Edexcel International A Level (IAL) Biology

Your notes

Ecosystems

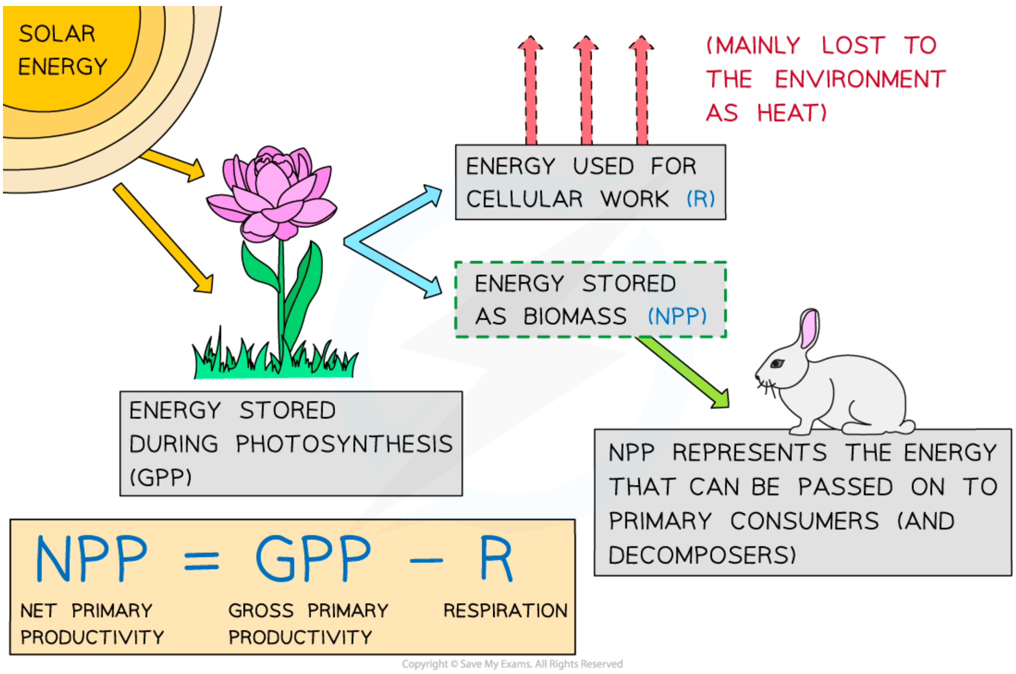
Contents

Your notes

Ecological Productivity

- During photosynthesis organisms such as plants convert **light energy** into **chemical energy** stored in biological molecules
  - Organisms that do this are known as **producers**
- The **rate** at which producers convert light energy into chemical energy is known as **primary productivity**
- **Gross primary productivity,** or **GPP,** can be defined as the **rate at which chemical energy is converted into carbohydrates** during photosynthesis
- **Net primary productivity,** or **NPP,** is the **GPP minus plant respiratory losses**
  - Of the total energy stored in glucose during photosynthesis, 90 % will be released from glucose to create ATP for the plant during respiration
  - 90 % of the energy originally converted by the plant will therefore **not be stored as new plant** biomass and will **not be available to be passed on** to **herbivores**, also known as **primary consumers**
- The NPP can therefore be defined as the **rate at which energy is stored in plant biomass**
  - NPP is important because it represents the energy that is available to organisms at **higher** trophic levels in the ecosystem, such as **primary consumers** and **decomposers**
- Net primary productivity can be calculated using the equation

NPP = GPP – R



Net primary productivity, or NPP, is the rate at which energy is stored in plant biomass and made available to primary consumers.

