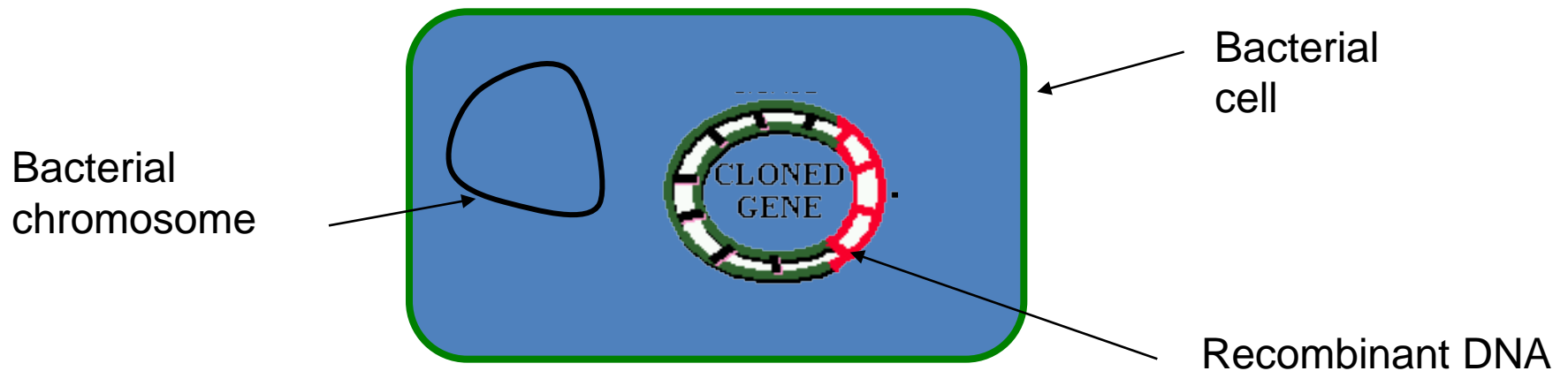
Ligation –rejoining cut fragments of DNA and forming artificial recombinant molecules

