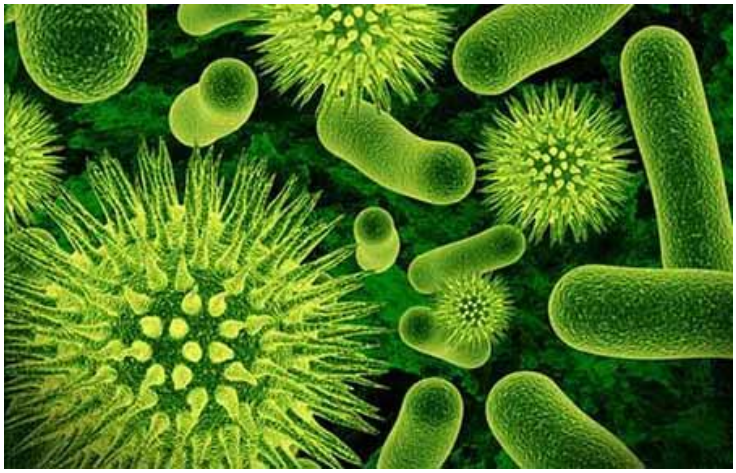
S3 N4/5 Biology
Unit 1-Cell Biology
Part A: It's a small world



NAME:

CLASS:

	N	I can now…..	Track
		MICRO-ORGANISMS	
1	4	state different foods which are produced using yeast	
2	4	write a word equation for the process of fermentation in yeast	
3	4	state that yoghurt is produced using bacteria	
4	4	write a word equation for the process of fermentation in bacteria	
5	4	state what biofuel is	
6	4	state the term bioremediation as a way of dealing with pollution using microbes	
	4	Grow colonies of microorganisms on agar.	
		DNA, GENES AND CHROMOSOMES	
7	4/5	Describe the structure of DNA as a double helix	
8	5	Describe the base pairing in DNA (A and T and C and G)	
9	4	state that chromosomes are made up of a chemical called DNA and can be divided into genes	
10	5	State that DNA codes for amino acids	
11	5	work out a chain of amino acids given a DNA code	
12	5	Explain how proteins are made from DNA	
13	4	Explain the 5 different functions of proteins	
		ENZYMES	
14	5	Describe what enzymes are made out of and their role in the cell	
15	5	Describe the 'lock and key' theory as it applies of enzymes, using the term active site	
16	5	Explain the terms degradation and synthesis	
17	5	Write a word equation for an enzyme, including the substrate, enzyme and product	
18	5	Understand how to carry out a fair experiment by controlling variables	
		GENETIC ENGINEERING	
19	5	Describe the process of genetic engineering and the stages involved.	
20	4	Describe why genetic engineering is a controversial biological procedure.	

Micro-organisms

There are three main types of microorganisms:

- F
- B
- V

For thousands of years people have been used microorganisms to make foods, drinks and other useful products.

Useful characteristics of microorganisms

The microorganisms most commonly used are single-celled organisms, in particular, _____ and _____ . They are the most useful because of their:

- _____ growth
- Diverse_____ sources.
- Growth can be controlled to produce a wide range of useful_____.

Revision:
1. What is the difference between a unicellular and a multicellular organism?

2. Give an example of each.

Bacteria

Bacteria are used in the Dairy industries to make _____ and _____ .

Bacteria are also involved in the spoiling of milk.

B_____ feed on the sugar in milk (lactose) and turn it into lactic _____.

Write the word equation to show how bacteria feed on the sugar lactose to produce lactic acid.

Making yoghurt

Bacteria are involved in the process of making yoghurt. To make yoghurt milk needs to be turned _____.

The bacteria feed on the sugar, _____ , in the milk and produce lactic_____. The lactic acid causes the milk to thicken and its taste to change.

Describe the steps taken to produce yoghurt:

The bacteria causes the pH of the milk to _____ making it more acidic. This is why natural yoghurt has a more sour taste than milk.

Your teacher may let you sample the difference in taste between the two.

Resazurin Dye can be used to indicate the numbers of bacteria in a sample of milk.

Age of milk (days)	**Colour of resazurin**
0 (fresh)	

Making Cheese

Bacteria can also be used to make _____. Bacteria has a similar role in cheese production and the same type of bacteria can be used.

Milk is_____ to kill any unwanted microorganisms. It is then cooled back down to a suitable temperature for cheese making bacteria. Bacteria is added to the milk to turn the sugar lactose into _____ _____ which causes the milk to thicken. The enzyme _____ is added to the milk to _____ the milk proteins. The rennet causes _____ and _____ to be formed. The curds and whey are then _____ and whey is discarded. The curds are then treated with salt and pressed to make solid cheese.

Steps in cheese making	No.
Curds are pressed into shape to make solid cheeses	
Milk is heated to kill any unwanted microorganisms	
Rennet added to clot milk protein	
Curds and whey are formed	
Milk is cooled down and cheese making bacteria is added	
Curds and whey are separated.	
Bacteria causes milk to thicken as they produce lactic acid.	

Organise the steps in cheese making into the correct order.

Yeast (Fungi)

Yeast is a single-celled_____that is used in industries for Baking and Brewing.

In the baking and brewing industries yeast carry out a process called **fermentation** to produce beer, wine and _____. They convert _____ into _____ dioxide and ethanol (alcohol).

