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GCSE Biology

AQA Topic – Infection and Response

Overview
Infection and Response

Communicable diseases

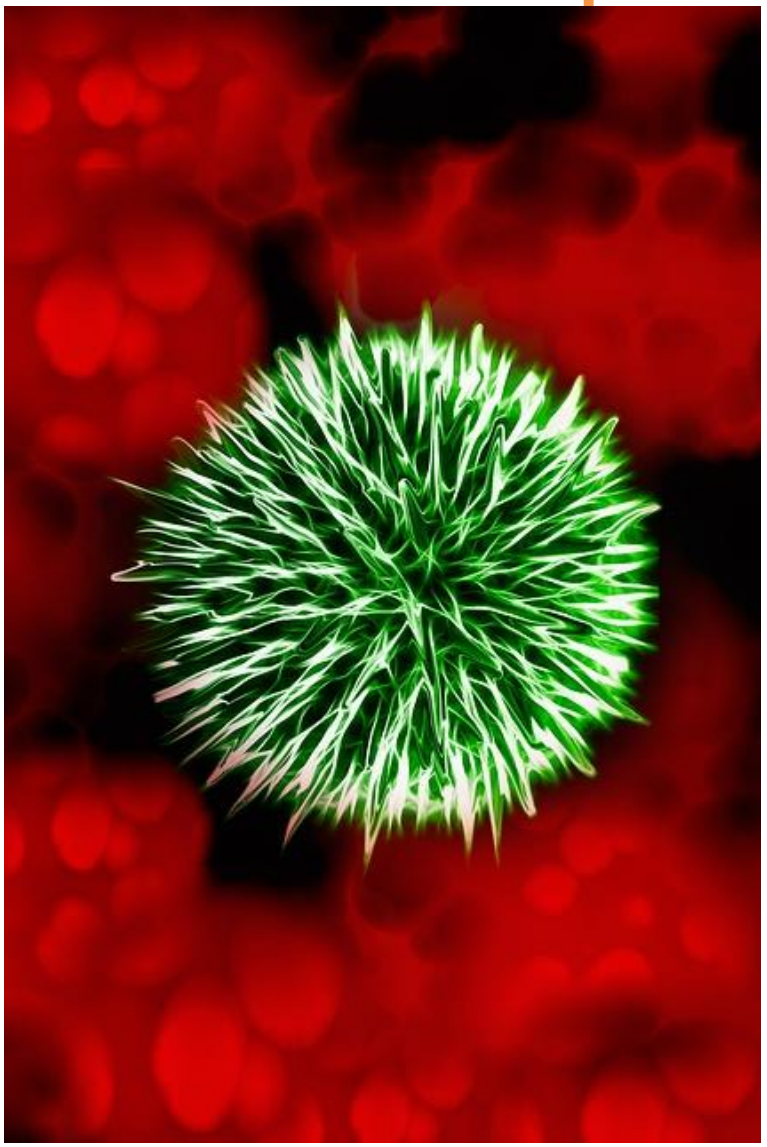
- Communicable (infectious) diseases
- Viral diseases
- Bacterial diseases
- Fungal diseases
- Protist diseases
- Human defence systems
- Vaccination
- Antibiotics and painkillers
- Discovery and development of drugs

Monoclonal Antibodies (Biology HT only)

- Producing monoclonal antibodies
- Uses of monoclonal antibodies

Plant Disease (Biology only)

- Detection & identification of plant diseases
- Plant defence responses



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Infection and Response Part 1

- Communicable diseases
- Viral diseases
- Bacterial diseases
- Fungal diseases
- Protist diseases

Infection and Response part 1 – Infectious diseases

Pathogens are **micro organisms** that cause **infectious disease.**

Pathogens may **infect** **plants or animals** and can be **spread** by **direct contact,** by **water** or by **air.**

Pathogens **depend** on the **host** to provide the suitable **conditions and nutrients** that they need to **grow and reproduce.**

Pathogens can be **bacteria, viruses, fungi** or **protists.**

Viral diseases

- **Viruses may reproduce rapidly**
- **Viruses live and reproduce inside cells causing damage**

Bacterial diseases

- **Bacteria may reproduce rapidly**
- **Bacteria may produce toxins that damage tissues and make us feel ill**

Infection and Response part 1 – Infectious diseases

Pathogens may **infect** **plants or animals** and can be **spread** by **direct contact (D), by water (W)** or **by air (A).**

Examples of Viral Diseases

Measles

- Symptoms of fever and a **red skin rash**
- Can be **fatal** if complications occur
- Spread by **inhaling** droplets containing the virus from sneezes and coughs
- It is controlled by vaccinating young children

HIV

- Initially causes a **flu-like** illness and spread by **sexual contact** or exchange of body fluids such as blood when drug users share needles
- Unless HIV is successfully controlled with **antiretroviral** drugs, the virus will attack the body's immune cells
- Late stage HIV or **AIDS** occurs when the body's immune system can no longer deal with other infections or cancers

Tobacco Mosaic virus

- Common plant virus which enters through a damaged epidermis
- Seen as a distinct **mosaic** discolouration pattern on the leaves
- Affects **growth** as **photosynthesis** cannot occur as efficiently
- Control by removing affected leaves and destroying pests which caused initial epidermal damage

Examples of Bacterial Diseases

Salmonella

- Salmonella food poisoning is spread by bacteria **ingested** in food or on food prepared in **unhygienic** conditions.
- Bacteria secrete **toxins** and cause symptoms including fever, abdominal cramps, diarrhoea and **vomiting.**
- In the UK, **poultry** are **vaccinated** against salmonella to **control** the spread of the disease.

Gonorrhoea

- Sexually transmitted disease **(STD)** caused by bacteria.
- Causes a thick yellow or **green discharge** from the **penis or vagina** and pain when urinating.
- Can be controlled with **antibiotics** or barrier methods of contraception such as a **condom.**
- Easily treated with the antibiotic **penicillin** until many **resistant bacterial** strains were found.

Infection and Response part 1 – Fungal and Protist diseases

Example of a Fungal Disease

Rose Black Spot

- Purple or black spots develop on leaves
- Leaves often turn yellow and drop off
- **Photosynthesis** is reduced. Growth is affected as a result
- Fungal **spores spread** by wind or water
- Treat by **removing** infected leaves and burning them
- Spray with **fungicide** (a pesticide which is used to kill fungus)

Example of a Protist Disease

Malaria

- The malaria causing **protist** is spread by **mosquitoes** feeding on infected blood and then biting a human
- Mosquitoes are **vectors** as they pass on malaria but do not suffer themselves
- Symptoms include **recurrent fever** and malaria can be fatal
- Control the **spread** by preventing mosquitoes **breeding** and use mosquito **nets** to avoid being bitten

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Infection and Response part 1 – Types of diseases

Disease	Symptom	Method of transmission	Control spread of disease by:	Caused by:
Malaria	Recurrent fever	By a vector from an infected person	Preventing breeding of mosquitoes or use of a net to prevent being bitten	**Protist**
Tobacco Mosaic Virus	Mosaic pattern on leaves	Enters via wounds in epidermis caused by pests	Remove infected leaves and control pests which are damaging leaves	**Virus**
Measles	Fever Red skin rash	Droplet infection from sneezes and coughs	Child Vaccination	**Virus**
Gonorrhoea	Green discharge from penis or vagina	Direct sexual contact or body fluids	Use of a condom and treat infected person with antibiotics	**Bacteria**
Rose Black Spot	Purple black spots on leaves	Spores carried via wind or water	Remove infected leaves and spray with pesticide	**Fungus**
Salmonella	Fever, cramp, vomiting, diarrhoea	Food prepared in unhygienic conditions or not cooked properly	Improve food hygiene, wash hands, vaccinate poultry, cook food thoroughly	**Bacteria**

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QuestionIT!

Communicable diseases Part 1a

- Viral diseases
- Bacterial diseases
- Fungal diseases
- Protist diseases

Infection and Response part 1 – QuestionIT

1. What is the definition of a pathogen?

2. List four types of micro-organism which can act as pathogens.

3. Copy and complete the table to describe one similarity and one difference between how bacteria and viruses act as pathogens.

Pathogen	Similarity	Difference
Bacteria		
Virus		

4. What do pathogens need from the host organism?

5. Complete the sentences:

HIV can be successfully controlled with _____drugs. If the immune system is badly damaged then _____ may develop.

Infection and Response part 1 – QuestionIT

6. Copy and complete the table for each disease.

Disease	Symptom	Method of transmission	Control spread of disease by:	Caused by:
Measles	Fever Red skin rash		Child Vaccination	
	Fever, cramp, vomiting, diarrhoea	Food prepared in unhygienic conditions or not cooked properly		**Bacteria**
Rose Black Spot	Purple black spots on leaves		Remove infected leaves and spray with pesticide	
Gonorrhoea		Direct sexual contact or body fluid exchange	Use of a condom and treat infected person with antibiotics	**Bacteria**
	Recurrent fever	By a vector from an infected person	Preventing breeding of mosquitoes or use of a net to prevent being bitten	
Tobacco Mosaic Virus	Mosaic pattern on leaves			**Virus**

Infection and Response part 1 – QuestionIT

7. Look at this photograph.
Suggest how pathogens could be transferred in this situation.
What could people do to reduce the spread of pathogens?

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AnswerIT!

Communicable diseases Part 1

- Viral diseases
- Bacterial diseases
- Fungal diseases
- Protist diseases

Infection and Response part 1 – AnswerIT

1. What is the definition of a pathogen?

Micro-organisms which cause infectious disease in animals & plants.

2. List four types of micro-organism which can act as pathogens.

Bacteria, Virus, Protist, Fungus.

3. Copy and complete the table to describe one similarity and one difference between how bacteria and viruses act as pathogens.

Pathogen	Similarity	Difference
Bacteria	**Reproduce rapidly inside the body**	**Produce toxins that damage tissues**
Virus	**Reproduce rapidly inside the body**	**Live and reproduce inside cells causing cell damage**

4. What do pathogens need from the host organism?

Suitable conditions and nutrition to be able to grow and reproduce.

5. Complete the sentences:

HIV can be successfully controlled with **antiretroviral** drugs. If the immune system is badly damaged then **AIDS** may develop.

Infection and Response part 1 – AnswerIT

6. Copy and complete the table for each disease.

Disease	Symptom	Method of transmission	Control spread by:	Caused by:
Measles	Fever Red skin rash	**Droplet infection from sneezes and coughs**	Child Vaccination	**Virus**
Salmonella	Fever, cramp, vomiting, diarrhoea	Food prepared in unhygienic conditions or not cooked properly	**Improve food hygiene, wash hands, vaccinate poultry, cook food thoroughly**	**Bacteria**
Rose Black Spot	Purple black spots on leaves	**Spores carried via wind/water**	Remove infected leaves and spray with pesticide	**Fungus**
Gonorrhoea	**Green discharge from penis or vagina**	Direct sexual contact or body fluids	Use of a condom and treat infected person with antibiotics	**Bacteria**
Malaria	Recurrent fever	By a vector from an infected person	Preventing breeding of mosquitoes or use of a net to prevent being bitten	**Protist**
Tobacco Mosaic Virus	Mosaic pattern on leaves	**wounds in epidermis caused by pests**	**Remove infected leaves and control pests which are damaging leaves**	**Virus**

Infection and Response part 1 – AnswerIT

7. Look at this photograph.
Suggest how pathogens could be transferred in this situation.
What could people do to reduce the spread of pathogens?