Ligation and Insertion



4. Transformation

Recombinant DNA introduced into bacterial cell

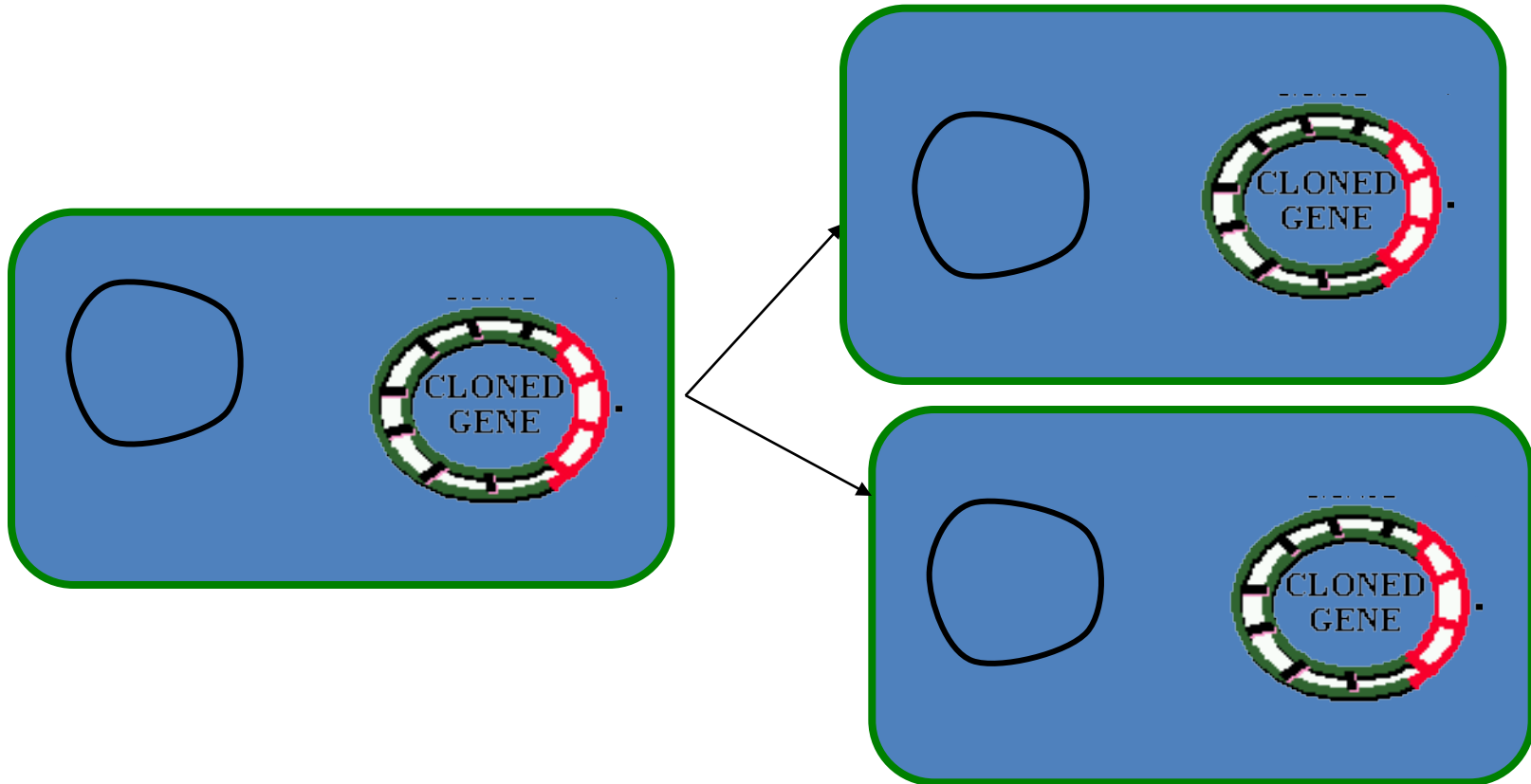


5. Expression

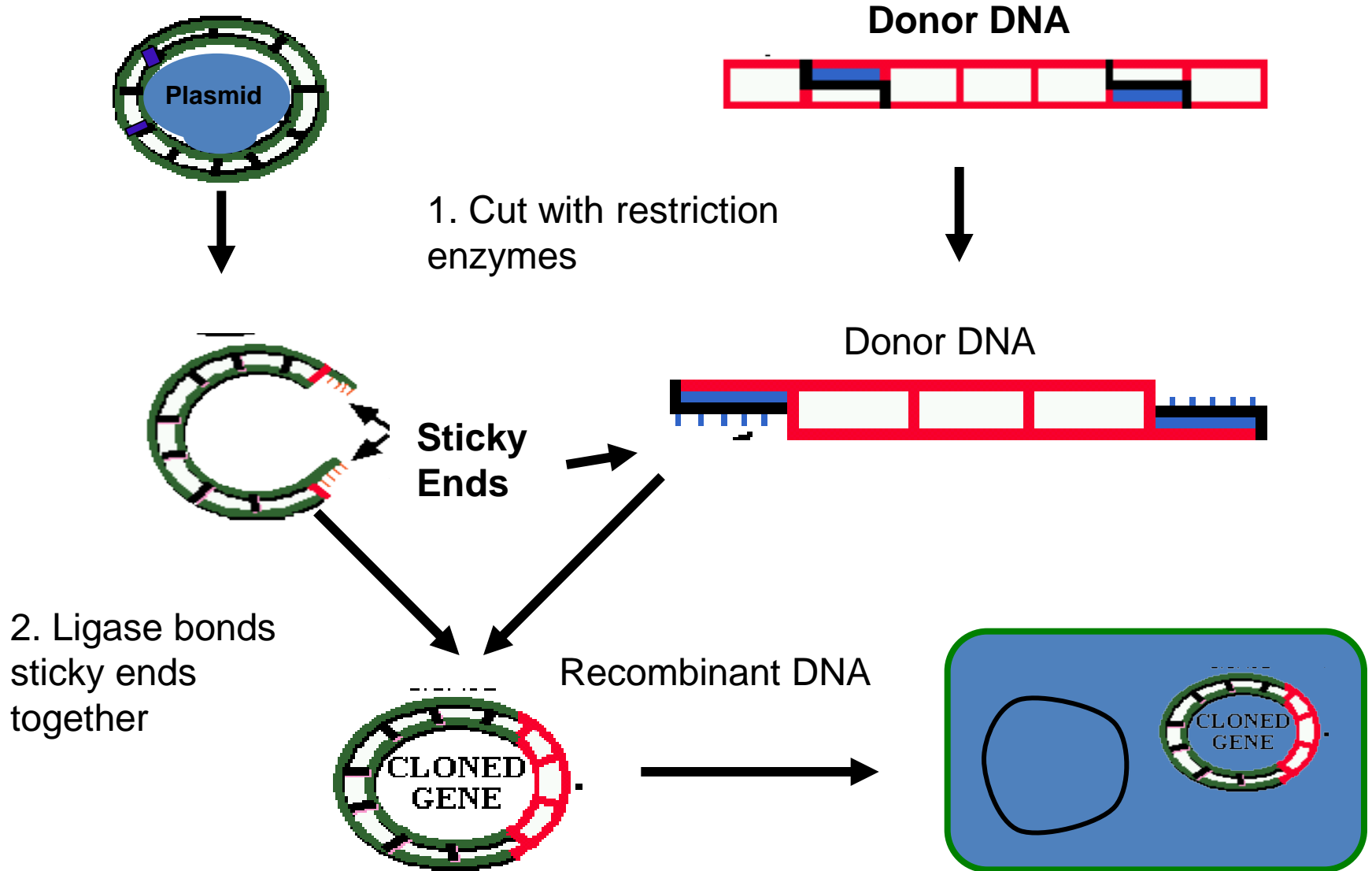
Bacterial cell reproduces by Binary Fission

Bacterial cell produces the polypeptide

Coded for by the donor DNA



Summary of steps



Expression

- Expression is getting the organism with the recombinant DNA to produce the desired protein
- When the protein is produced in large amounts it is isolated and purified

Learning Check

1. What are the stages involved in GE?
2. Outline what happens in the stage isolation ?
3. What enzyme is used to cut the DNA?
4. Can you explain what happens in transformation?
5. What is meant by gene expression?

