St Ninian's High School

Biology Department

National 5 Biology

Life on Earth

Revision Notes

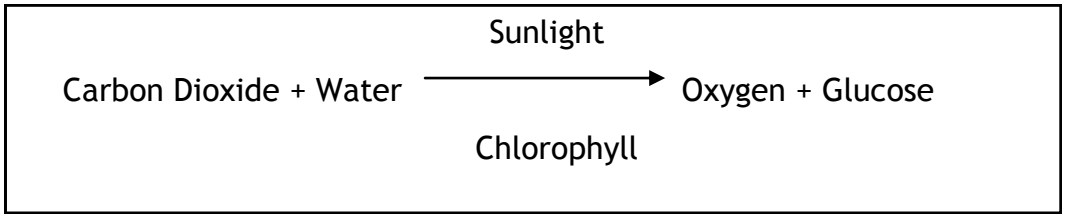
Cultivating Excellence in Science

Life on Earth Topics

1. Photosynthesis
2. Energy in Ecosystems
3. Competition and Niche
4. Ecosystem and Biodiversity terms
5. Sampling biotic and abiotic factors
6. Paired statement keys
7. Food production
8. Mutations and Speciation

1. Photosynthesis - Pathway

The basic photosynthesis equation :



Photosynthesis is a two stage process.
1. Light reactions (light dependent stage)

2. Carbon Fixation

1. Light Reactions

- Photosynthesis starts with light energy being absorbed by chlorophyll in the chloroplast and converted into chemical energy used to make ATP.
- Water is split to produce hydrogen and oxygen (photolysis)
- Oxygen is a by-product which diffuses from the cell.

2. Carbon Fixation

- Uses hydrogen and ATP (produced by the light reactions) with carbon dioxide to produce sugar (Glucose).

Carbon Fixation is a series of enzyme controlled reactions

(enzymes are used in this process)

Fates of Glucose

The chemical energy stored in glucose can be converted into:

1. **S**tarch for **S**torage

2. **C**ellulose for **C**ell walls (structural)

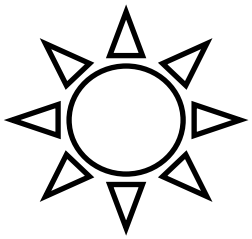
3. Energy for respiration

Potential Exam Question - Energy Transfer - 3 marks

1. Light energy is absorbed by chlorophyll. **2.** This is converted into chemical energy in the form of ATP. **3.** This is used to make chemical energy called glucose.

1. Photosynthesis - Pathway

Light Reactions



Light energy

Diffuses from cell as a by-product

Absorbed by chlorophyll in the chloroplast

Chemical energy

Water

ATP

Oxygen + Hydrogen

Carbon Fixation

(light reactions)