Direct contact by touching a contaminated surface.
Droplet infection if someone sneezes or coughs in the lift.
Air - if fungal spores are present.

Could reduce the spread by:
Hand over mouth if coughing and then washing.
Use a tissue if sneezing and then dispose of it and wash hands.
Washing hands with soap after visiting the toilet.
Wear a face mask.

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Infection and Response
Part 1b

- Human defence systems
- Vaccination
- Antibiotics and painkillers
- Discovery and development of drugs

Infection and Response part 1 – Human Defence Systems

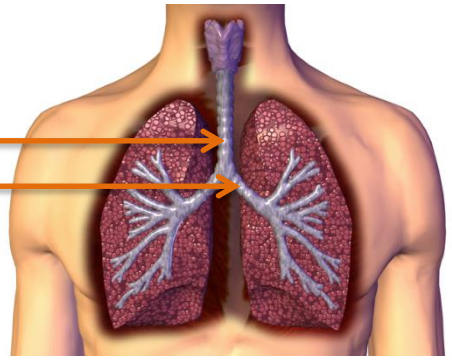
The human body has several non specific ways of defending itself from pathogens getting in.

video

nose

Nasal hairs, sticky mucus and cilia prevent pathogens entering through the nostrils.

trachea
bronchus

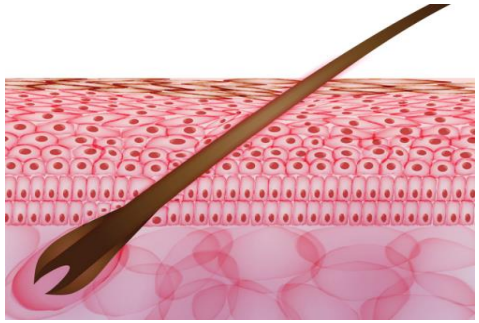


Respiratory system is lined with mucus to trap dust and pathogens. Cilia move the mucus upwards to be swallowed.

stomach

Stomach acid (pH1) kills most ingested pathogens

skin



Hard to penetrate waterproof barrier. Glands secrete oil which kill microbes.

Infection and Response part 1 – Human Defence Systems

Sometimes pathogens gain entry to the body.
The **immune system** takes over to destroy them.
The **white blood cells** are part of the immune system. **Pathogens** are identified by white blood cells because they have different surface proteins. We call these surface proteins **antigens.**

White blood cells act in **3** ways to **defend** the body:

1. White blood cells (called **phagocytes**) engulf the pathogens and digest them. This is called **phagocytosis**. Video phagocytes
2. White blood cells (called **lymphocytes**) identify the **antigen** on the pathogen. They make **specific antibodies** to destroy the pathogens. This can take time and so an infection may occur. If a person is **infected again** by the same pathogen, the white blood cells make the **antibodies** much **faster.** Video lymphocytes
3. Bacteria may produce toxin (poison). White blood cells release specific **antitoxins** to **neutralise** the effect of the toxin.

Infection and Response part 1 – Vaccination

Communicable diseases can be dangerous leading to epidemics or pandemics. **Vaccination** can be used to **enhance** the immune system to reduce the chances of this happening. A vaccine contains a small amount of **dead or inactive** form of the pathogen that can be introduced into the body.

Lymphocyte

pathogen

White blood cells detect pathogens in the vaccine.

→

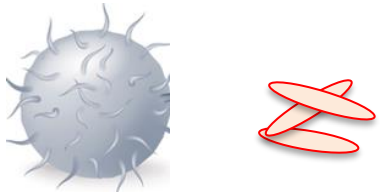
Antibodies are released into the blood.

→

Pathogens are destroyed by antibodies.

Infection and Response part 1 – Vaccination

If the body becomes **re-infected** with the same pathogen then the white blood cells are prepared.
The white blood cells can respond much more **quickly** and make **more** of the right type of **antibodies** much more quickly.



White blood cells detect pathogens.

Antibodies are made and released into the blood much faster and in larger amounts.

Pathogens are destroyed by the antibodies much faster.

This means that the person is **unlikely to suffer** the symptoms of the harmful disease.
Infection has been prevented by **enhancing** the immune system.

Infection and Response part 1 – Antibiotics

An **antibiotic** is a drug that helps to cure a bacterial disease by killing the infective bacteria **inside** the body.

Different bacterial infections need a **different** antibiotic.

Antibiotics **cannot** be used to **treat viral** pathogens.

Penicillin is a well known antibiotic medicine.

Using antibiotics has greatly **reduced** deaths.

It is difficult to develop **drugs** to kill **viruses** without harming body tissues because viruses live and reproduce inside cells.

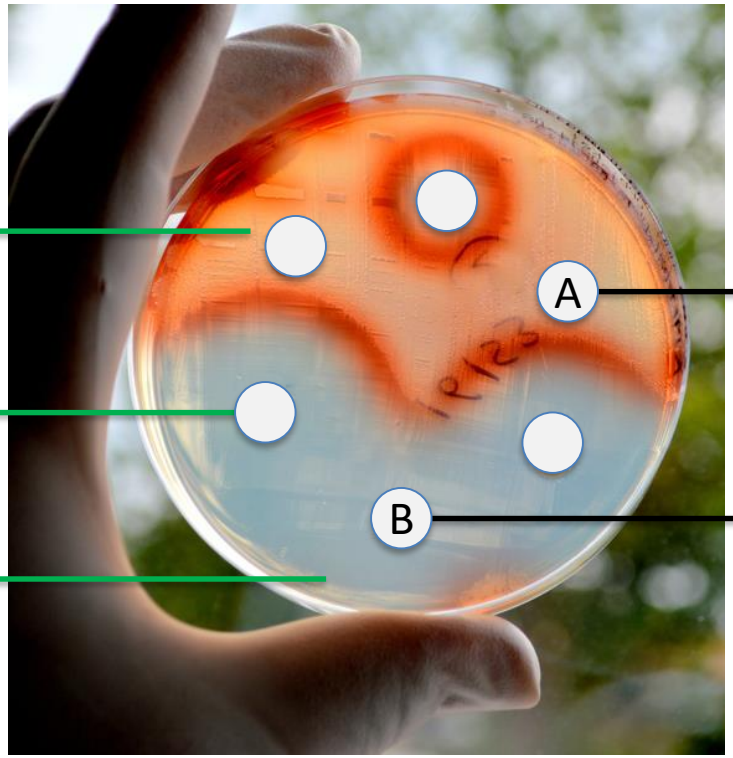
Infection and Response part 1 – Antibiotics

Bacteria can **mutate**.
Sometimes this makes them **resistant** to antibiotic drugs.
The **mutated** bacteria are **not killed**. Increasing numbers of different bacteria are becoming resistant and this is **of concern**.

Red = bacteria colonies

Disc soaked in antibiotic

Clear = no bacterial colonies



Bacteria are resistant to antibiotic A

Bacteria are killed by antibiotic B

Infection and Response part 1 — Painkillers

A doctor will **not prescribe** antibiotics for a **viral infection** as they do not work.

Antibiotics can only be used for **bacterial infections**

Painkillers, steroids or anti inflammatory medicines can be used to **relieve** the **symptoms** of viral infections. Symptoms may include: fever, muscle ache, headache or a runny nose.

Painkillers **do not** kill pathogens.

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QuestionIT!

Infection and Response
Part 1b

- Human defence systems
- Vaccination
- Antibiotics and painkillers

Infection and Response – QuestionIT

1. Name and describe 3 ways the human body defends against the entry of pathogens.

2. Draw a series of pictures to show how white blood cells carry out phagocytosis.

3. What is an antigen?

4. Why will the antibody produced for measles not be effective in other diseases?

5. Why are dead or inactive pathogens used in a vaccine?

6. What happens if the live pathogen invades the body after being vaccinated?

7. What is an antibiotic and what is it used for?

8. Why is there a growing concern about bacterial resistance to antibiotics?

9. Which one of these statements is true?

Painkillers are used to treat the symptoms of a disease and kill the pathogens which cause it.

Painkillers are used to kill the pathogens causing a disease.

Painkillers are used to treat the symptoms of a disease but do not kill the pathogens.

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AnswerIT!

Infection and Response Part 1b

- Human defence systems
- Vaccination
- Antibiotics and painkillers

Infection and Response – AnswerIT

1. Name and describe 3 ways the human body defends against the entry of pathogens. **Skin – barrier, nose - nasal hairs , mucus and cilia, trachea & bronchi – mucus to catch, cilia to remove from lungs, stomach - HCl acid kills.**

2. Draw a series of pictures to show how white blood cells carry out phagocytosis. **Diagram of white blood cell moving towards and engulfing foreign body and then adding digestive enzymes.**

3. What is an antigen? **A protein on the surface of a pathogen.**

4. Why will the antibody produced for measles not be effective in other diseases? **Antibody has a specific shape which fits with a specific antigen.**

5. Why are dead or inactive pathogens used in a vaccine?

To stimulate white blood cells to make antibodies without causing the disease.

6. What happens if the live pathogen invades the body after being vaccinated?

White blood cells able to respond much faster and produce more antibodies quicker to destroy the pathogens so the person doesn't suffer the symptoms of the disease.

7. What is an antibiotic and what is it used for?

Kills bacteria inside the body without harming human cells.

8. Why is there a growing concern about bacterial resistance to antibiotics? **The resistant bacteria are not killed and can continue to multiply inside the body making the person very ill and infecting others too.**

9. Which one of these statements is true?

Painkillers are used to treat the symptoms of a disease and kill the pathogens which cause it

Painkillers are used to kill the pathogens causing a disease

Painkillers are used to treat the symptoms of a disease but do not kill the pathogens.

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Infection and Response Part 2

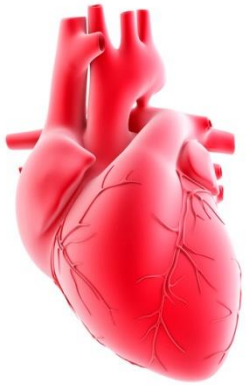
- Discovery of Drugs
- Development of Drugs
- Monoclonal Antibodies (Biology HT only)

Infection and Response part 2 – Discovery & drug development

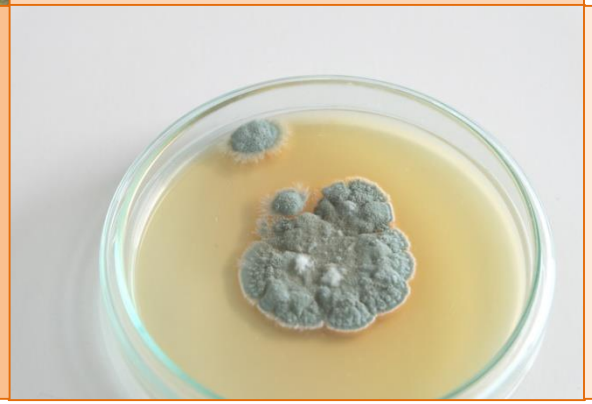
Traditionally drugs were extracted from plants and micro-organisms. video

Aspirin is a painkiller and anti-inflammatory drug. This was first found in **willow bark**.