Animals used in GE

- The human gene to clot blood has been inserted into the DNA of sheep
- Sheep produce human clotting factor needed for Haemophiliacs in their milk
- Goats produce a protein to treat emphysema

Applications (Micro-organisms)

Production of humulin



www.healthtap.com

Used by diabetics

Plant Application



Golden Rice – a possible solution to Vitamin A deficiency.

Applications of Genetic Engineering

- Pharming
- Gene pharming is a technology that scientists use to alter an animal's own DNA, or to splice in new DNA, called a transgene, from another species.
- In pharming, these genetically modified (transgenic) animals are mostly used to make human proteins that have medicinal value. The protein encoded by the transgene is secreted into the animal's milk, eggs or blood, and then collected and purified.

Tracy the Sheep

- One of the first mammals engineered successfully for the purpose of pharming was a sheep named Tracy, born in 1990 and created by scientists led by British developmental biologist Ian Wilmut at Roslin Institute in Scotland. Tracy was created from a zygote genetically engineered through DNA injection to produce milk containing large quantities of the human enzyme alpha-1 antitrypsin, a substance used to treat cystic fibrosis and emphysema



Xenotransplantation

- **Xenotransplantation** is the transplantation of living cells, tissues or organs from one species to another.
- However there are ethical issues and issues with rejection
- There are also issues with virus transmission from one species to another
- Porcine islet transplants are being investigated for use in type 1 diabetes due to the shortage of human islet cells

Gene Therapy

- It involves modifying human DNA either to repair it or to replace a faulty gene.
- The idea of gene therapy is to overcome the effects of a mutation which causes a genetic disease.
- Cystic fibrosis is the best known disease where gene therapy has been tried.



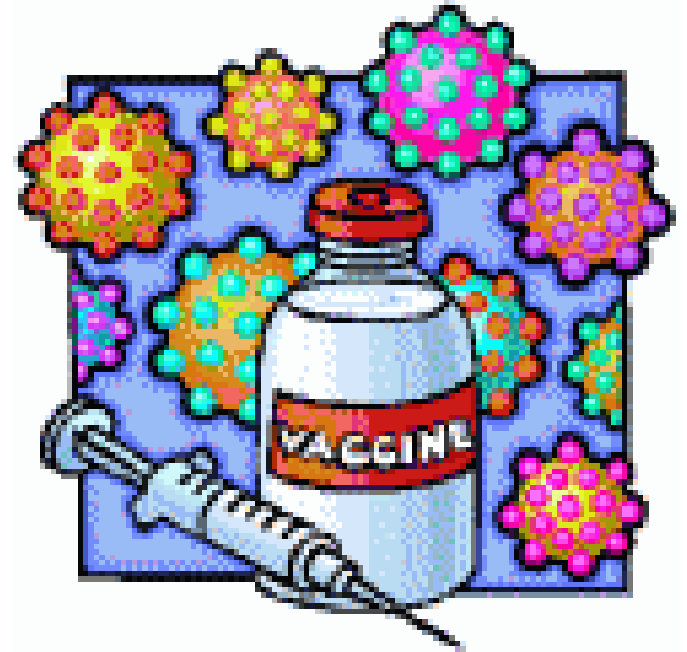
Diagnostic Tests

Genetic engineering can produce very specific and sensitive diagnostic tests for many diseases, using engineered proteins.

This new technology is also opening up novel ways of delivering medicines to specific targets.

Vaccines

- Genetically engineered microbes can be used to produce the antigens needed in a safe and controllable way.
- The use of genetically modified yeast cells to produce a vaccine against the hepatitis B virus has been a major success story.



Plants

- **Weedkiller resistant crops**
 - Weeds die but the crops survive
- **Vitamin A in Rice**
 - The gene which produces vitamin A was taken from daffodils and put into rice to help prevent blindness

Micro organisms

- Bacteria can make human insulin
- This prevented many diabetics from getting an allergic reaction to animal insulin
- Bacteria make interferon which can fight virus infections and some cancers

Learning Check

1. Can you outline 3 uses of Genetic Engineering?
2. What is the purpose of Pharming?
3. Outline a use for Gene Therapy
4. What have GE modified yeast cells been used to produce?
5. What do you feel are the ethical issues associated with GE?

What have you learned?

Can you.....

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

End