Your notes

Calculation of Ecological Productivity

- **Net primary productivity** can be calculated using the equation

NPP = GPP – R

- Where
  - NPP = net primary productivity; the rate at which light energy is **stored in plant biomass**
  - GPP = gross primary productivity; the rate at which light energy is **converted into carbohydrates** during photosynthesis
  - R = respiratory losses; the carbohydrates used up by the plant that are **not stored in plant biomass**
- NPP is expressed in **units of energy per unit area or volume per unit time** e.g.
  - Using area: J m^{-2} yr^{-1} (joules per square metre per year)
  - Using volume: J m^{-3} yr^{-1} (joules per cubic metre per year)
    - Volume would be used when calculating NPP in aquatic habitats

Worked Example

The grass in a meadow habitat converts light energy into carbohydrates at a rate of 17 500 kJ m^{-2} yr^{-1}. The grass releases 14 000 kJ m^{-2} yr^{-1} of that energy during respiration. Calculate the net primary productivity of the grass in the meadow habitat.

Answer:

Step 1: Work out which numbers correspond to which parts of the equation

The meadow grass converts 17 500 kJ m^{-2} yr^{-1} into carbohydrates; this is its GPP

The meadow grass releases 14 000 kJ m^{-2} yr^{-1} of that energy in respiration; this is R

Step 2: Substitute numbers into the equation

NPP = GPP - R

NPP = 17 500 - 14 000

Step 3: Complete calculation

17 500 - 14 000 = 3 500

NPP = 3 500 kJ m^{-2} yr^{-1}

Your notes

Examiner Tips and Tricks

The worked example above uses the equation in its basic form, but you may also be expected to rearrange the equation e.g. to calculate GPP or R

- If a question provides you with the **NPP** and **R** and asks you to calculate **GPP**, you will need to use the equation

  GPP = NPP + R

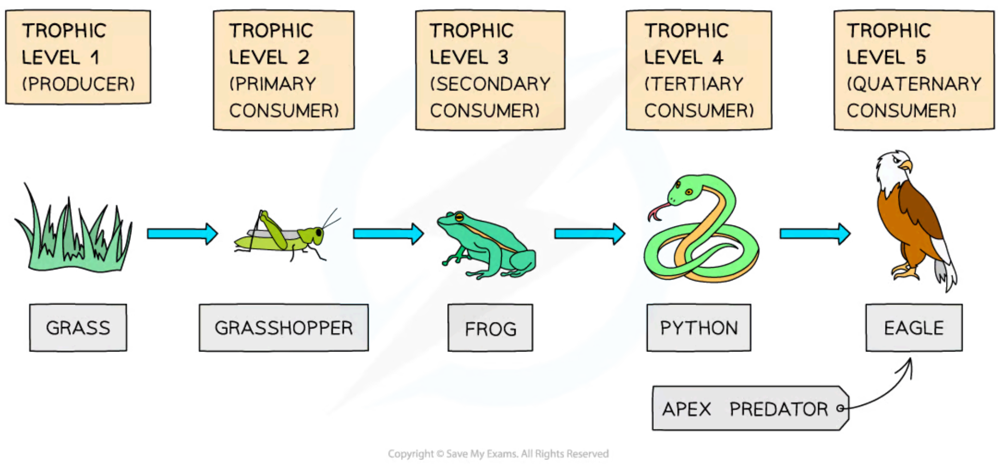
- If a question provides you with the **NPP** and the **GPP** and asks you to calculate **R**, you will need to use the equation

  R = GPP – NPP

Energy & Biomass Transfer Calculations

Transfer of energy through a food chain

- During photosynthesis organisms such as plants convert **light energy** into **chemical energy** stored in biological molecules
  - Organisms that do this are known as **producers**
- The chemical energy stored in plant biomass is passed to **primary consumers** when the plant is **ingested**
  - **Primary consumers** are animals that eat plant material; they can be herbivores or omnivores
- The primary consumer **digests** the plant tissues and uses the stored chemical energy either to fuel **respiration** or to build up **biomass**; this latter means that the **stored chemical energy is transferred** to the **tissues** of the primary consumer
- When the primary consumer is ingested by a **secondary consumer** the **stored chemical energy** passes to the secondary consumer, and so on up the food chain
  - When an organism dies, the chemical energy stored in its tissues passes to **decomposers** such as bacteria and fungi
- In a food chain the arrows represent the **transfer of energy** from one trophic level to the next by the process of **feeding**
  - The term **trophic level** refers to the stage in a food chain