Write the word equation to show the fermentation process.

Baking

Bread making investigation:

Your teacher will allow you to design an experiment to investigate the **rising of dough.** You will write up your report in your jotter.

Remember:

- Aim, hypothesis, materials and method, results, graph, conclusion and evaluation.
- What variables are you changing and what are you keeping the same?

When making bread, the_____ _____ produced during fermentation causes the dough to rise as it becomes trapped. The alcohol produced during fermentation_____ due to the heat of baking.

Brewing

The process of fermentation is used to make a wide range of alcoholic drinks including _____, _____ and _____.

Beer

The yeast feeds on the cereal used to make beer and produces alcohol and _____ _____. The carbon dioxide makes the beer fizzy.

Wine

Making wine involves the fermentation of the sugary juices from the grapes. The yeast feeds on the sugar and produces _____ and _____ _____.

Cider

A similar process is used to make cider, but instead using _____.

Brewing investigation:

Your teacher may allow you to design an experiment to investigate the fermentation of grapes and apple juice with yeast.

Follow up:

- Can you remember the test for carbon dioxide gas?
- Carbon dioxide is a product of fermentation can you collect and test the gas produced during your experiment?

FUN FACT: Wild salmon are pink because they eat lots of shrimp. Farmed salmon (that don't have any shrimp to eat) are naturally brown. However, these farmed salmon are fed pink yeast to make them pink so it can be sold in the shops!

Other uses of microorganisms

Microorganisms are not only used to make food products. They can also be used to produce_____and to remove pollutants and decontaminate soil in a process called _____.

Bioremediation

Bioremediation is the process by which _____ are used to _____ polluted soil. Some scientists are investigating the possibility of using this method to clean up _____spills.

The process involves the _____in the soil taking in the pollutants and contaminants and turning them into harmless _____and water.

Biofuels

Disposal of Biological waste is a huge problem. _____ can be used to breakdown organic matter (usually plant material) to produce _____.

Biofuels are a source of _____ energy and are a potential alternative to _____ _____. Biofuels are less harmful to the environment than fossil fuels as they do not add extra carbon dioxide.

However there are some problems associated with Biofuels:

- Land is needed to grow crops for Biofuels that could be used to grow crops for food.
- Increased deforestation
- Increased water usage.

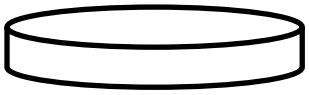
Fill in the summary table below to show the different uses of microorganisms

Process	Microorganism	Product/use
Yoghurt making		Yoghurt
Cheese making		Cheese
Baking		Bread
Brewing	Yeast	
Wine making		Wine
Biogas	Bacteria	_____ (a fuel that can be burnt for cooking or to generate electricity)
Bioremediation	Bacteria	

<u>Growing cells</u>

We can grow cells in the lab to model how cells are grown in the food and biotechnology industries.
Growing cells requires an appropriate _____ for the cells to grow on, such as _____ jelly which provides all the nutrients the cells need.

We usually spread the cells on a _____ _____ filled with agar jelly.



When we are growing cells it is important to follow _____techniques. This ensures that no other microbes are transferred and grown in the dish and the work conditions are sterile.

Note the aseptic techniques you used when growing cells to ensure you didn't grow any unwanted microorganisms.

You learned earlier that microorganisms are useful to us because they grow rapidly. Try the example question below.

If bacteria double every 20 minutes, starting with one bacteria, how many bacteria would exist after 4 hours?

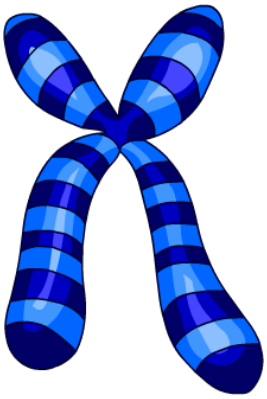
DNA and the production of proteins

Revision:

During your introduction to Biology you learned about the basic structure of a cell.

Where in the cell is the DNA found?

DNA structure



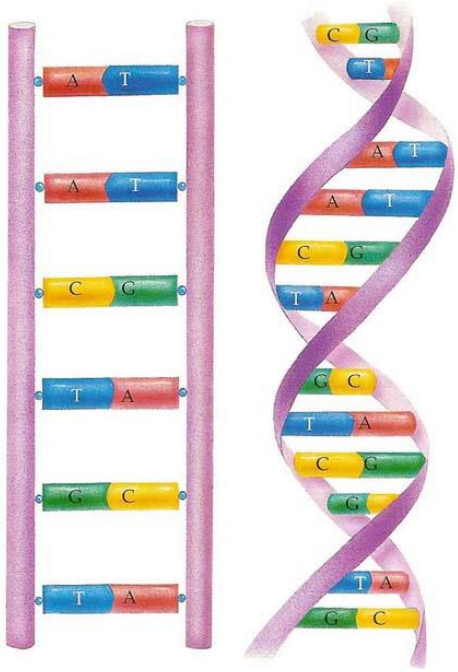
DNA is found in all living organisms. It is the information needed to create an organism. DNA is found in structures called _____. Each chromosome is divided into sections called _____. Each gene contains the information to build a specific protein.