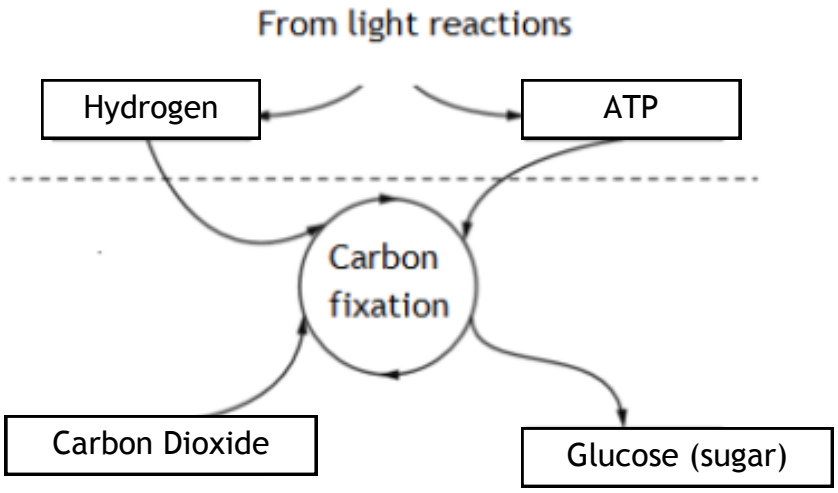
ATP

Carbon Dioxide + Hydrogen → **Glucose**

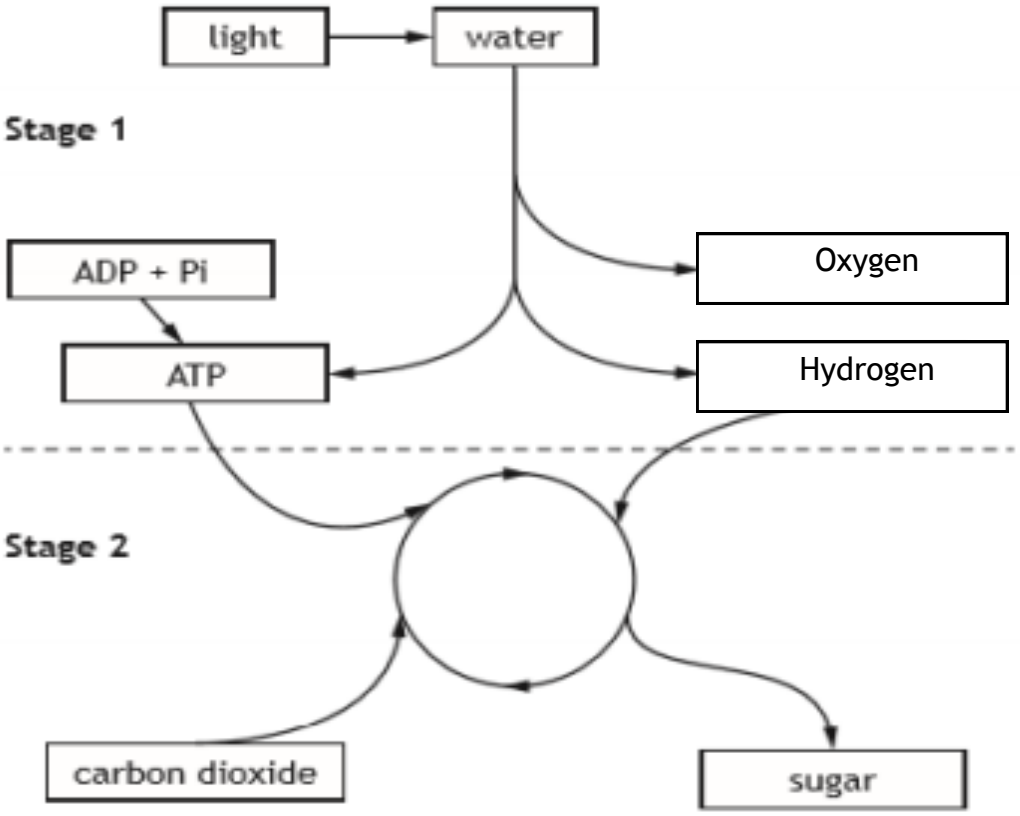
(atmosphere) (light reactions) (Sugar)

1. Photosynthesis - Pathway

Example Exam Diagram 1.



Example Exam Diagram 2.



1. Photosynthesis - Limiting Factors

Limiting Factors

Limiting factors limit the rate of photosynthesis that occurs within a plant and will affect plant growth.

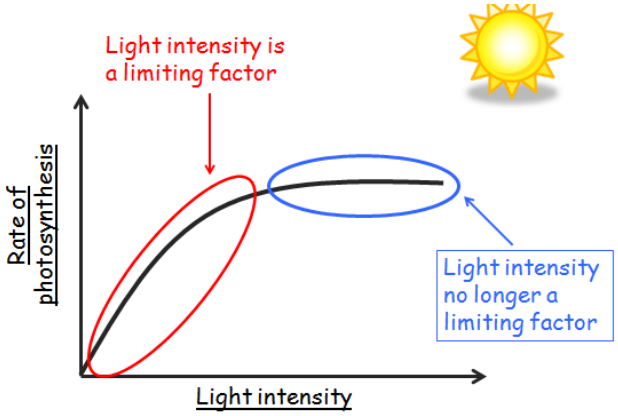
There are **three** limiting factors:

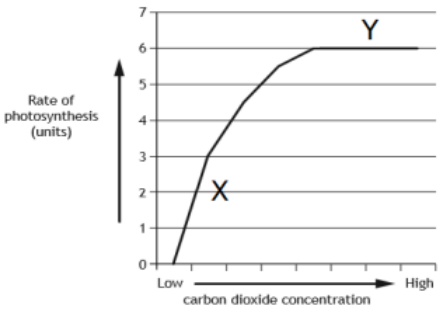
1. Temperature
2. Light Intensity
3. CO_2 Concentration

Limiting Factor Graphs

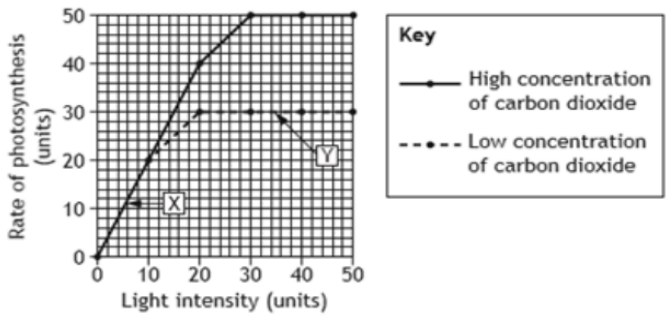
Hint: If the line is still increasing look down at the X Axis