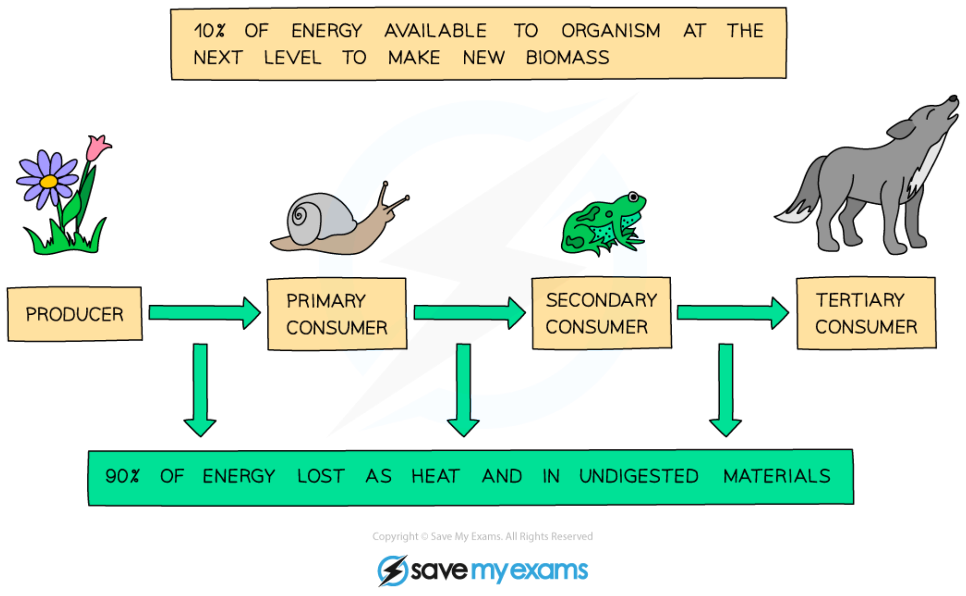


The light energy converted into chemical energy by producers is passed up the food chain by the process of feeding

Energy losses in a food chain

Your notes

- The transfer of energy in a food chain is not 100 % efficient; **energy is lost to the environment** at every trophic level
- A large proportion of the sun's energy is not available to **producers** for building **biomass**
  - Light **passes through leaves** or is **reflected** away
  - Light hits non-photosynthetic parts of the plant e.g. bark or flowers
  - Light is a mixture of wavelengths and **only certain wavelengths** are absorbed in photosynthesis
  - Plants release energy during respiration, some of which is lost to the environment in the form of **heat**
- When a consumer ingests another organism, **not all the chemical energy in the consumer's food is transferred to the consumer's biomass**
  - **Only around 10 %** of the energy is available to the consumer to store in their tissues
  - This is because **around 90 %** of the energy is **lost to the environment**
- Around 90 % of the energy is lost to the environment because
  - **Not every part of the food organism is eaten,** e.g. the roots and woody parts of plants or the bones of animals, meaning that the stored energy in these uneaten tissues is **lost** to the **environment**
  - Consumers are **not able to digest** all of the food they ingest, e.g. cellulose in plants or the fur of animals, so some is **egested** as **faeces**; the chemical energy in this undigested food is also lost to the environment
  - Energy is lost to the environment in the form of **heat** when consumers **respire**
  - Energy is lost to the environment when organisms **excrete** the waste products of metabolism e.g. urea in urine
- The energy that is left after these losses **is available to the consumer** to fuel their **life functions,** including being stored in **biomass during growth**
  - The **rate** at which energy is converted into **biomass** in the body of a **consumer** is known as **net productivity**
    - Note that this is slightly different to the rate at which energy is converted into biomass in **producers**, which is known as net **primary** productivity
- The energy losses at each trophic level act to **limit the maximum length of food chains**; organisms at higher trophic levels need to consume more food to gain enough energy to survive