If a gene becomes damaged, the wrong protein or none may be produced.

Practical activity: DNA extraction steps

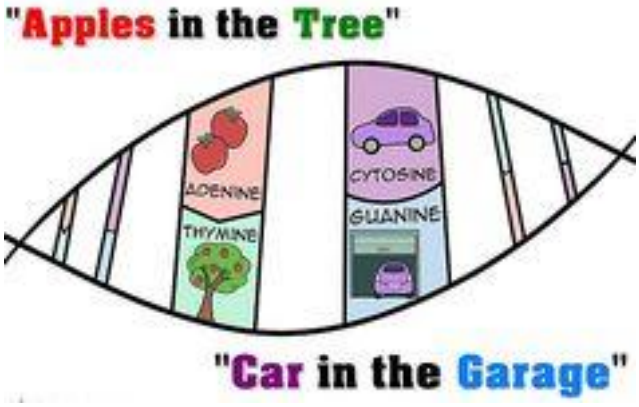
DNA is made up of _____ strands twisted together into a double-stranded _____.

If we were to 'unwind' the double helix, DNA would look just like a ladder.



Each 'step' of the ladder is a set of complementary base pairs that hold the two strands of DNA together.

There are four different bases: Adenine (__), Thymine (__), _____(C) and _____ (G). A always pairs with T and C always pairs with G.



Your teacher may allow you to make one of the following DNA models to help you understand its shape.

<u>Practical activity A:</u> **Paper DNA model**	**<u>Practical activity B:</u>** **Sweetie DNA models**

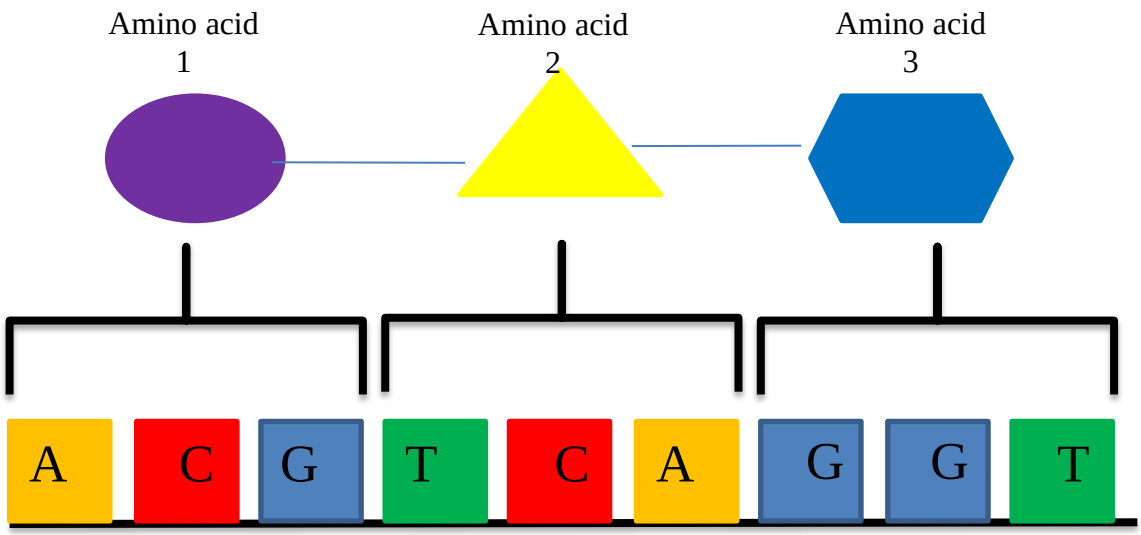
Proteins

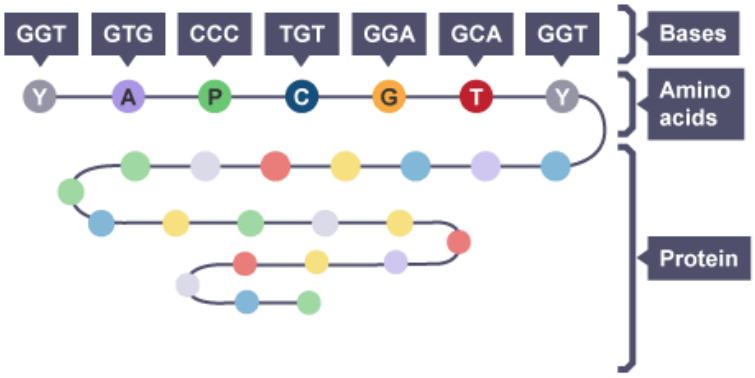
The order of the bases in a DNA molecule contains the instructions to make _____.

Proteins do all the work in a cell giving cells their shape and appearance, controlling the passage of chemicals and controlling chemical reactions that take place.

Each protein is made up of a long chain of _____ _____. Each group of ___ bases carries the code to make one amino acid. The order of the base _____ determines the amino acid sequence in the protein.

The diagram below shows how the sequence of bases on the DNA strand codes for different amino acids. The amino acids are all joined together into a long chain to form a protein.





Activity C: Make protein paper chains to show how the sequence of bases in a DNA molecule code for different proteins.

Example 1:

The diagram below shows a section of a gene.