If the line stays the same it will be one of the other limiting factors





X - Carbon Dioxide Concentration
Y - Temperature or Light Intensity



X - Light Intensity
Y - Carbon Dioxide Concentration

1. Photosynthesis - Measuring rate of photosynthesis

Measuring the Rate of Photosynthesis
Photosynthesis can be measured in the following ways:

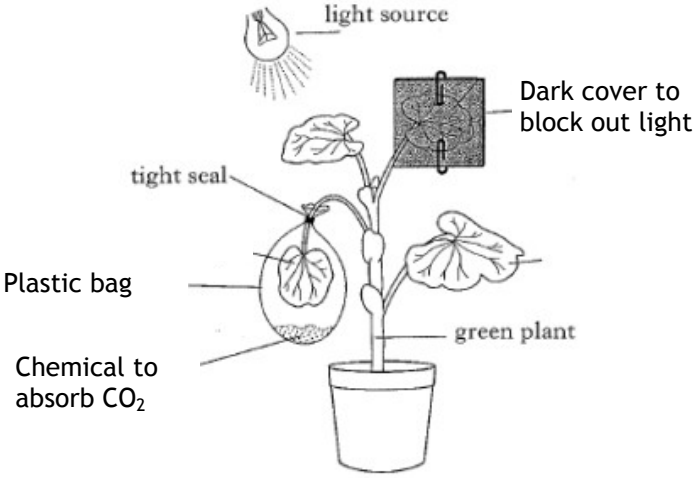
1. Number of **oxygen** bubbles produced per minute.

2. Volume of **carbon dioxide** taken in by the plant.

3. Measuring the increase in dry mass of the plant.

   (measures the mass of starch produced)

Limiting Factor Investigations - (investigates if photosynthesis has taken place)



Black paper - removes light.

Plastic bag with chemical - removes CO_2

1. Photosynthesis - Investigation Question/Answer

Experiment Question

An experiment was set up to investigate the effect of light intensity on rate of photosynthesis in the water plant, *Cabomba*.

The number of oxygen bubbles produced in one minute was used to measure the rate of photosynthesis.

Distance of lamp from beaker (cm)	Number of O_2 bubbles produced per minute.
10	40
20	30
30	25
40	15
50	5

Potential Investigation Question and Answers

Question	Answer
What is the independent variable?	Light intensity
What is the dependent variable?	Rate of photosynthesis
Give an example of a variable you need to keep the same.	Volume of water, mass of Cabomba, temperature, carbon dioxide concentration
Describe a suitable control for this experiment.	Exact same set up but no light
State the purpose of a control.	To prove that light intensity is causing an effect
How would you make the experiment more reliable?	Repeat at each light intensity
How would you make the experiment valid?	Keep everything the same apart from light intensity
Describe two ways in which the apparatus would be adapted to demonstrate the effect of temperature rather than light intensity.	1. Keep light intensity the same 2. Use a wide range of temperatures.
What conclusion can be drawn from the results?	As light intensity increases, rate of photosynthesis increases.

2. Energy in Ecosystems - Food Chains

Terms

Producer – makes their own food (by photosynthesis).

Consumer – needs to eat other organism to obtain food.

Food Chains

All food chains start with a producer (green plant).

The arrows show the **direction of energy flow.**

Food Chain Terms

Primary consumer = first consumer.

Secondary consumer = second consumer.

Tertiary consumer = third consumer.

Predators = animals who hunt other animals for food.

Prey = animals who are hunted by other animals.

(note prey cannot be PLANTS)

Carnivores = eat animals only

Herbivores = eat plants only

Omnivores = eat animals & plants

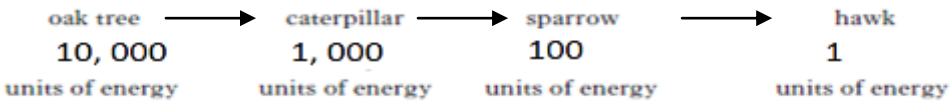
2. Energy in Ecosystems - Energy Transfer

All energy comes from the **sun**.

Plants absorb a **small percent** of this energy and use this to make food (photosynthesis).

<u>Likely calculation</u>

Working out the units of energy passed on to each organism in a food chain.



Only **10% of energy** is passed on at each stage of a food chain for **growth.**

<u>90% of energy is lost from the food chain.</u>

How is 90% of the energy lost from the food chain?