Your notes

Energy is lost to the environment at every trophic level of a food chain

Calculating the efficiency of energy transfer

- The efficiency of energy transfer in a food chain can be calculated using the following equation

Energy efficiency = (net productivity ÷ energy received) × 100

- Note that net productivity can be calculated by **subtracting energy losses from energy received**
- Efficiency of energy transfer is given as a **percentage**

Worked Example

A wheat farmer decides to use biological control against insect pests that are eating her wheat crop. The farmer introduces a species of toad. By eating the insect pests the toads ingest 10 000 kJ m^{-2} yr^{-1} of energy. The toads lose 7 000 kJ m^{-2} yr^{-1} of this energy as heat from respiration and 2 000 kJ m^{-2} yr^{-1} of energy in faeces and urine. Calculate the efficiency of energy transfer from the insects to the toads.

Answer:

Step 1: Calculate the net productivity of the toads

Toad energy received= 10 000 kJ m^{-2} yr^{-1}

Toad energy losses = 7 000 + 2 000 = 9 000 kJ m^{-2} yr^{-1}

Toad net productivity = 10 000 - 9 000 = 1 000

$$\text{Toad net productivity} = 1\,000 \text{ kJ m}^{-2}\text{ yr}^{-1}$$

Step 2: Substitute values into the equation

$$\text{Energy efficiency} = (\text{net productivity} \div \text{energy received}) \times 100$$

$$\text{Energy efficiency} = (1\,000 \div 10\,000) \times 100$$

Step 3: Complete calculation

$$\text{Energy efficiency} = (1\,000 \div 10\,000) \times 100$$

$$\text{Energy efficiency} = 10\ \%$$

Calculating the efficiency of biomass transfer

- It is also possible to calculate the **efficiency of biomass transfer** from one trophic level to the next in a food chain
- In order to calculate this scientists need to know the **biomass** of the organisms concerned
  - **Dry biomass** is used, as the amount of water stored in tissues can vary
  - Dry biomass can be measured by **drying a sample of the organism** in an oven at a low heat and **weighing the sample** at regular intervals until the mass becomes constant; this will be the dry biomass
    - The organism needs to be dead for this process to be carried out, so an estimate is often used
  - Depending on the transfer being studied, it may then be necessary to multiply up the sample to take into account the size of the area or number of organisms being studied
- The efficiency of biomass transfer can be calculated using the following equation

Efficiency of biomass transfer = (biomass transferred ÷ biomass intake) × 100

- **Biomass transferred** refers to biomass that has passed to the higher trophic level while **biomass intake** refers to biomass of the lower trophic level that has been consumed
- Efficiency of biomass transfer is given as a **percentage**

Worked Example

A blackberry bush with a dry mass of 35 kg is fed upon by aphids with a collective dry mass of 4.1 kg. Calculate the percentage efficiency of biomass transfer in this step of the food chain.

Answer:

Step 1: Ensure both units are the same

Your notes

In this case, both are expressed in kg so the units do not need to be converted

Step 2: Substitute the values into the equation

Efficiency of biomass transfer = (biomass transferred ÷ biomass intake) × 100

Efficiency of biomass transfer = (4.1 ÷ 35) × 100

Step 3: Complete calculation

Efficiency of biomass transfer = (4.1 ÷ 35) × 100

Efficiency of biomass transfer = 11.7 %

Examiner Tips and Tricks

It is worth bearing in mind that the **biomass** of an organism is effectively a measure of how much **chemical energy** is stored within it, so a calculation of the efficiency of biomass transfer essentially provides the same information as a calculation of the efficiency of energy transfer.