1. How many amino acids are coded for in each?
2. Using the table, what would the order of the amino acids be?

DNA code	Amino acid
ACG	Phenylalanine
TTC	Lysine
TCA	Cysteine
GGC	Threonine
CAG	Glycine
GGT	Proline

Example 2:

ATGCTGTTGATGCAACAGTATAAT

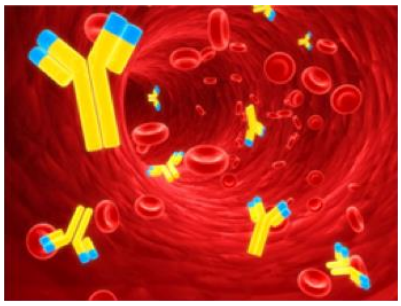
1. How many amino acids are coded for in this base sequence?
2. How many **different** amino acids are coded for in this base sequence?

Example 3:

A section of DNA has 800 bases. Complete the table below to show how many of each type of base there are and the percentage of each type of base. REMEMBER the complementary base pair rule.

Base	Number of bases	Percentage of bases
A	160	
T		
G	240	
C		30

The **sequence** of bases in a DNA molecule determines which protein is made.



Therefore, **different sequences** can make **different proteins**.

Use the table below to summarise different proteins and their functions.

Name of protein	function

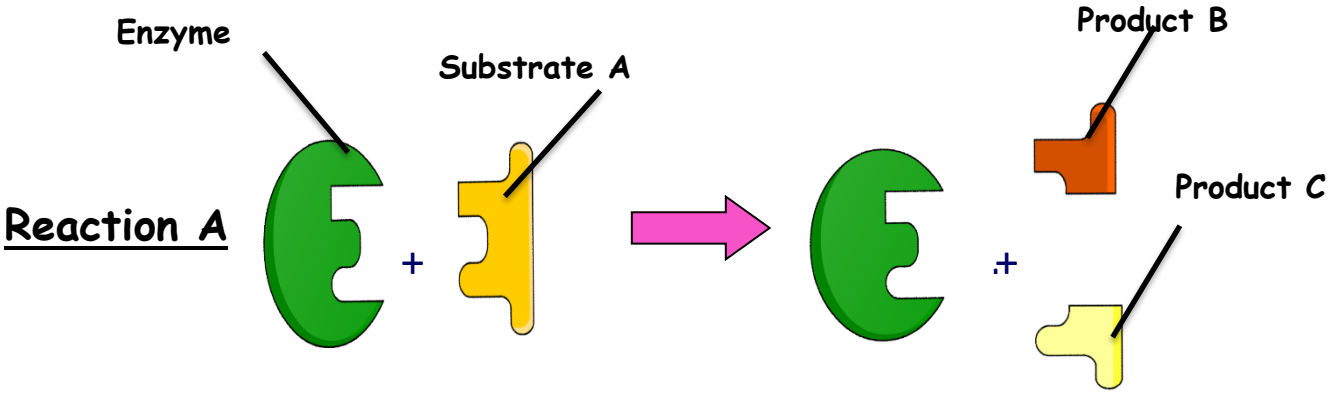
Enzymes

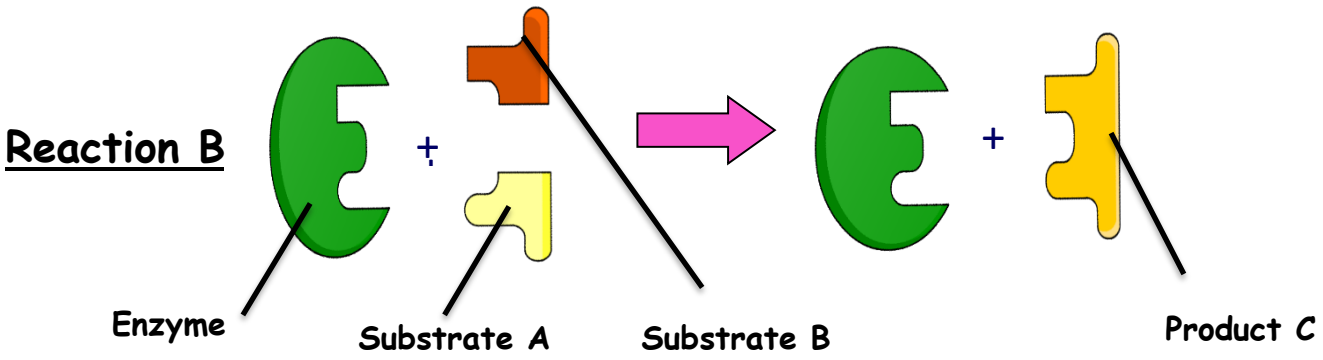
Enzymes

Enzymes are proteins made by all living cells. They function as _____ _____ which means that they _____ _____ chemical reactions in cells. They are _____by the chemical reaction they speed up.
They speed up reactions like digestion, photosynthesis and respiration. Without enzymes, these essential reactions would not take place or would occur too slowly to be of use.

Enzymes are involved in _____and _____ reactions.

Synthesis reactions **build** up smaller molecules into larger ones.
Degradation reactions **break down** larger molecules into smaller ones.





The substance they work on is called the _____and what they produce at is called the _____.

Write the simple word equation in the box below that shows an enzyme catalysed reaction.