1. Heat
2. Movement
3. Undigested material (faeces/bones)

2. Energy in Ecosystems - Pyramids

Two types of Pyramids *** learn definitions ***

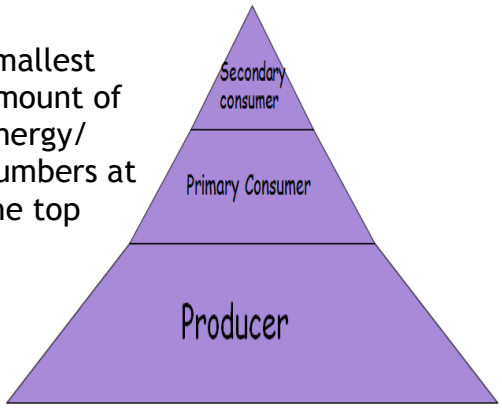
1. Pyramids of Numbers

   The **number of organisms** at **each stage of a food chain.**

2. Pyramids of Energy

   The **energy** received by organisms at **each stage of a food chain.**

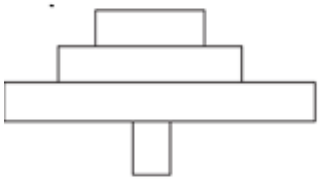
Smallest amount of energy/ numbers at the top



Largest amount of energy/ numbers at the bottom

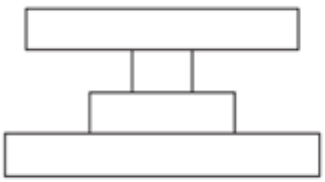
Problem with pyramids of numbers

Pyramid of numbers does not resemble a true pyramid shape when a tree is a consumer (smaller at bottom) OR insect at the top!



Too small at bottom if tree is the producer

Oak tree → greenfly → was → blue tit



Too large at top if insect is the top consumer

Grass → zebra → lion → flea

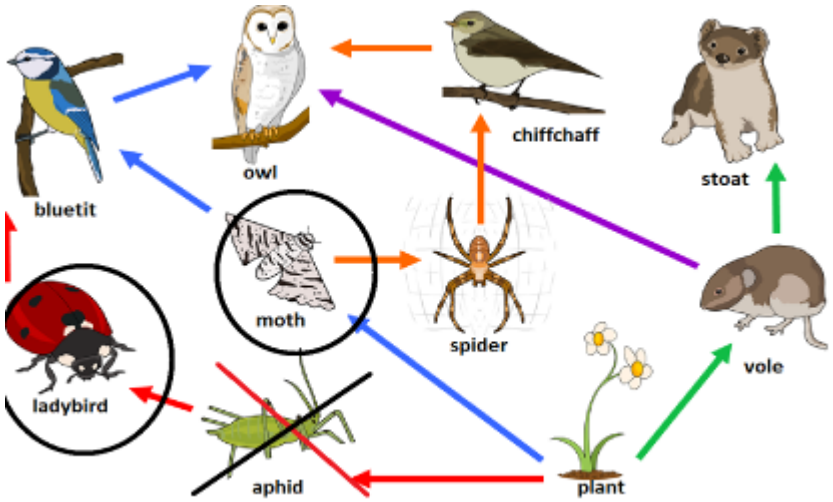
****Pyramid of energy always looks like a pyramid shape ****

2. Energy in Ecosystems - Food Webs

All organisms are **connected in a food web**. Removing one organism from the food web destroys the delicate balance.

When an organism is removed it will **ALWAYS affect** other organisms in a good or bad way, dependent on the circumstances.

Common Exam Question



What would happen to the moths and ladybirds if the aphids were removed?

A) Moths—increase

Why—Less aphids mean more plants for moth to eat.

B) Ladybirds—decrease

Why—Less aphids to eat. OR

More moths mean more blue tits which mean less ladybirds.

3. Competition and Niche

Competition

When animals/plants require the same resources.

Resources required.

Animals	**Plants**
Food	Water
Shelter	Nutrients
Mates	Space
Territory	Light

Interspecific Competition

DIFFERENT SPECIES

Between **different** species

who want the **same resources**.

e.g. lion and hyena

Intraspecific Competition

SAME SPECIES

Within the **same species** who want the **same resources**. (More fierce!)

e.g. Two lions

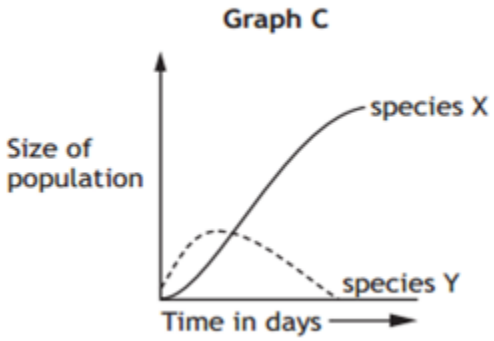
Competition Graphs

Results in the survival of the fittest

(Natural Selection)

1 species increases

1 species decreases



Niche

The **role an organism plays in its community**

Example:

different **beak SHAPE** for different food.