Foxglove plants have been a source of the drug digitalis which acts on the **heart**.



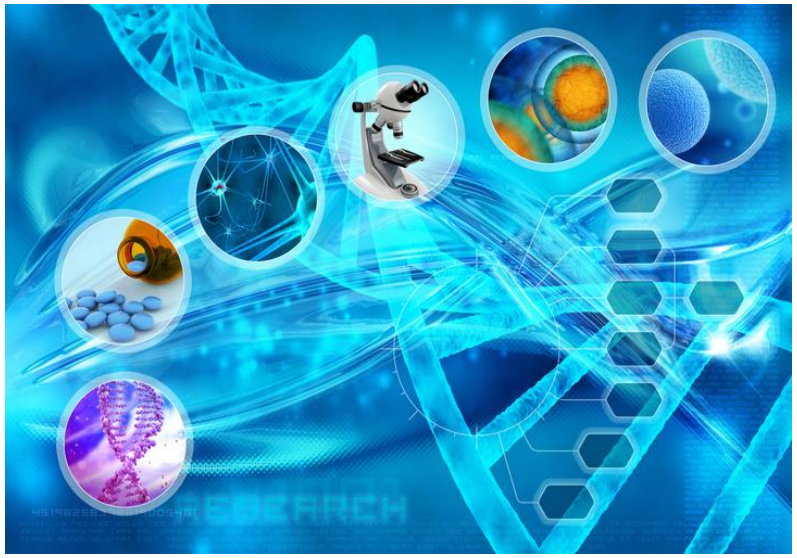
Alexander Fleming is famous for discovering ***Penicillium*** mould.



Fleming noticed the fungus on unwashed equipment and went on to discover its antibiotic properties.

Infection and Response part 2 – Development of drugs

Most **new drugs** are **developed** and **synthesised (made)** in a laboratory by chemists in the pharmaceutical industry. The initial chemical may have been sourced from a plant.



New drugs must be tested and trialled to check:

- ✓ **Efficacy** - that the drugs work
- ✓ **Toxicity** - that the drug is not poisonous
- ✓ **Dose** - the most suitable **amount** to take

Preclinical tests must be carried out before humans are allowed to take the drug.

These preclinical tests are done on **cells**, **tissue** samples and live **animals**.

Infection and Response part 2 – Drug development

If successful the new drug will proceed to a **clinical trial**.

The stages of a clinical trial are:

Stage 1

- Healthy volunteers try small doses of the drug to check it is **safe** and has **no side effects**

Stage 2

- A small number of **patients** try the drug at a **low dose** to see if it works

Stage 3

- A larger number of patients take the new drug and different doses are trialled to find the **optimum dose**

Stage 4

- **A double blind trial** will occur to see how effective the new drug is. The patients are divided into groups

video

Infection and Response part 2 – Drug development

A **double blind trial** is carried out on **patients** who **have** the **disease** to make sure that it is actually the drug which is having an effect on the patients and not anything else.

The details of everyone taking part in the trial is entered into a computer database. The computer groups people **randomly**.

Each person receives a unique code and they receive the medicine which is labelled with the matching code.

No-one knows who is receiving the real drug or a **placebo** until the end of the trial.

The **placebo** is often the drug the patient was originally taking so they still receive medical treatment.

Monoclonal antibodies are identical copies of **one** type of **antibody** produced in a laboratory.

How to produce monoclonal antibodies:

1. A mouse is **injected** with a pathogen

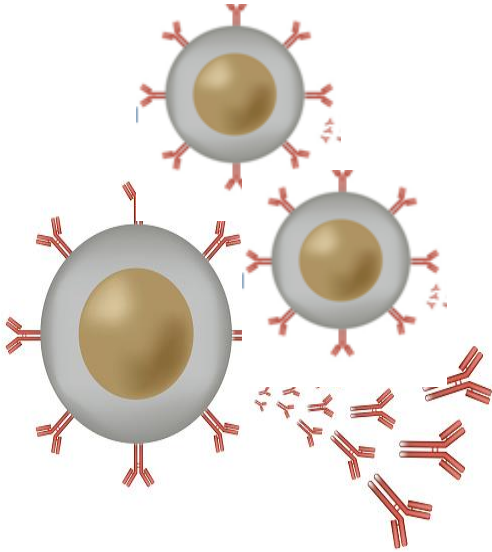
2. White blood cells called **lymphocytes** produce **antibodies**

3. Lymphocytes are removed from the mouse and **fused** with rapidly dividing mouse **tumour cells**

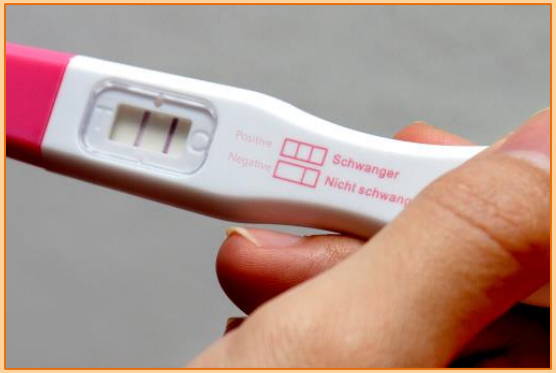
4. The new cells are called **hybridomas**.

5. The hybridomas divide rapidly and release lots of **antibodies** which are then collected.

Mono = one



Monoclonal antibodies are **specific** to one **binding site** on the **antigen**.
This means that we can use monoclonal antibodies to **target** a specific **chemical** or specific **cells** in the body.



During pregnancy, a **hormone called HCG** is released into the blood. **Monoclonal antibodies** can detect the presence of this chemical at low levels and are used in **pregnancy testing kits.**

Monoclonal antibodies are also used in treating some **cancers**.

- The monoclonal antibodies are **specific** to the antigen on the cancer cells.
- A chemical which **stops cells dividing** can be bound to the monoclonal antibodies.
- The patient is given the monoclonal antibodies and they attach to **receptors** on the cancer cells.
- The chemical **stops** the cancer cells growing and dividing.

Infection and Response part 2 – Monoclonal antibodies (Biology HT)

Monoclonal antibody research has raised some concerns about their **ethical** use.

Mice are injected with pathogens and so they will **experience** the **disease** symptoms.

Mice provide antibody producing cells and tumour cells. Mice are **induced** with **cancer** to get the tumour cells.

Monoclonal antibodies have been **successful** in treating some cancers and diabetes. But there have been **deaths** when used to treat patients with **multiple sclerosis** (MS).

Herceptin is used for breast cancer. It is **not toxic** and is **specific** to breast cancer cells so **few side effects**. But it is **costly**.

QuestionIT!

Infection and Response Part 2

- Discovery of Drugs
- Development of Drugs
- Monoclonal Antibodies (Biology HT only)

1. Choose the answer from the box to complete the sentences.

Willow tree bark	Foxgloves	Laboratory	Mould

Digitalis is a drug used for heart conditions.

It originates from _____.

Aspirin is a drug used as a painkiller.

It originates from _____.

Penicillin is an antibiotic drug.

It originates from _____.

2. Any potential new drug has to go through a series of tests.

   What is meant by the following terms?

   a) Efficacy b) Toxicity c) Optimum dose

3. Number these statements to show how drugs are tested.

   Drugs are trialled on live animals

   Drugs are trialled on people with the disease the drug is for

   Drugs are trialled in laboratories on cells and tissue cultures

   Drugs are trialled on healthy volunteers

4. Drugs companies often use a placebo in their trials.

   a. What is a placebo? b. Why is it used?

Questions for Biology HT only

5. Place the statements in the correct order to show how monoclonal antibodies are produced.

- ❑ Mouse lymphocytes produce antibodies.
- ❑ The antibodies are collected and purified.
- ❑ Mouse lymphocytes are collected.
- ❑ Mouse is injected with a pathogen.
- ❑ Hybridoma cells are separated and cultured to form a clone.
- ❑ Mouse lymphocyte and mouse tumour cell are fused.
- ❑ The clone produces large quantities of antibody.

6. What are the applications of monoclonal antibodies?

7. Why do some people feel the use of monoclonal antibodies is unethical?

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AnswerIT!

Infection and Response Part 2

- Discovery of Drugs
- Development of Drugs
- Monoclonal Antibodies (Biology HT only)

Infection and Response – AnswerIT

1. Choose the answer from the box to complete the sentences.

Willow tree bark	Foxgloves	Laboratory	Mould

Digitalis is a drug used for heart conditions.

It originates from **Foxgloves.**

Aspirin is a drug used as a painkiller.

It originates from **willow tree bark.**

Penicillin is an antibiotic drug.

It originates from **mould.**

2. Any potential new drug has to go through a series of tests.

   What is meant by the following terms?

   a) Efficacy **how effective the drug is**

   b) Toxicity **how poisonous the drug is**

   c) Optimum dose **minimum amount of the drug which provides the best response**

3. Number these statements to show the process of drug testing.

   2. *Drugs are trialled on live animals*

   4. *Drugs are trialled on people with the disease the drug is for*

   1. *Drugs are trialled in laboratories on cells and tissue cultures*

   3. *Drugs are trialled on healthy volunteers*

4. Drug companies often use a placebo in their trials.

a. What is a placebo?

A medicine that does not contain the drug that is being trialled.

b. Why is it used?

A placebo is used to check that there are no other factors which may cause the patient's condition to improve without the drug.