In the same way that a key only fits into one lock, an enzyme will only act on one substrate.

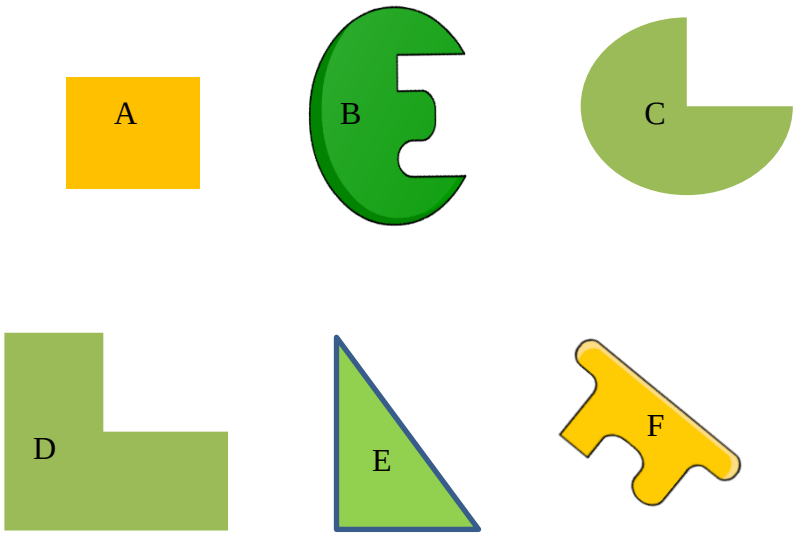
The part of the enzyme which the substrate fits into is called the_____ _____. It is a very specific shape. The shape of the enzyme's active site is _____to one substrate, meaning only one substrate can fit in.

An **enzyme-substrate complex** forms, which helps the reaction, take place and the substrate(s) to become a product(s).

Activity:
Label the enzyme to show its active site.

What would this enzymes-substrate complex look like?

Activity:
Match up the enzymes with their substrates.



Activity:
Using playdough make an enzyme, substrate and product model and show how a synthesis and a degradation reaction takes place. Remember enzymes are **specific**.

Enzyme reactions

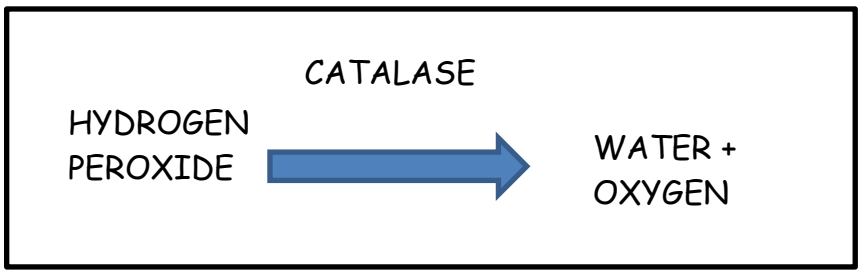
Catalase, **lactase**, **amylase** and **phosphorylase** are common examples of enzymes that are involved in chemical reactions.

Your teacher will now select some experiments to help you understand the action of each enzyme. You will write a report on the experiments you do in your jotter.

Example 1-Catalase

Catalase is an enzyme found in cells. Catalase breaks down hydrogen peroxide into _____ and oxygen. This is an example of a _____ reaction.

The box below shows the word equation for the breakdown of hydrogen peroxide to oxygen and water by catalase.

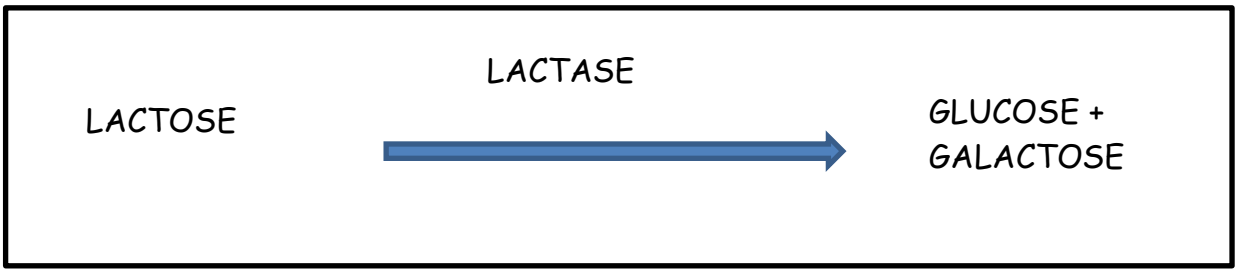


In the word equation:
What is the substrate?
What are the products?

Experiment A:
Investigating the catalase content in different tissues.

Experiment B:
Investigating the breakdown of hydrogen peroxide by catalase using immobilised yeast.

Example 2 -Lactase
Lactose is a sugar found in milk. Lactase is an enzyme in the digestive system breaks Lactose down into smaller sugars. _____ breaks down Lactose into _____ and _____. This is another example of a _____ reaction.



Normally our digestive system produces Lactase which breaks down the Lactose in milk for us. However when people are _____ intolerant they have stopped producing the enzyme _____ so the lactose can't be broken down.