Having different niches **reduces competition**.

4. Ecosystem and Biodiversity terms

Biodiversity

Variety and relative abundance (amount) of living organisms.

Importance of Biodiversity

Allows organisms to adapt to environmental changes.

Ecosystem Terms

Term	Definition	Example
Habitat	Where an organism lives.	Pride Rock/Caves
Population	Total number of one type of species.	Lions
Community	All the different species living together .	Lions, hyenas, monkeys
Ecosystem	Made up of living (community) and non living (habitat) parts.	Desert

5. Sampling Biotic and Abiotic Factors

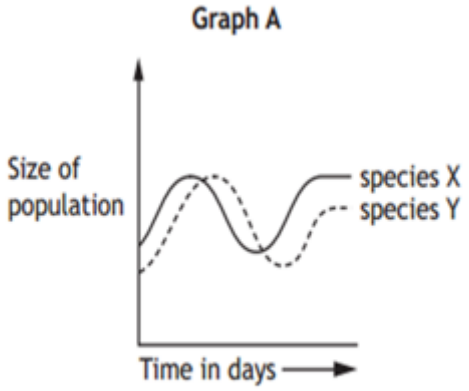
Factors affecting the distribution of organisms which can cause an increase or a decrease in biodiversity.

Biotic Factors (LIVING)

Abiotic Factors (NON LIVING)

Biotic Factors	**Abiotic Factors**
Grazing	Temperature
Predation	Light Intensity
Disease	pH
Competition	Moisture
Food availability	

Predation and Prey Graphs (Biotic Factor)



Explaining the Graph
Prey are high when predators are low
Why—less predators to eat prey

Prey are low when predators are high
Why—prey eaten by predators

5. Sampling Biotic and Abiotic Factors

Sampling techniques can be used to sample both biotic and abiotic factors.

Biotic Sampling Techniques	**Abiotic Sampling Techniques**
Pitfall Traps	pH meter
Quadrats	Moisture meter
	Light meter
	Thermometer

Biotic Sampling Techniques

Pitfall Trap - Samples number of small invertebrates living on the ground, such as beetles, spiders and slugs.

Using a Pitfall Trap

1. Dig hole level with ground to ensure insects fall in.

2. Cover in leaves to ensure nothing eats insects.

Errors when setting up a Pitfall Trap

1. Trap too high above soil

2. Trap not camouflaged

3. Trap left too long (all insects die or are eaten)

Quadrat - Samples number of plants and slow moving animals e.g. slugs and snails.

Using a Quadrat

1. Throw quadrat at **random** to make sure sample is representative.

2. Count the number of squares that have chosen plant present.

Errors when using a Quadrat

1. Only throwing quadrat once - not reliable.

2. Counting the number of plants rather than the number of squares.

5. Sampling Biotic and Abiotic Factors

Abiotic Sampling Techniques

pH and Moisture meters - used to measure pH or moisture

Using the meter

Place **probe** into soil and take reading

Errors

Forgetting to wipe the probe between readings

Light meter - used to measure light intensity

Using the meter

Meter held at **maximum** light intensity

Errors

Casting a shadow over the meter.

Thermometer - used to measure temperature

Using the meter

Hold thermometer at the top and read temperature

Errors

Avoid holding the bulb at the bottom.

Line Transect

Uses a quadrat to measure the abundance of a plant at regular intervals.

Shows the effect of an abiotic factor on the distribution of a plant.

E.g. The effect of light intensity on daisy population.

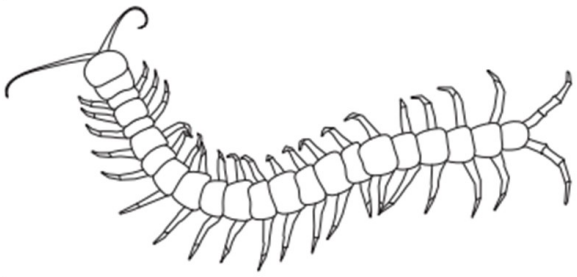
6. Paired Statement Keys

Paired statement keys are used to identify organisms.

Example Question 1.
This question requires you to **use a** paired statement key to identify the name of the organism.

At each stage you are given a choice. Make the appropriate choice and go to where you are asked to go. This will allow you to identify the organism.

What is the name of this invertebrate?



The following paired statement key can be used to identify invertebrate groups.