Questions for Biology HT only

5. Place the statements in the correct order to show how monoclonal antibodies are produced.

2. Mouse lymphocytes produce antibodies.

7. The antibodies are collected and purified.

3. Mouse lymphocytes are collected.

1. Mouse is injected with a pathogen.

5. Hybridoma cells are separated and cultured to form a clone.

4. Mouse lymphocyte and mouse tumour cell are fused.

6. The clone produces large quantities of antibody.

6. What are the applications of monoclonal antibodies?

Pregnancy testing

Used to measure levels of hormones and other chemicals in blood

Treat some cancers by delivering a toxic drug to the cancer cells

To find various molecules in cells or tissues by binding to them with a fluorescent dye

7. Why do some people feel the use of monoclonal antibodies is unethical?

Mouse has to suffer the disease deliberately

Mouse is induced to have cancer

Treatment not always safe

It's very expensive and money could be better used

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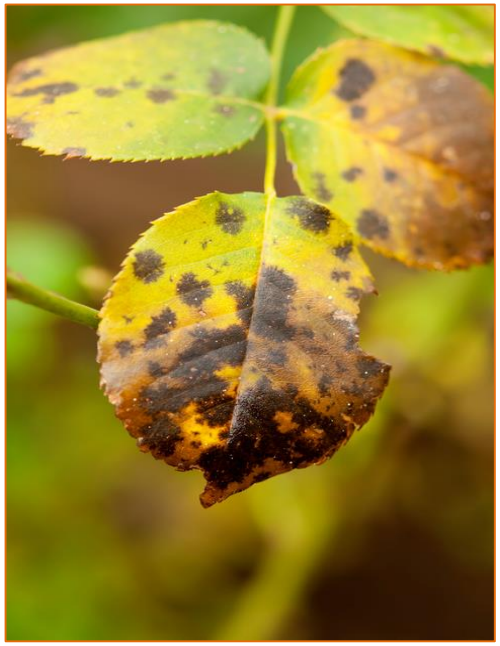
Infection and Response
Part 3

- Plant Disease (biology only)

Infection and Response part 3 – Plant disease (Biology HT)

Plants suffer from a range of infections caused by pathogens or insect pests. We can detect a plant is diseased by these signs:

Unusual **growths**



Spots or discoloured leaves

Malformed leaves or stems

Infection and Response part 3 – Plant disease (Biology HT)

The presence of **pests**

Stunted growth

Areas of **decay** (rot)

If a plant disease is suspected then it may be **identified** using:

- ✓Gardening manuals
- ✓Gardening websites
- ✓ Test kits containing **monoclonal antibodies**
- ✓Taking infected plants to a laboratory to identify the pathogen

Infection and Response part 3 – Plant disease (Biology HT)

Healthy plants need **mineral ions.**
Nitrate ions are needed in **protein synthesis** and hence growth.
Horticulturists use knowledge about the effect of **ion deficiencies** to supply plants with optimum conditions.

Nitrate ions = healthy growth

Lack of nitrate = stunted growth

Magnesium = healthy chlorophyll

Lack of magnesium = chlorosis (yellowing of leaves due to lack of chlorophyll)

Infection and Response part 3 – Plant disease (biology only)

Plants have several ways of defending themselves from pathogens and to deter herbivores.

video

Physical

Thick waxy layers, tough cellulose cell walls and bark defend the plant from pathogen entry

Mechanical

Touch can make Mimosa leaves suddenly curl which frightens animals

Chemical

Antibacterial and poisonous chemicals are found in many plants like witch hazel.

Mechanical

Thorns make plants painful to be eaten

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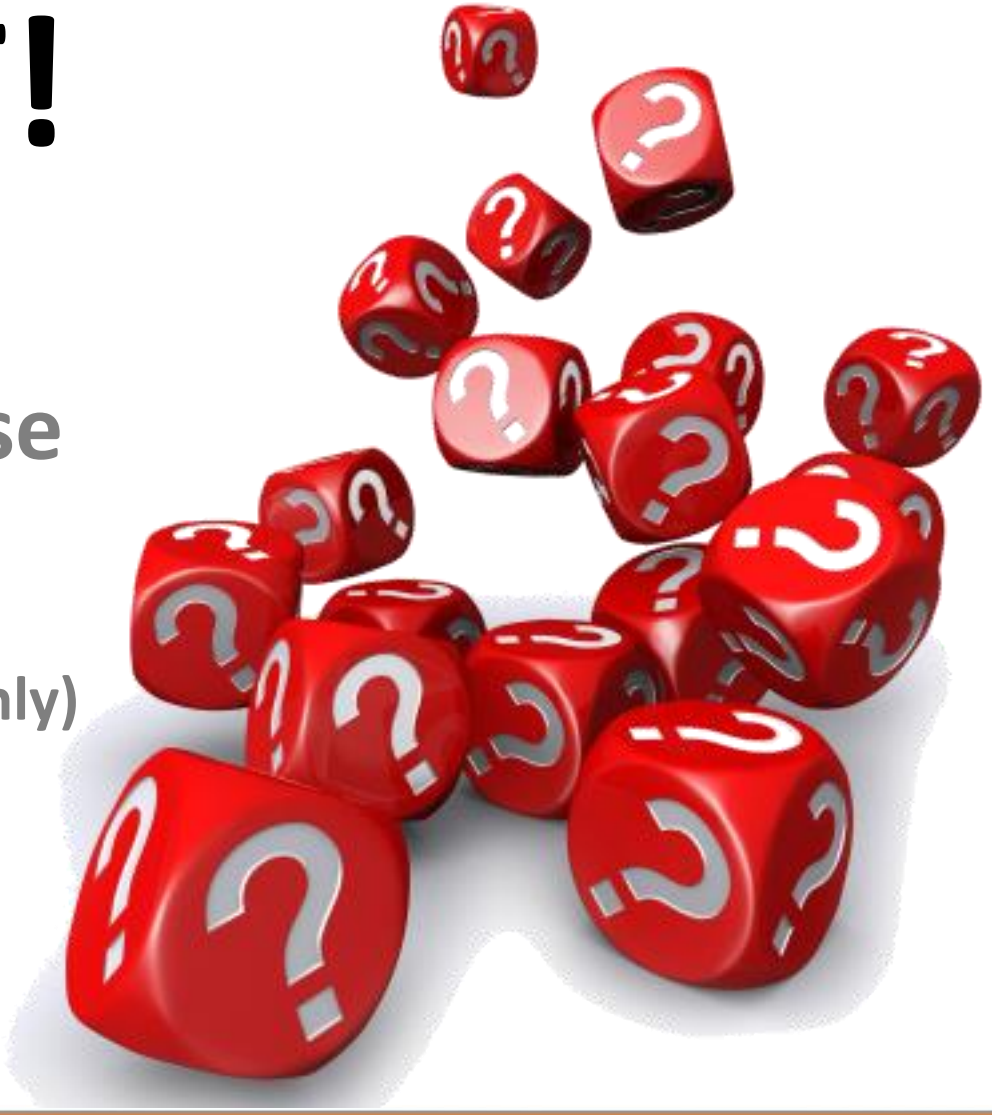
QuestionIT!

Infection and Response Part 3

- Plant Disease (biology HT only)



Infection and Response part 3 – QuestionIT

1. Name 3 ways you can detect that a plant is diseased.

2. Copy and complete the table below:

Type of plant defence used (Mechanical, physical or chemical)	What is the plant being defended from?	Describe the defence being used
	Herbivores eating it	Thorns or hairs
Chemical		The chemical released is antibacterial
	Herbivores and pathogen entry	Dead bark coating which falls off
Physical	Insects such as aphids	

Infection and Response part 3 – QuestionIT

3. Describe why nitrate ions are very important for plants.

4. What is chlorosis and how can it be prevented?

5. Why would a test kit containing monoclonal antibodies be useful to detect plant disease?

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AnswerIT!

Infection and Response Part 3

- Plant disease (biology only)

Infection and Response part 3 – AnswerIT

1. Name 3 ways you can detect that a plant is diseased.

leaf spots/discolouration, growths, malformed stems or leaves, presence of pests, stunted growth, areas of decay (rot)

2.

Type of plant defence used (mechanical, physical or chemical)	What is the plant being defended against?	Describe the defence being used
Mechanical	Herbivores eating it	Thorns or hairs
Chemical	**Pathogens/bacteria Herbivores/animals**	The chemical released is antibacterial or poisonous
Physical	Herbivores and pathogen entry	Dead bark coating which falls off
Physical	Insects such as aphids	**Waxy cuticle/cellulose cell walls are hard to penetrate**

Infection and Response part 3 – AnswerIT

3. Describe why nitrate ions are very important for plants.
   Nitrate is crucial for protein synthesis and hence growth. Without sufficient nitrate ions, the plant would be stunted.
4. What is chlorosis and how can it be prevented?
   Chlorosis is the yellowing of the leaves. It can be prevented by providing the plant with magnesium.
5. Why would a test kit containing monoclonal antibodies be useful to detect plant disease?
   The monoclonal antibodies can be used to detect a particular chemical which is only present in one type of pathogen. This would then show whether the plant was infected with this disease or not.

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GCSE Biology

AQA Topic – Bioenergetics

Overview
Bioenergetics

Photosynthesis

- Photosynthetic reaction
- Rate of photosynthesis
- Use of glucose from photosynthesis

Respiration

- Aerobic and anaerobic respiration
- Response to exercise
- Metabolism

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LearnIT!
KnowIT!

Bioenergetics
Part 1

- Photosynthetic reaction
- Rate of photosynthesis
- Use of glucose from photosynthesis

Bioenergetics part 1 – Photosynthetic reaction

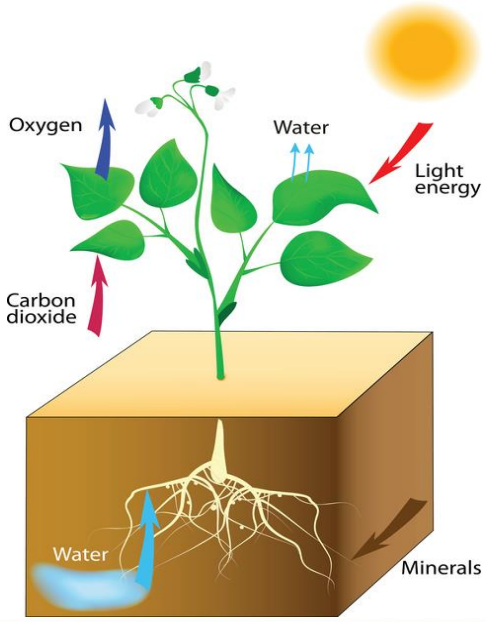
Plants make use of the **Sun's energy** to make **food** (glucose)

This process is called **photosynthesis**.

photo = light **synthesis** = to make

The plant manufactures **glucose** from carbon dioxide and water using **energy transferred** from the environment to the **chloroplasts** by light.

This is an **endothermic** reaction because photosynthesis needs an input of energy from the environment.