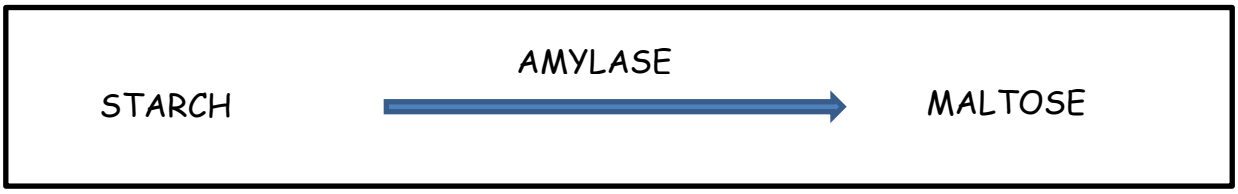
Scientists can produce Lactose free milk for people who are Lactose intolerant. This can be done by _____the milk directly with Lactase or treating the milk with _____Lactase, before it is put into cartons. This breaks the Lactose down into Glucose and Galactose so the Lactose intolerant person will not get sick.

Experiment C:
Treating milk with 'immobilised' lactase to break the Lactose down into Glucose and Galactose.

Example 3 -Amylase

Starch is a substance found in plants where it acts as a food store, it is also important in the diet of many animals, including humans. Starch is made of large _____ molecules which must be broken down into smaller _____ molecules so it can be absorbed and used by the body.

_____ is the enzyme needed to break down starch into _____. This is another example of a _____ reaction.

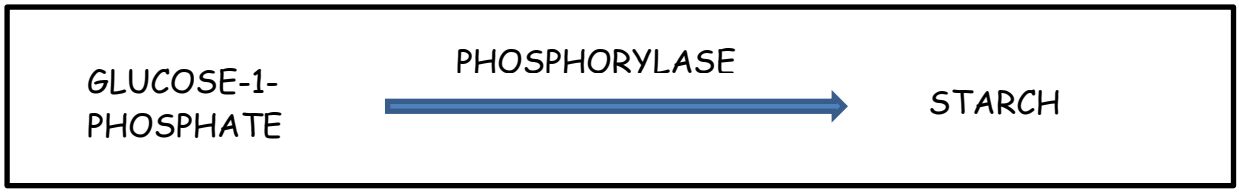


<u>Experiment D:</u>

Starch, Amylase and iodine clock.

Example 4 –Phosphorylase

Green plants are able to make sugar which they use as food. Sugar is not easily stored so it must be converted to starch so it can be stored. The enzyme responsible for building the glucose into starch is called _____. This is an example of a _____ reaction.



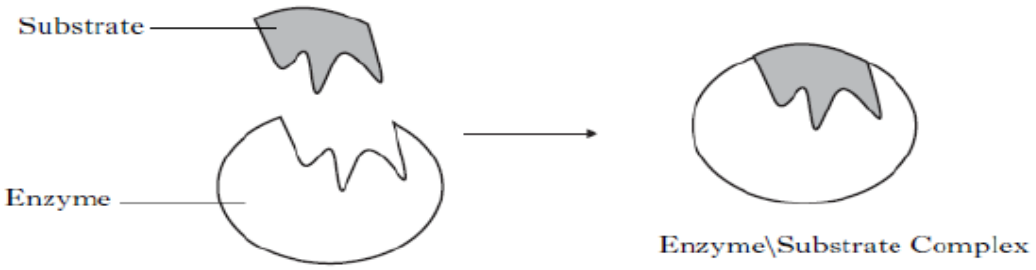
<u>Experiment E:</u>

Glucose-1-phosphate, phosphorylase and iodine clock.

Activity:
Try the example questions about Enzymes below.

Mar

1. Enzymes are biological catalysts. The diagram below shows part of an enzyme controlled reaction.



(*a*) Describe the features of an enzyme which allow it to combine with only one substrate.

_____

_____

_____ 2

2. Complete the following word equation for the enzyme catalase.

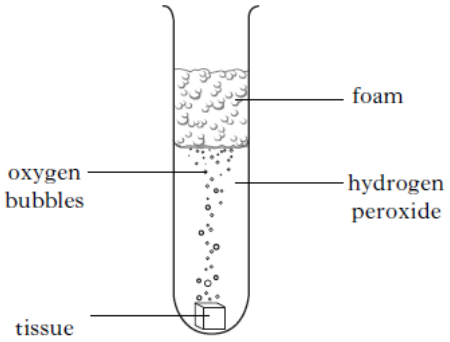
hydrogen peroxide $\xrightarrow{\text{catalase}}$ _____ and _____ 1

substrate **products**

3. Enzymes are described as "biological catalysts".
What is the meaning of the term "catalyst"?

4. Name the substance from which enzymes are made.

5. Catalase enzyme releases oxygen from hydrogen peroxide.
Different tissues were tested for catalase activity by adding equal masses of tissue to hydrogen peroxide at pH 7.The height of the foam produced was used as a measure of the volume of oxygen released.



a. The results are shown in the table. Plot a bar chart of the results below.

Type of tissue	Height of foam (mm)
apple	24
potato	28
beef	53
carrot	22
fish	48
chicken	50

b. Beef, fish and chicken tissues produced greater volumes of oxygen than the others. Suggest a hypothesis which could explain this fact.