1. Six legs..... *Hexapoda*
   More than six legs..... go to 2
2. 8 legs..... go to 3
   More than 8 legs..... go to 4
3. Curved sting..... *Dromopoda*
   No curved sting..... *Arachnida*
4. 1 pair of legs per body segment..... *Chilopoda*
   2 pairs of legs per body segment..... *Diplopoda*

A Dromopoda
B Arachnida
C Chilopoda
D Diplopoda

6. Paired Statement Keys

Paired statement keys are used to identify organisms.

Example Question 2.
This question requires you to **construct** a paired statement key to identify an organism.

TIP
Use the first statement and categorise all the animals that fit into that statement.

E.g. only categories the animals with legs then go back and categorise the animals with no legs.

Complete the following key using information from the diagrams.

1 Legs ..... Go to 2

No legs .....

Butterfly species	*Wing shading*	*Wing tip*	*Wing spots*
Large White	pale	black	yes
~~Orange Tip~~	~~pale~~	~~black~~	~~no~~
Peacock	dark	blue	yes
Red Admiral	dark	white	yes
Wood White	pale	black	no

TIP
Information in the paired statement key needs to be the opposite of one another.

4 Shell .....

No Shell .....

Black breast stripe absent

Black breast stripe **Present**

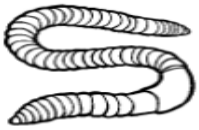
Tail length **Shorter than body**

Tail length longer than body

6. Paired Statement Keys

Example Question.

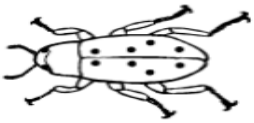
The diagrams below show the invertebrates collected by the pupils.
They are not drawn to scale.



Earthworm

Snail

Spider



Beetle

Woodlouse

Complete the following key using information from the diagrams.

1	Legs	Go to 2	
	No legs	Go to 4	1
2	12 legs or more	*Woodlouse*	
	Fewer than 12 legs	Go to 3	
3	Spots on body	*Beetle*	
	No spots on body	Spider	1
4	Shell	*Snail*	
	No Shell	Earthworm	1

7. Food Production

World Food Problem

Population rising sharply, hence not enough food.

Need to **increase food yield.**

Three solutions

1. Intensive farming
2. Biological Control
3. Genetic Modification of crops

1. Intensive Farming

Intensive farming methods	Description	Problem	Alternative
Fertiliser	Add nitrates into soil which increase the growth of crop plants.	Algae bloom	GM crops
Pesticide	Kill insects which eat crops.	Pesticide builds up in the food chain and is toxic to the top predator	GM Crops Biological control

Fertilisers - Potential Exam Question
****Important****

Nitrates dissolve into soil water and are absorbed by plants. The nitrates are used to make amino acids which then create plant protein.

Animals consume other animals or plants to gain amino acids for protein synthesis.

7. Food Production - Intensive Farming Problems

Problem with fertilisers ***learn this process***

Fertiliser washes into water

↓

Increased algae bloom due to extra nitrates

↓

This **decreases** light levels killing aquatic plants/algae.

↓

Increase in bacteria as they feed on dead algae/plants

↓

Decreases oxygen levels

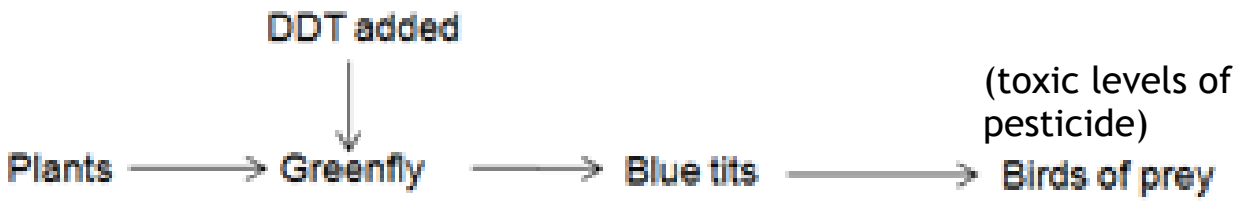
↓

Decreases biodiversity (aquatic animals die)

Problems with Pesticides (DDT is an example)

Pesticides can accumulate in the bodies of organisms over time.

They build up in the food chain and reach toxic levels, killing the top predator.



7. Food Production - Alternatives to Intensive Farming

Biological Control (Alternative to Pesticide)

Natural method of pest control.

1. Introducing disease
2. Introducing predator

Virus Myxoma & Rabbits

Virus introduced to limit rabbit population.

Ladybirds & greenfly

Ladybirds (predator) of greenfly, reduce their numbers.

GM Crops (Alternative to Fertilisers and Pesticides)

When a foreign gene in inserted into a plant to produce a desirable characteristic.