Bioenergetics part 1 – Photosynthetic reaction

The **word equation** which represents photosynthesis is:

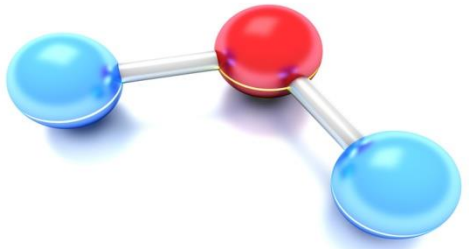
carbon dioxide + water $\xrightarrow{\text{light}}$ glucose + oxygen

The balanced **symbol equation** which represents photosynthesis is:

$6CO_2 + 6H_2O \xrightarrow{\text{light}} C_6H_{12}O_6 + 6O_2$

Molecule name	Chemical Symbol
Carbon dioxide	**CO_2**
Water	**H_2O**
Oxygen	**O_2**
Glucose	**$C_6H_{12}O_6$**

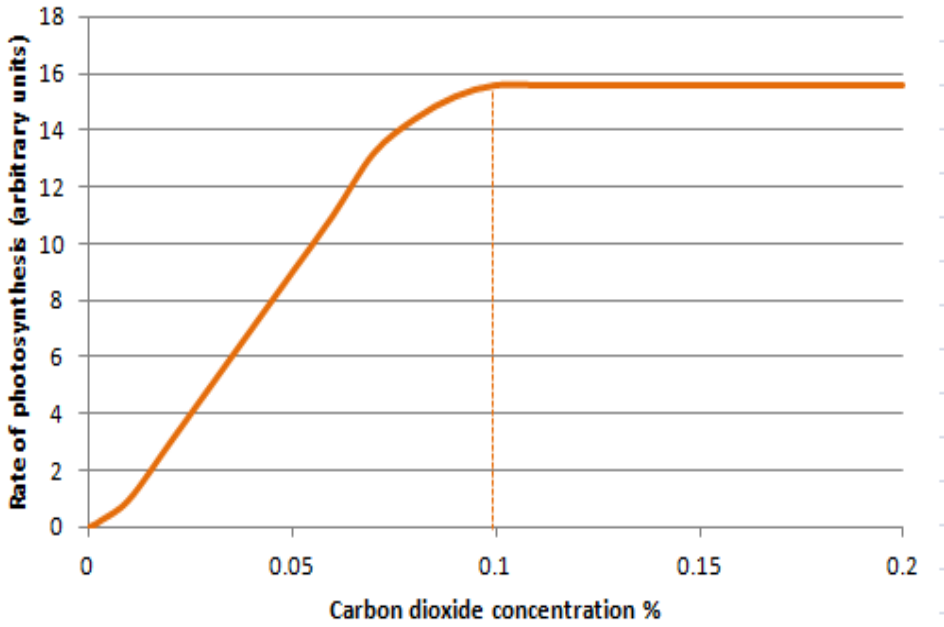
You need to be able to recognise the chemical symbols for these molecules.



Video - Van Helmont's experiments

Bioenergetics part 1 – Rate of photosynthesis

Carbon dioxide is one of the **reactants** needed for plants to make glucose. The **rate** of photosynthesis will **increase** when a plant is given **higher** concentrations of carbon dioxide **up** to a point.



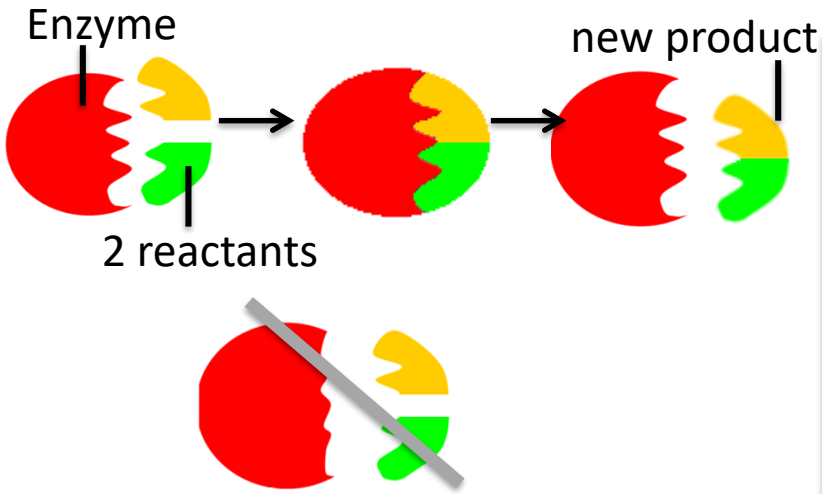
For this plant, the **maximum rate** of photosynthesis is achieved at a concentration of **0.1%** carbon dioxide.

Another factor is now preventing the rate of photosynthesis from increasing. This is called a **limiting factor**.

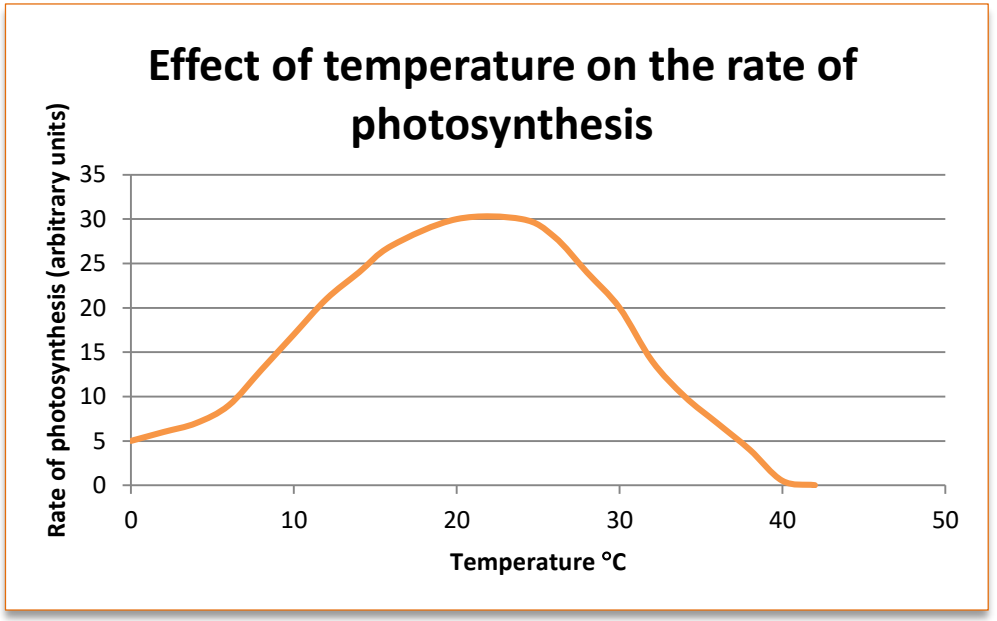
Possible limiting factors could be **light intensity**, **temperature** or amount of **chlorophyll**.

Bioenergetics part 1 – Rate of photosynthesis

Temperature affects the rate of all chemical reactions including photosynthesis. As the environment warms up, chemical reactions speed up. Photosynthesis is an **enzyme controlled reaction**. If the temperature increases too much, then the enzymes become **denatured** and the rate of reaction will **decrease** and stop. **Temperature is a limiting factor of photosynthesis.**



As temperature rises the enzyme is denatured. The active site is damaged so no reaction can occur.



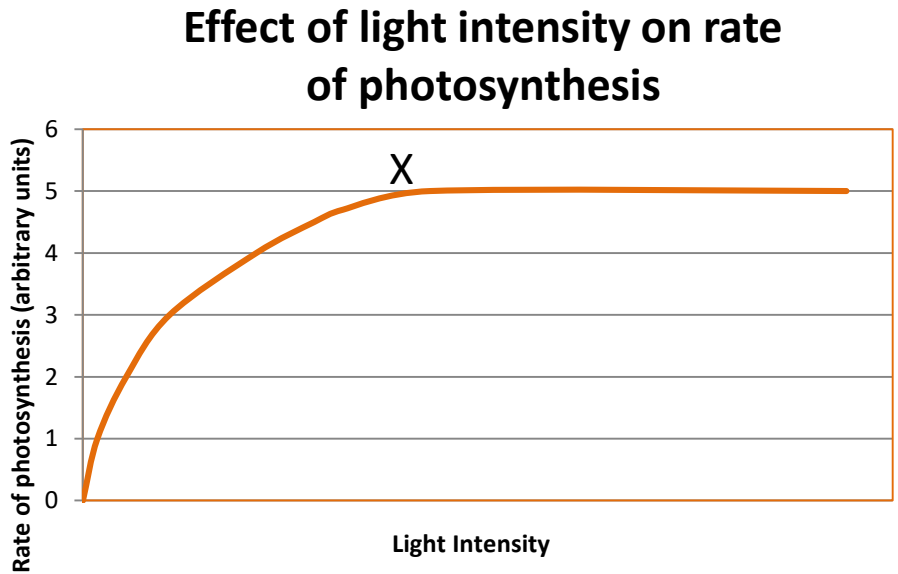
Bioenergetics part 1 – Rate of photosynthesis

The **amount of light** a plant receives affects the rate of photosynthesis. Plants found in areas of lower light do not tend to grow as tall.

Light intensity decreases as the distance between the plant and the light source increases.

The graph shows that as **light intensity increases** so does the **rate** of photosynthesis up to a point. At **point X** another **factor** is **limiting** the rate of photosynthesis. This could be carbon dioxide concentration, temperature or amount of chlorophyll.

Light intensity is a limiting factor.



Bioenergetics part 1 – Rate of photosynthesis

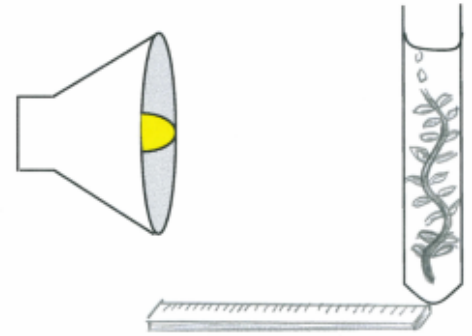
Water plants produce **bubbles of oxygen** when they photosynthesise. The bubbles can be **counted** over time and used to **calculate** the **rate** of photosynthesis. video

Investigating the effect of light intensity on photosynthesis in pondweed.

1. Fill a boiling tube with 0.2% **sodium hydrogen carbonate solution**.
2. Freshly cut a **10 cm piece of pondweed** and place it in the boiling tube with the cut end at the top.
3. Set up an **LED lamp** at a distance of **10 cm** to the boiling tube and leave to settle for 5 minutes.
4. **Start** the stopwatch and count the number of **bubbles** released in **one minute**.
5. Repeat twice and calculate the mean number of bubbles.
6. Repeat steps 1-6, altering distance of the lamp so it is 30 cm, 40 cm and 50cm away from the boiling tube.

Why do we use sodium hydrogen carbonate solution?

This provides excess dissolved carbon dioxide for the plant to use in photosynthesis so it is not a limiting factor.



Why is an LED lamp used?

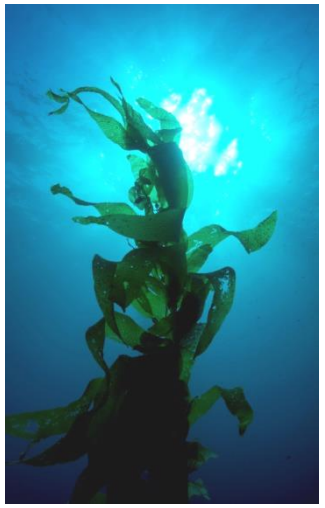
LED lamps produce less heat and this reduces the effect of temperature on the experiment.

Bioenergetics part 1 – Rate of photosynthesis HT only

Light is **a limiting factor** when the light intensity is too low, but very **high light intensities** may slow the rate of photosynthesis too. This may be caused by:

a) **saturation** of the **active sites** in the enzymes catalysing the reactions,

b) bleaching of chlorophyll.