_____

_____

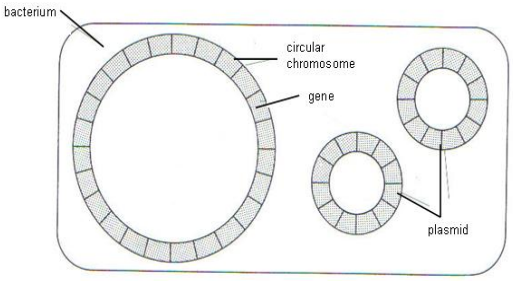
The example of the enzymes given above work at their best in different conditions. You will learn about these different conditions and the factors that affect enzyme activity in S4.

Genetic engineering

So far in this unit you have learned about microorganisms, DNA and enzymes. We are going to look in more depth at a particular use of one type of microorganism (bacteria) and how enzymes can be used to transfer DNA from one organism to another to help manufacture useful products.

Genetic Engineering is the transfer of _____ from one organism to another using Biotechnology. _____ is the use of organisms to develop or make useful products.

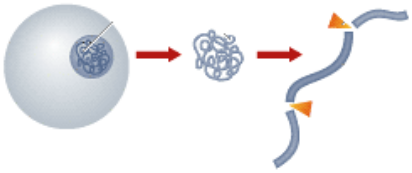
Bacterial cells are frequently used in Biotechnology industries and can be compared to 'tiny factories' as they are able to quickly produce large quantities of the desired products. _____ is an example of a useful protein that can be made using genetic engineering. The insulin produced can be collected and purified and given to people who suffer from _____.



The diagram shows the structure of a bacterial cell. The _____ and _____ are made up of genes (DNA).

A human _____ is made up of thousands of genes made of DNA joined together in a particular order. Remember, DNA carries the instructions to make proteins.

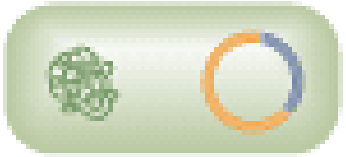
In order to get the bacterial cell to produce the desired protein we must transfer the human _____ that codes for the particular protein, into the _____ (host) cell. We then rely on one of the key properties of microorganisms (rapid growth) to make lots of copies of the bacterial cell, all of which produce the desired _____.



The section of the chromosome that contains the required gene is identified. The gene is then extracted using enzymes.

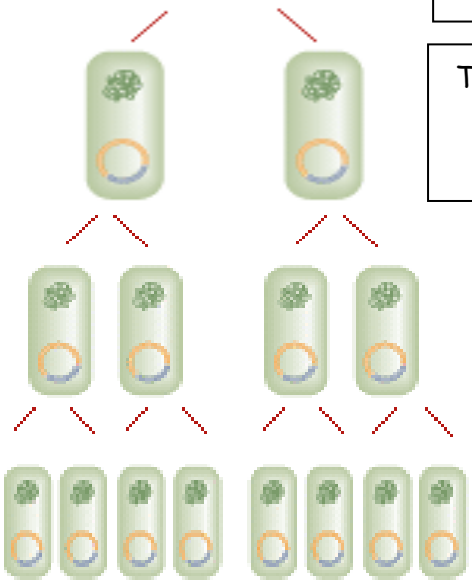
The plasmid (containing bacterial genes) is removed from the bacterial cell and cut open using enzymes.

The human gene (that codes for the desired product) is inserted into the bacterial plasmid using enzymes.



The plasmid containing the human gene is then inserted into the bacterial cell. This bacterial cell is called the **HOST** cell.

The **HOST** cell is now said to be a **GENETICALLY MODIFIED** organism.



The bacteria then reproduce rapidly to make lots of copies of the genetically modified cell that can produce the desired protein.

Activity:
Put the steps of genetic engineering in the table into the correct order.

Genetic engineering	**No.**
Lots of cells exist, all of which make the desired product.	
Genetically modified cell reproduces rapidly to make lots of cells containing the source (human) gene.	
Insert the source (human) gene into the plasmid using enzymes	
Extract the plasmid from the bacterial cell and cut open using enzymes.	
Extract required gene from source (human) chromosome using enzymes to cut the gene out.	
Insert plasmid into HOST cell. Bacterial cell is now GENETICALLY MODIFIED.	
Identify the section of the source (human) chromosome that contains the required gene.	

Other uses of genetic engineering

Genetic engineering is not restricted to microorganisms, scientists have successfully inserted genetic material into multicellular organisms.

Genetic Modification simply involves the transfer of genes from one organism into another OR the changing of an organism's genes in order to achieve a desired characteristic.

Arctic fish DNA

+

Strawberry

=

A strawberry resistant to frost

Rice, corn and tomatoes are common examples of genetically modified (GM) foods. By genetically modifying crops we can give crops new and useful characteristics. Characteristics such as _____ resistance and a _____ shelf life are useful in crops.

Although genetic engineering is useful, it is also considered a _____ biological issue. This means that there is some debate about the ethics of the scientific research. Some individuals question whether genetically modified foods are _____ to eat.

Another ethical debate concerns genetically engineered plants intended to produce _____.

This process is considered controversial and has several associated ethical issues:

- Although not intended for food, these plants may harm animals if they enter the food chain and are eaten.
- Modified plants could cross-pollinate with unaltered plants.
- The modified plants could pose a threat to biodiversity.