Desirable characteristics of GM crops:

1. Plants that are now Drought resistant
2. Plants that are now Disease resistant

Some GM Rice plants take up nitrates more efficiently - Alternative to fertilisers

GM plants with added Bt toxin to kill off pests - Alternative to pesticides

7. Food Production - Indicator Species

Indicator species definition

By its presence or absence determines the level of pollution.

Two Examples

1. Lichen (air pollution)

Lichen only grow where air is clean.

(no sulphur dioxide)

2. Stone fly nymph (water pollution)

Nymphs only live where water is oxygenated.

(no pollution)

8. Mutations and Speciation

Random change to genetic material
(e.g. DNA base sequence A, G, C, T)

Remember

1. Change to DNA base sequence
2. Changes the Amino Acid sequence at the ribosome
3. **Changing the protein** produced (non functional)

E.g. enzyme, hormone, antibody etc

Mutations are **ROLF!!!**

Randomly **O**ccurring (unpredictable) **L**ow **F**requency (do not occur often)

Mutagenic Agents

Environmental factors that **increase the frequency** of a mutation occurring.

1. Radiation (UV, X-Ray)
2. Chemical agents (mustard gas)
3. High Temperatures

Types of Mutations

1.	Disadvantageous	=	cause genetic disease
2.	Advantageous	=	help to increase variety & biodiversity (cause natural selection & formation of new species)
3.	Neither	=	no effect

8. Mutations and Speciation

1. Disadvantageous Mutations—genetic disease

Down Syndrome

3 copies of **chromosome 21**

Symptoms

Causes physical & mental development problems.

2. Advantageous Mutations (does not occur often but important)

1. Create new alleles (versions of a gene).
2. Increases variety & biodiversity.
3. Leads to **Natural Selection** & formation of a new species (speciation).

Example 1—black & grey squirrel	Example 2—black & peppered moth
Black more aggressive	black camouflaged against polluted lichen

8. Mutations and Speciation - Adaptations

New alleles produced by mutations can result in plants and animals becoming better adapted to their environment.
This allows populations to adapt to changing environmental conditions.

Adaptations are often result of a favourable mutation leading to Natural selection and often formation of a new species who have a selective advantage.

Adaptations increase biodiversity

Types of Adaptations

Physiological (desert rat)

Large back feet help them to jump away

from predators.

Does not sweat

Very efficient large intestine

Behavioural (desert rat)

Nocturnal as too hot during day

Burrowing into sand when temperature is too high.

8. Mutations and Speciation - Natural Selection

Also called "survival of the fittest" as proposed by Darwin for how species evolve.

The best adapted organisms will **survive** and **reproduce**, passing on successful alleles.

Process

1. **Variation** occurs naturally due to different alleles (mutations)
2. Fierce **competition** for resources (inter/ intra).
3. Increased selection pressure for those with a **selective advantage.**
4. Those individuals with a selective advantage **survive**, **reproduce and pass on the successful alleles.**
5.. Weaker individuals die out.

Example of Natural Selection	Alleles	Selective Advantage
Peppered Moth	Dark & Peppered moth	Black moth—camouflaged against polluted lichen.
Antibiotic Resistance	Sensitive & Resistant bacteria	Only resistant bacteria can survive antibiotics leading to multi-resistant bacteria.
Human Skin Colour	Light & Darker Skin	Darker skin advantage where weather is warmer as melanin protects against the sun.

8. Mutations and Speciation - Speciation

Species Definition:
Can **interbreed** to produce **fertile offspring**.

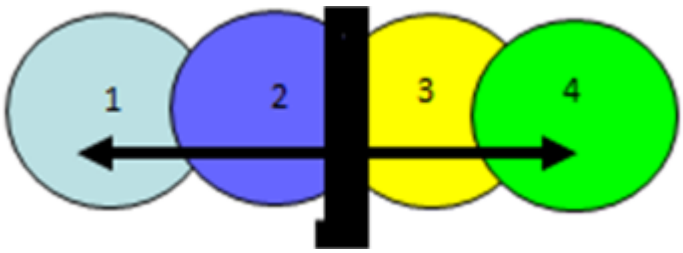
Speciation: formation of a new species

I'M a New Species!

1. Isolating Mechanisms
2. Mutations
3. Natural Selection
4. Speciation

Isolating Mechanisms (barrier)

Importance: Prevent gene flow between sub populations.



2 sub populations form

Type of Isolating mechanisms: (learn these)

1. Behavioural/reproductive
2. Geographical - mountain or river
3. Ecological

Exam Tip:

Write Geographical NOT river in exam!

8. Mutations and Speciation - Speciation

2. Mutations

As mutations are RANDOM— different mutations will occur at either side of the barrier

3. Natural Selection

Increased **selection pressure** for those with a **selective advantage**.

These individuals **survive and reproduce** & **pass on successful alleles**.