Light intensity obeys the **inverse square** law. This means if you **double the distance** between the plant and the light source you **quarter the light intensity.**

To calculate light intensity use the formula:

Light Intensity = $1/distance^2$

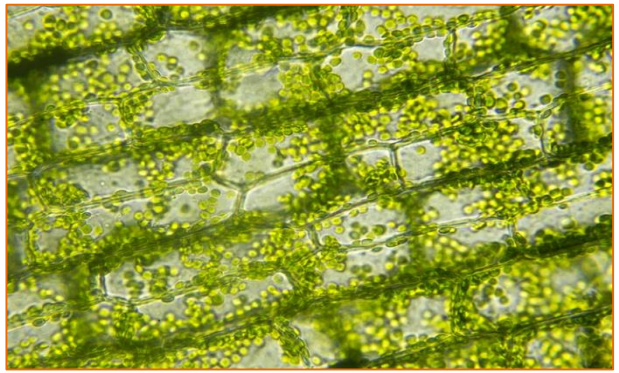
Distance (d) of lamp from pond weed (m)	0.4	0.2
Light Intensity $1/d^2$	**d^2 = 0.4 x 0.4 =0.16 $1/d^2$ = 1/0.16 = 6.25**	**25**

Bioenergetics part 1 – Rate of photosynthesis

If sunlight shines onto water and carbon dioxide, a reaction will **not** occur.
The energy must be transferred from the environment, to the **chlorophyll,** by light.

This energy is used to convert carbon dioxide and water into glucose and oxygen. Chlorophyll is **essential** to the process of photosynthesis.

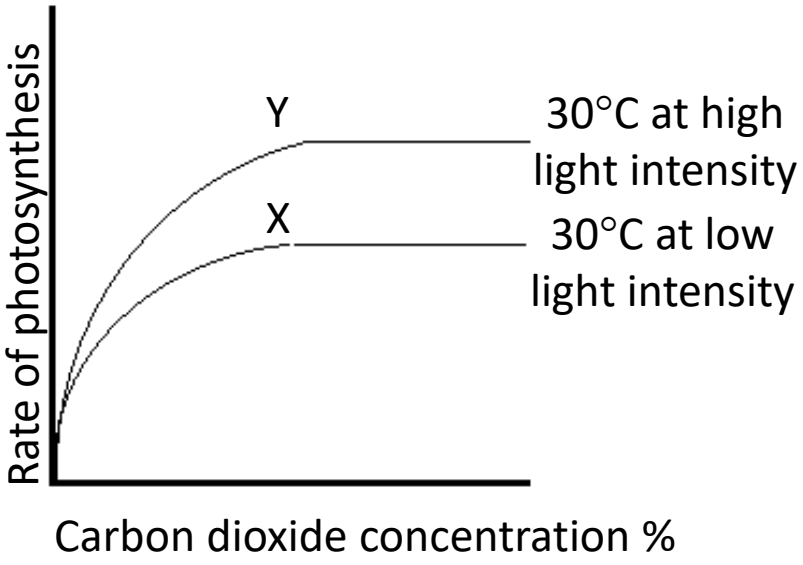
If there is a **reduction** in the amount of chlorophyll available to the plant then the amount of glucose made by photosynthesis will reduce. The plant will not grow as well.



Variegated leaves are white and green.
The white areas do not have any chlorophyll.

Bioenergetics part 1 – Rate of photosynthesis HT only

In **laboratory** investigations, plants experience variation in only **one** environmental factor.
Normally in **nature**, **more than one** environmental factor will vary and the rate of photosynthesis is due to the **interaction** of these factors.
Any one of the environmental factors may **limit** the rate of photosynthesis.

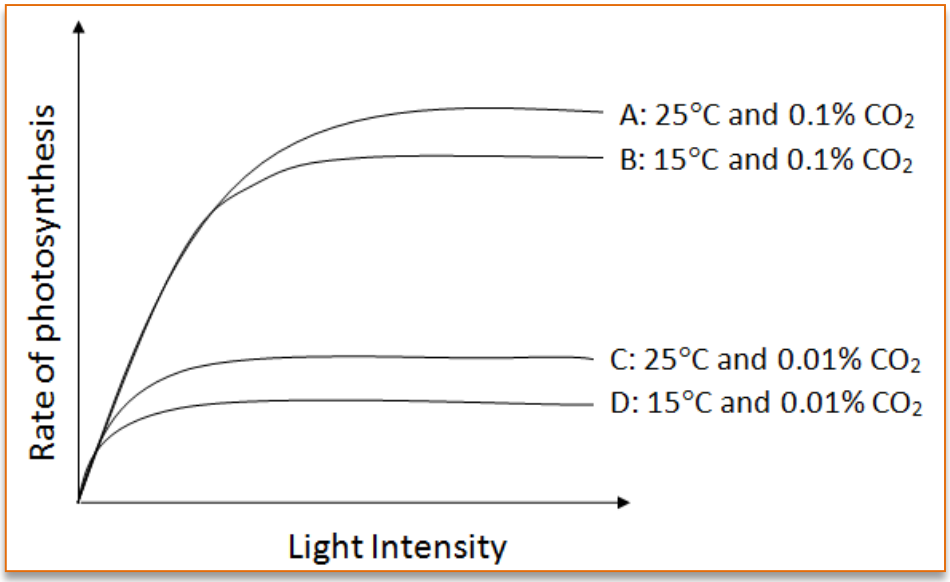


Carbon dioxide is not the limiting factor

In this experiment **temperature** is controlled.
At **low light intensity** the photosynthetic reaction becomes limited at point X.
If the light intensity is increased the reaction rate also increases.
Light intensity is therefore the limiting factor at point X.
A different factor is now limiting the rate of photosynthesis at Y.
This could be environmental **temperature** or the amount of **chlorophyll.**

Bioenergetics part 1 – Rate of photosynthesis HT only

Graph line A: Rate could be limited by temperature and/or amount of chlorophyll. Plant tissue can be damaged when carbon dioxide concentrations exceed 0.1%



Light intensity is <u>not</u> a limiting factor

Graph lines A and D: If carbon dioxide concentration **and** temperature are increased the rate of photosynthesis increases significantly up to a point.

Graph Lines A and B: If carbon dioxide concentration is increased from 0.01% to 0.1%, then a large increase in rate occurs up to a point.

Graph lines C and D: If temperature is increased by 10°C then a slight increase in rate of photosynthesis occurs.

Bioenergetics part 1 – Rate of photosynthesis HT only

Farmers apply their understanding of limiting factors to **improve** crop **yields**.
They can control conditions inside greenhouses more easily than in the fields.

- **Heating** can be used to provide optimum temperatures for maximum plant growth.
- **Artificial lighting** enhances the natural sunlight especially overnight and on cloudy days.
- **Extra carbon dioxide** gas can be pumped into the air inside the greenhouses.

In commercial greenhouses the environmental factors are often controlled by computerised systems to minimise cost. The farmer must balance the **economics** of **additional costs** of heating, lighting and computer systems to achieve maximum photosynthesis whilst still making a **profit.**

Video - Improving crop yields

Bioenergetics part 1 – Use of glucose from photosynthesis

All living cells need energy. This energy is released from glucose by a process called respiration.

Uses of glucose made from photosynthesis

To produce **cellulose** which strengthens plant cell walls.

To be converted into insoluble starch for storage inside cells or special areas like roots or bulbs.

To be converted into **amino acids** for protein synthesis.
Glucose is combined with **nitrate** ions absorbed from the soil.
Specific amino acids join in long chains to make a named **protein**.

To produce **fat or oil** for storage.
Seeds and nuts contain lots of fat or oil as an energy store.

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QuestionIT!

Bioenergetics
Part 1

- Photosynthetic reaction
- Rate of photosynthesis
- Use of glucose from photosynthesis

Bioenergetics part 1 – QuestionIT

1. Write down the word equation for photosynthesis.

2. Copy and complete this table

Name of molecule	Chemical Symbol
Water	
Oxygen	
Carbon dioxide	
Glucose	

3. Photosynthesis is affected by limiting factors.

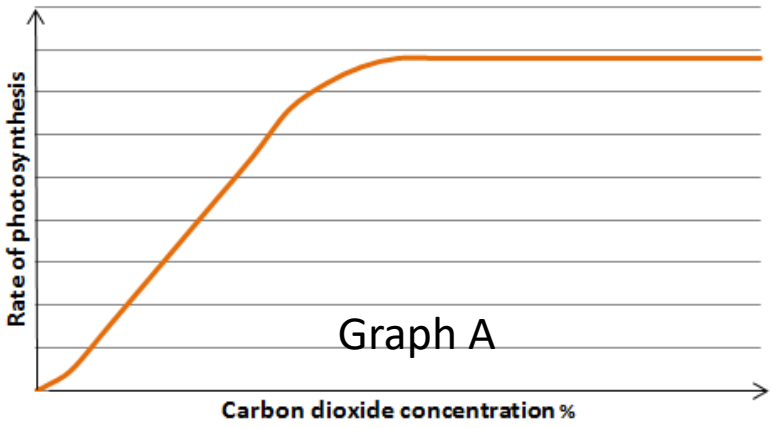
   What is meant by the term ‘limiting factor’?

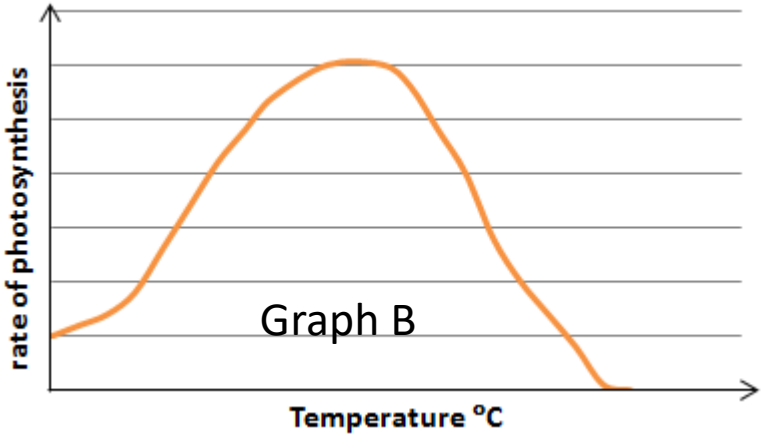
4. Name the raw materials needed by a plant for photosynthesis?

5. Name the green pigment present in plant cells.

6. What is the role of this green pigment?

7. For the graphs below - identify what the limiting factor(s) might be in the experiments.





8. Sketch a line onto Graph A showing what might occur if the experiment was repeated at a lower light intensity.

9. List three ways commercial farmers improve the environmental conditions to maximise photosynthesis and ensure they make a profit.