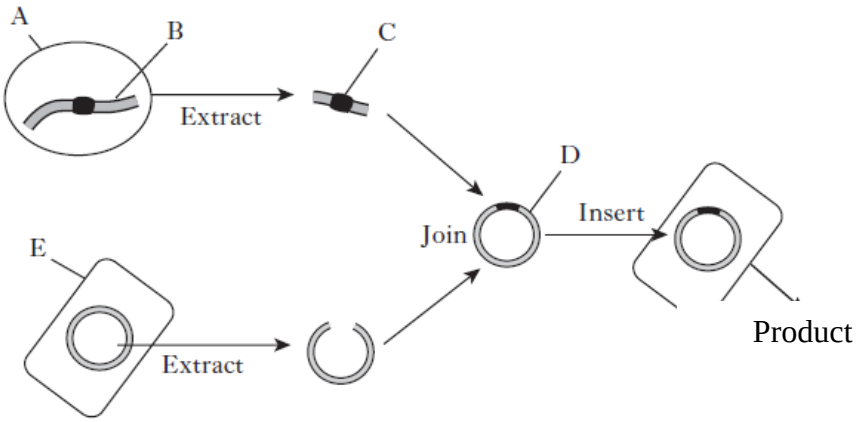
Activity 1:
Genetic engineering debate.

Activity 2:
Research genetic engineering and make a presentation that shows the ethical issues associated with genetic engineering.

What are your opinions on genetic engineering and genetically modified organisms?

Activity 3:
Try the example questions below

1. The diagram below represents some of the stages of genetic engineering which are used to produce medicines such as insulin for human use.



Match the correct letter to the parts below.

- Bacterial cell-
- Insulin gene-
- Plasmid-

2. The following is a list of steps involved in the commercial production of human insulin by bacteria. However, the steps are not shown in the correct order.

A. Gene for human insulin is inserted into bacterium.

B. Human insulin is extracted and purified.

C. Gene for human insulin is isolated.

D. Bacterial plasmid is opened with an enzyme

E. Bacteria are grown and human insulin is produced

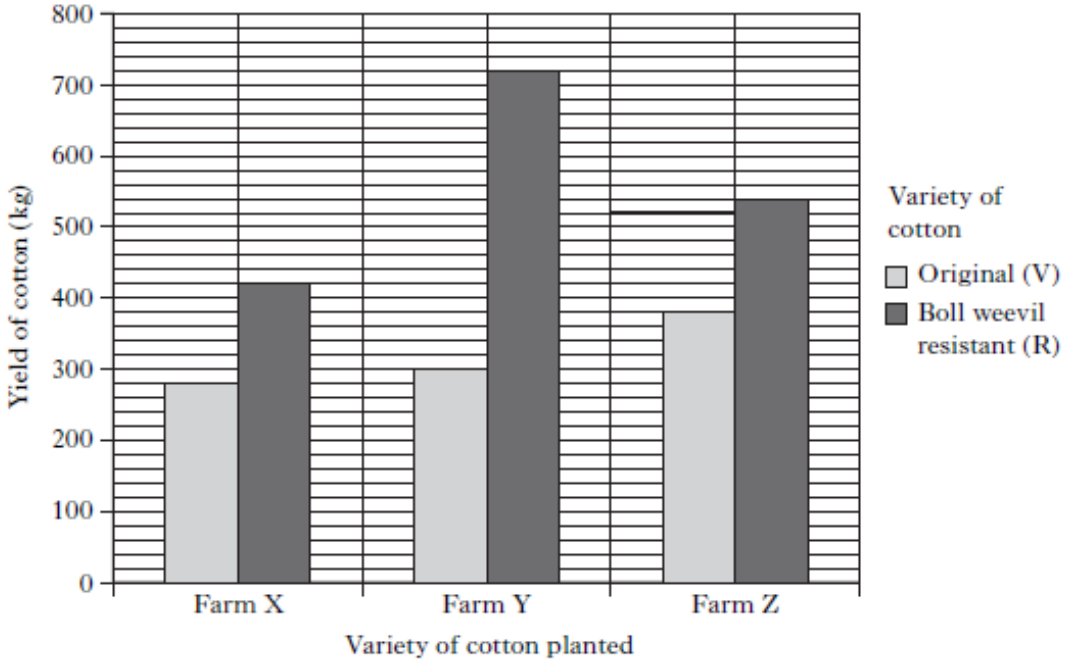
F. Bacterial plasmid containing human insulin is sealed using an enzyme.

Insert letters into the boxes below to complete the correct order of the steps. The first step has been done for you.

C	→		→		→		→		→	

3. Boll weevil insects, shown in the picture below, feed on cotton plants. There are two varieties of cotton plant, original variety (V) and boll weevil resistant variety (R). The resistant variety has been produced using genetic engineering.

Three farms were used to compare the yield of the two varieties. Each farmer planted two fields, one of each variety. All fields were treated identically. The yield of cotton from each field was weighed. The results are shown in the bar graph below.



a. Calculate the average yield of V cotton.

_____ kg

b. Calculate the percentage increase in yield between growing the resistant and original varieties of cotton at Farm X.

_____ %

c. Explain why using ten farms instead of three would have improved this investigation.

_____

_____

d. What conclusion can be drawn from these results?

_____