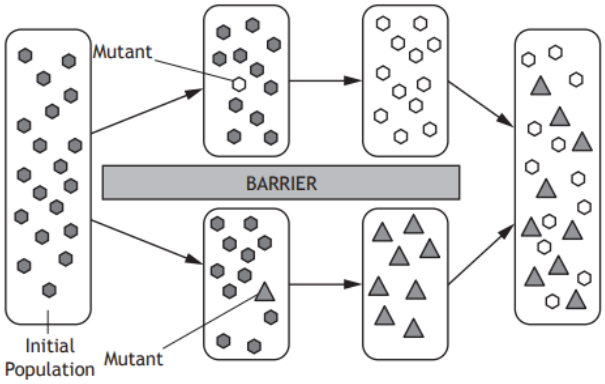
Weaker individuals die out.

4. Speciation

The two groups/subpopulations cannot interbreed to produce fertile offspring.

Example Exam Question

Using information from the diagram describe how new species are formed.



1. Initial population is separated /split by a barrier

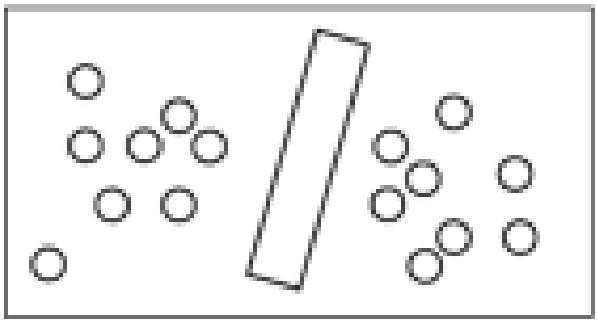
2. Different mutations occur in each subpopulation/ group at either side of the barrier

3. Natural selection occurs where the individual with a selective advantage will survive and reproduce and pass on successful alleles.

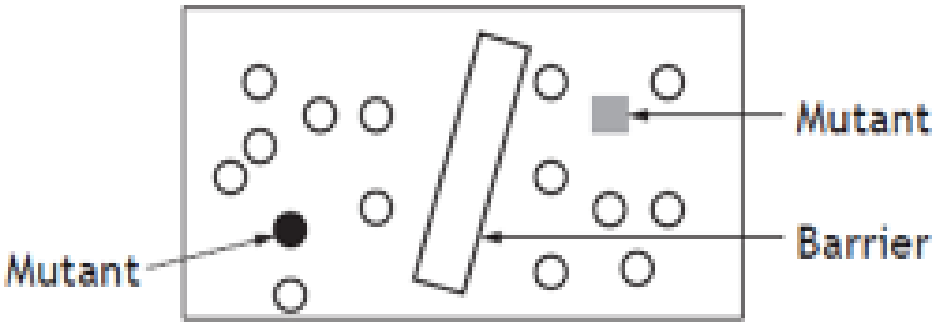
4. Subpopulations / groups are no longer able to interbreed to produce fertile offspring

8. Mutations and Speciation - Speciation

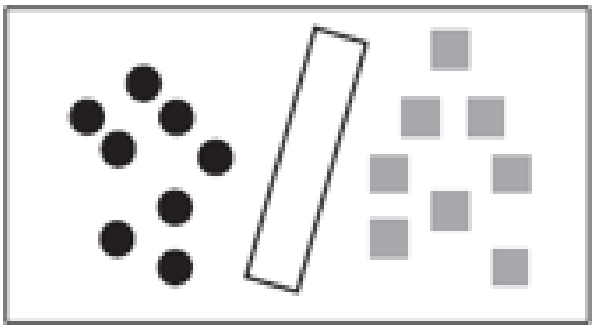
Diagram



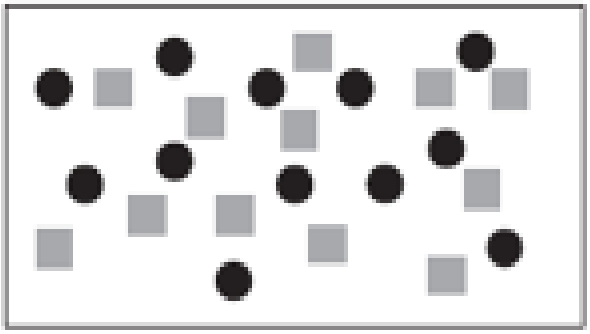
Isolating Mechanism
1 species split into 2 sub –populations by isolating mechanism (no gene flow)



Mutations
Mutation occurs on 1 side of barrier and not other OR Different mutations occur either side.



Natural Selection
Increased selection pressure for those with a selective advantage so they survive. Successful individuals reproduce & pass on their alleles.



Speciation
They cannot interbreed to produce fertile offspring.