10. How is the glucose produced by photosynthesis used in plants?

Higher Tier Questions

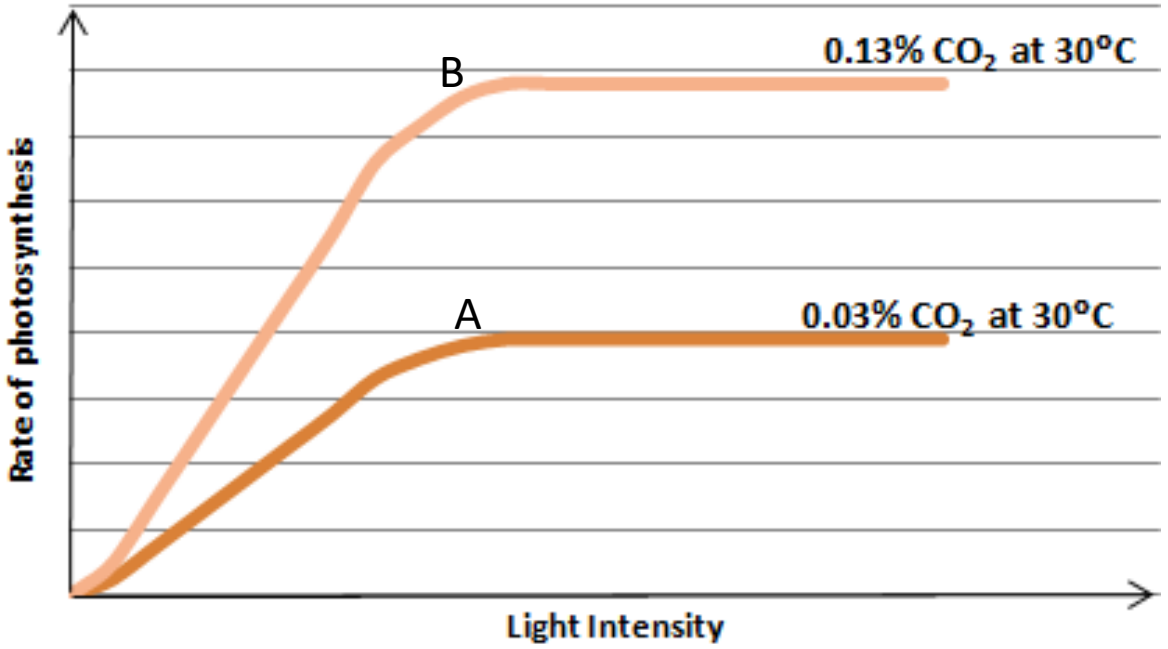
HT 11. Calculate the light intensity for the following student data. Use the formula:

Light Intensity = $1/\text{distance}^2$

Distance (d) of lamp from pond weed (m)	0.3	0.5
Light Intensity $1/d^2$		

HT 12. a) What is the limiting factor at A?

b) What might the limiting factor(s) be at point B?



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AnswerIT!

Bioenergetics
Part 1

- Photosynthetic reaction
- Rate of photosynthesis
- Use of glucose from photosynthesis

Bioenergetics part 1 – AnswerIT

1. Write down the word equation for photosynthesis.

   Carbon dioxide + Water $\xrightarrow{\text{light}}$ Oxygen + Glucose

2. Copy and complete this table

Name of molecule	Chemical Symbol
Water	H_2O
Oxygen	O_2
Carbon dioxide	CO_2
Glucose	$C_6H_{12}O_6$

3. Photosynthesis is affected by limiting factors.

   What is meant by the term 'limiting factor'?

   A factor which is not at an optimum level to enable maximum rate of photosynthesis e.g. temperature

Bioenergetics part 1 – AnswerIT

4. Name the raw materials needed by a plant for photosynthesis?

   Carbon dioxide and water

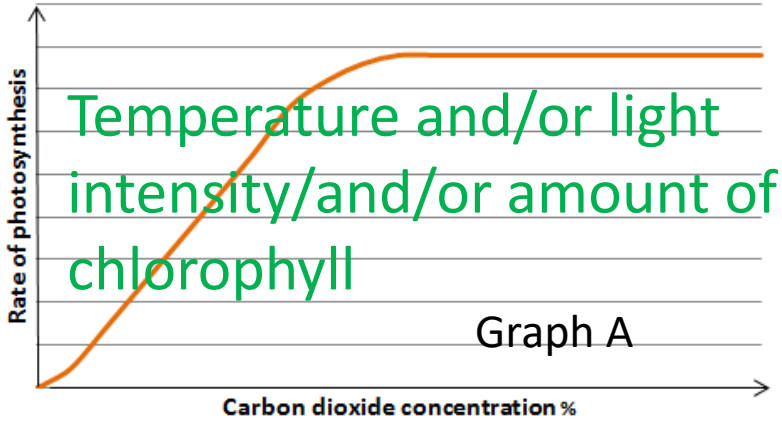
5. Name the green pigment present in plant cells.

   Chlorophyll

6. What is the role of this green pigment?

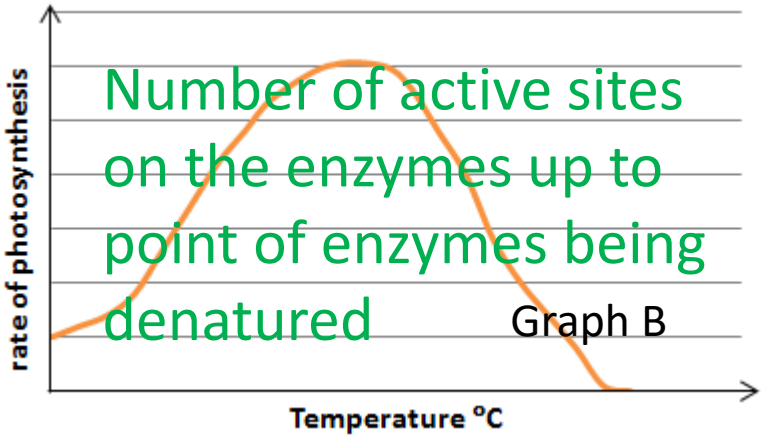
   To transfer energy from the environment and use it to synthesise glucose from carbon dioxide and water.

7. For the graphs below - identify what the limiting factor/s might be in each experiment.



Temperature and/or light intensity/and/or amount of chlorophyll

Graph A



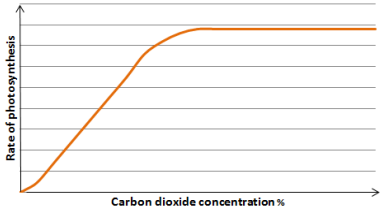
Number of active sites on the enzymes up to point of enzymes being denatured

Graph B

Bioenergetics part 1 – AnswerIT

8. Sketch a line onto graph A showing what might occur if the experiment was repeated at a higher light intensity.

Line drawn below that in Graph A but mirroring shape.



9.List **three** ways commercial farmers improve the environmental conditions in large greenhouses to maximise photosynthesis and ensure they make a profit.

Increase the air temperature with heaters.

Provide artificial lighting to supplement the sunlight and through the night.

Increase the amount of carbon dioxide in the atmosphere.

10. List **three** ways glucose produced by photosynthesis is used in plants?

Used for respiration; used to produce fats or oils for storage; used to produce amino acids for protein synthesis; converted into insoluble starch for storage; used to produce cellulose to strengthen cell walls.

Higher Tier Questions

HT 11. Calculate the light intensity for the following student data.
Use the formula: **Light Intensity α 1/ distance^2**

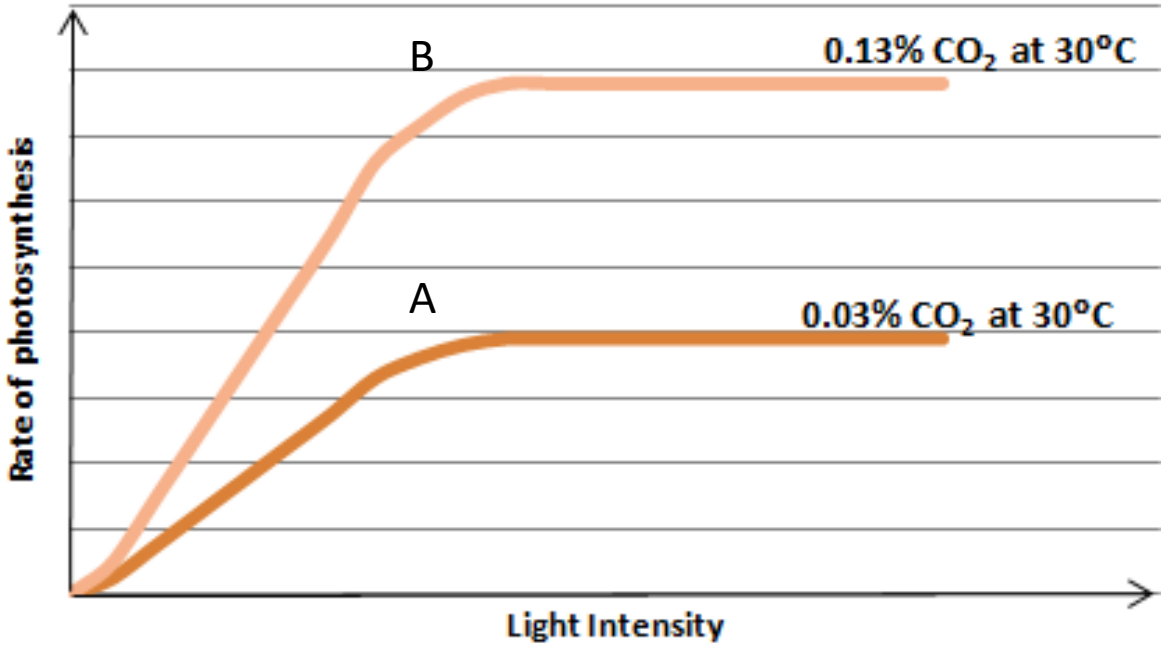
Distance of lamp from pond weed (m)	0.3	0.5
Light Intensity	11.11	4

HT 12. a) What is the limiting factor at A?

Carbon dioxide

b) What might be the limiting factor(s) be at point B?

Temperature/ amount of chlorophyll



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Bioenergetics Part 2

- Aerobic respiration
- Anaerobic respiration
- Response to exercise
- Metabolism

Bioenergetics part 2 – Aerobic respiration

Respiration is also sometimes called **cellular respiration**. This is because the reactions of respiration occur inside cells.

Every **living cell** needs energy and this energy is released from food (glucose) by a series of chemical reactions called respiration.

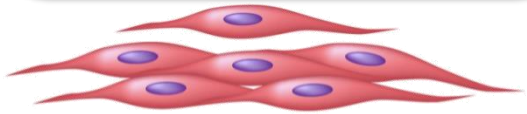
The reactions of respiration occur **24 hours a day,** continuously, in **all** living cells.

Respiration is **an exothermic** reaction which means energy is transferred to the environment. Some of the **energy** is used inside cells and the rest will be transferred **out of the cell.**

An organism will receive all the energy it needs for living processes as a result of the **energy transferred** from **respiration**.

Bioenergetics part 2 – Aerobic respiration

For movement
To enable muscles to contract in animals.



Smooth muscle cells

For keeping warm
To keep a steady body temperature in a cold environment

Why do living organisms need energy?

For chemical reactions
To build larger molecules from smaller ones

Bioenergetics part 2 – Aerobic respiration

Respiration can transfer energy in cells **aerobically** (with oxygen).

The **word equation** which represents aerobic respiration is:

glucose + oxygen ⟶ carbon dioxide + water

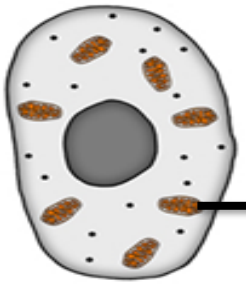
The balanced **symbol equation** which represents aerobic respiration is:

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

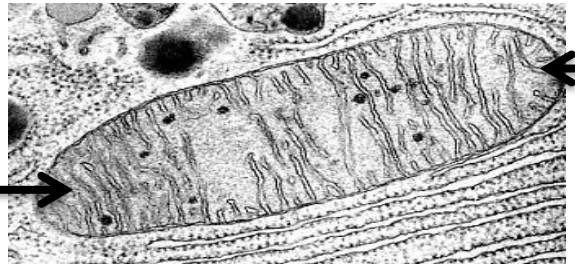
Aerobic respiration occurs inside **mitochondria** continuously.

Glucose is **oxidised** by **oxygen** to **transfer the energy** the organism needs to perform its functions.

Aerobic respiration releases a **large amount of energy** from each glucose molecule.



Animal cell



Electron micrograph of a mitochondrion

Plant cell

Bioenergetics part 2 – Anaerobic respiration

Respiration can transfer energy in cells **anaerobically** (without oxygen).

During **hard exercise**, muscles cells are respiring so fast that the blood cannot transport enough oxygen to meet their needs.

The muscle cells switch to use **ANAEROBIC RESPIRATION** to transfer energy.

Glucose is **not** completely broken down to carbon dioxide and water, so **less energy** is transferred. An end product called **lactic acid** is formed. This builds up in the muscle cells.

glucose ⟶ lactic acid

After exercise the lactic acid must be combined with oxygen to convert it to carbon dioxide. The amount of oxygen which must be taken in to convert all the lactic acid to carbon dioxide is called the oxygen debt.

During long periods of vigorous exercise the muscles become **fatigued** and stop contracting efficiently.

Bioenergetics part 2 – Anaerobic respiration

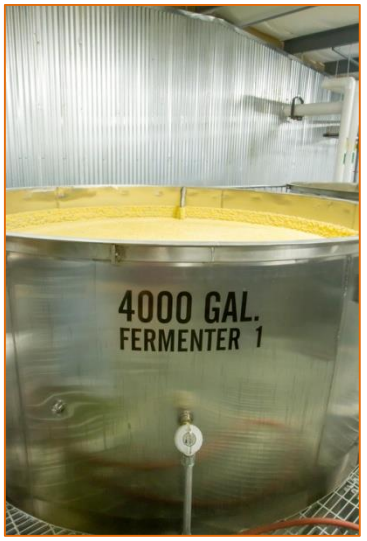
Anaerobic respiration also occurs in plant and yeast cells.

The end products are ethanol and carbon dioxide.

glucose ⟶ ethanol + carbon dioxide

Anaerobic respiration in yeast cells is called **fermentation**.

This process is economically important in the manufacture of alcoholic drinks and bread.



Bioenergetics part 2 – Respiration summary

	Aerobic respiration	Anaerobic respiration in animal cells	Anaerobic respiration in plant and yeast cells
Oxygen	Required	Not required	Not required
End products	Carbon dioxide and water	Lactic acid	Ethanol and carbon dioxide
Oxidation of glucose	Complete	Incomplete	Incomplete
Efficiency of energy transfer	High	Low	Low

Video - Respiration summary

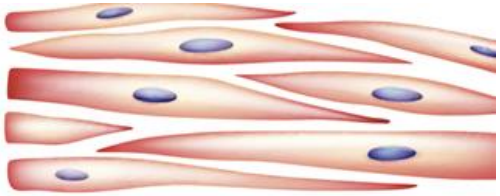
Bioenergetics part 2 – Response to exercise

During **exercise** the **human body** reacts to the **increased** demand for energy. If **insufficient oxygen** is supplied to the muscle cells then **anaerobic respiration** occurs.

The **heart rate increases** to pump oxygenated blood faster through the muscle cells.

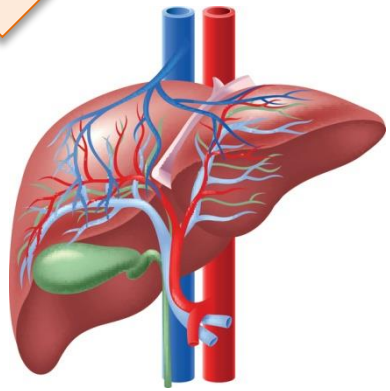
Breathing rate and breath **volume** increase. This increases the amount of oxygen entering the bloodstream.

Bioenergetics part 2 –Response to exercise HT only



Lactic acid builds up in the muscle **cells** during **exercise**.

Blood flows through the muscle cells and **transports** the **lactic acid** to the **liver**.



The **liver** oxidises the **lactic acid** and **converts** it back to **glucose**.

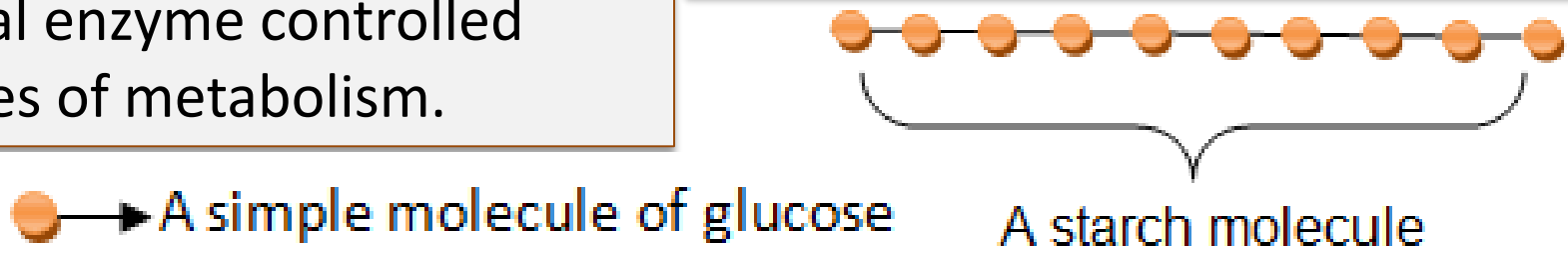
Glucose is used in **aerobic respiration** or it is converted to **glycogen** and stored in the **liver** for later use.

The extra amount of oxygen required to remove all lactic acid from the cells is called the **oxygen debt**.

Bioenergetics part 2 – Metabolism

Organisms use the energy transferred by respiration for the continual enzyme controlled processes of metabolism.

The conversion of glucose to starch is a metabolic reaction.



Metabolism = the sum of all reactions in a cell or body

Glucose and nitrate ions from the soil form amino acids. Amino acids are used to synthesise proteins. These are metabolic reactions.

Other examples of metabolic reactions that you **need to know** are:

- The conversion of **glucose to cellulose** in plants to strengthen cell walls;
- The conversion of **glucose to glycogen** in animal cells for storage;
- The **formation of lipids** from a molecule of glycerol and three molecules of fatty acids;
- The **breakdown of proteins** to form **urea** for excretion
- Respiration.

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QuestionIT!

Bioenergetics
Part 2

- Aerobic respiration
- Anaerobic respiration
- Response to exercise
- Metabolism

Bioenergetics part 2 – QuestionIT

1. When does respiration occur in cells?
2. Copy and complete the table below:

	Aerobic respiration	Anaerobic respiration in animal cells	Anaerobic respiration in plant and yeast cells
Oxygen required?			
End products			
Oxidation of glucose complete/incomplete?			
Efficiency of energy transfer is high or low?			

Bioenergetics part 2 – QuestionIT

3. Name **three** processes that organisms require energy for.
4. What does the chemical formula $\mathbf{C_6H_{12}O_6}$ represent?
5. Write down the word equation for aerobic respiration in a plant cell.
6. Write down the word equation for anaerobic respiration in a yeast cell.
7. Why is fermentation of economic importance?
8. Describe **three** ways in which the body responds to vigorous exercise in order to ensure sufficient oxygen reaches the muscle cells.
9. If exercise carries on for a long time, what happens to the muscles?
10. Why is respiration described as an exothermic reaction?

Bioenergetics part 2 – QuestionIT

11. Copy and complete the table below:

Name of large molecule	Made from subunits of ?
Carbohydrate	Glucose
Lipid	?
Protein	?

12. What is the definition of metabolism?

Higher tier questions

HT 13. Describe the process for removing lactic acid from the body.

HT 14. What is meant by the term 'oxygen debt'?

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AnswerIT!

Bioenergetics Part 2

- Aerobic respiration
- Anaerobic respiration
- Response to exercise
- Metabolism

Bioenergetics part 2 – AnswerIT

1. When does respiration occur in cells? Continuously

2. Copy and complete the table below:

	Aerobic respiration	Anaerobic respiration in animal cells	Anaerobic respiration in plant and yeast cells
Oxygen required?	Yes	No	No
End products	Carbon dioxide and water	Lactic acid	Ethanol and carbon dioxide
Oxidation of glucose complete/incomplete?	complete	incomplete	incomplete
Efficiency of energy transfer is high or low?	high	low	low

Bioenergetics part 2 – AnswerIT

3. Name three processes that organisms require energy for.

Chemical reactions to build larger molecules, keeping warm and movement.

4. What does the chemical formula $C_6H_{12}O_6$ represent? Glucose

5. Write down the word equation for aerobic respiration in a plant cell.

glucose + oxygen ⟶ carbon dioxide + water

6. Write down the word equation for anaerobic respiration in a yeast cell.

glucose ⟶ carbon dioxide + ethanol

7. Why is fermentation of economic importance?

Used in the manufacture of bread and alcoholic drinks.

8. Describe **three** ways in which the body responds to vigorous exercise in order to ensure sufficient oxygen reaches the muscle cells.

Increase in heart rate; increase in breathing rate and increase in breath volume.

9. If exercise carries on for a long time, what happens to the muscles?

Muscles become fatigued and stop contracting efficiently.

10. Why is respiration described as an exothermic reaction?

Respiration is an exothermic reaction because it transfers energy to the environment.

11. Copy and complete the table below:

Name of large molecule	Made from
Carbohydrate	Many glucose molecules
Lipid	1 molecule of glycerol and 3 molecules of fatty acid
Protein	Many amino acids

12. What is the definition of metabolism?

Metabolism is the sum of all reactions which occur in a cell or body.

Higher tier questions

HT 13. Describe the process for removing lactic acid from the body.

Blood flows through the muscle cells and transports the lactic acid to the liver where it is converted back into glucose. The glucose is then used in aerobic respiration or stored as glycogen.

HT 14. What is meant by the oxygen debt?

The amount of extra oxygen which is needed to remove all lactic acid from the body is known as the oxygen debt.