Your notes

Ecology: Key Terms

Habitat

- Species are adapted, or well-suited, to life in a particular habitat
- A habitat can be defined as **the place where an organism lives**
  - A habitat can be **large,** e.g. a desert, or **small,** e.g. an individual tree
    - Small habitats are sometimes referred to as **microhabitats**
  - Some species are habitat **specialists,** meaning that they can only survive in a very specific type of habitat, while others are **generalists** and can survive in a range of habitats
    - Generalists are more likely to be able to invade and take over a new habitat; such species are known as invasive species
      - Humans sometime release new species into a habitat, either accidentally or on purpose; these species can disrupt the normal species interactions in a habitat and cause serious problems

Population

- When a species is found in a habitat, that habitat is said to support a **population**
- A population can be defined as **all of the individuals of one species living in a habitat**
  - The size of a population can be measured; this is the **abundance** of a species in a habitat
  - The exact location of a population within a habitat is a species' **distribution** within that habitat

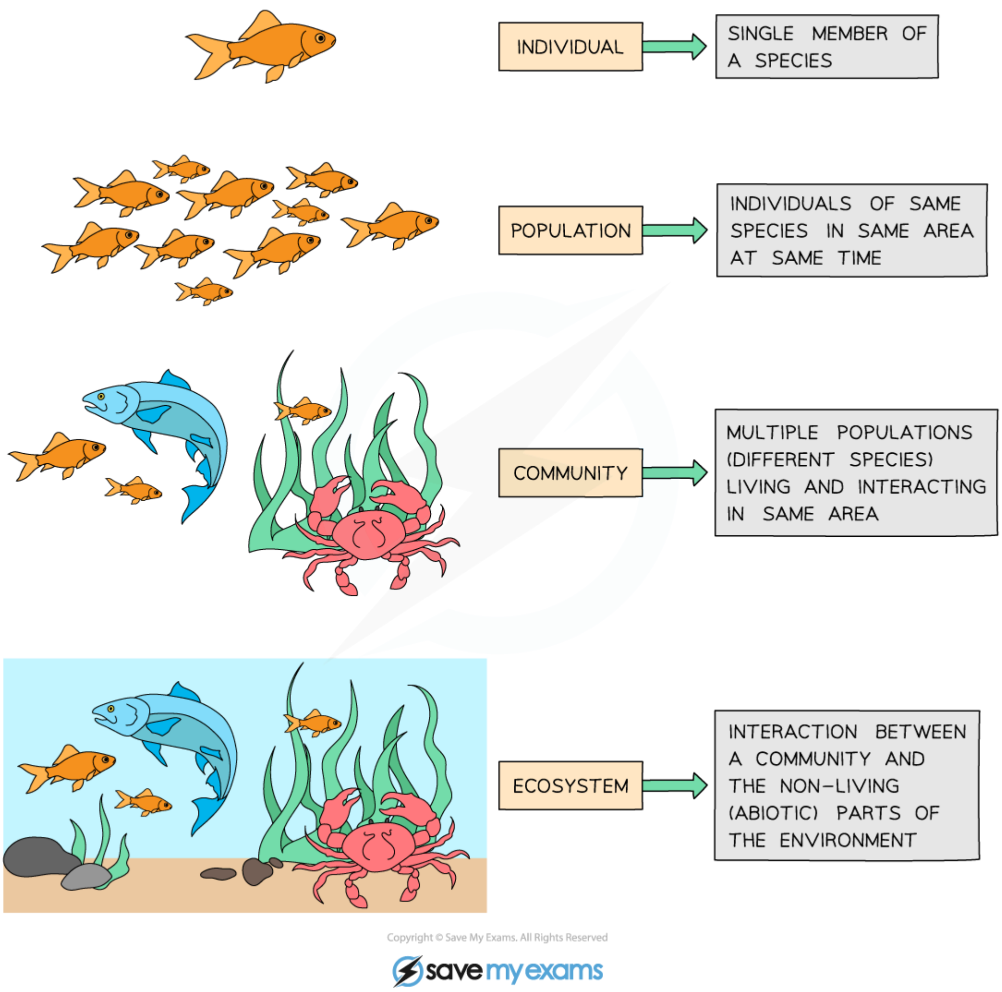
Community

- Species do not exist by themselves in their own isolated environment; they **interact** with **other species**, forming **communities**
- A community can be defined as **multiple populations living and interacting in the same area**
  - For example, a garden pond **community** is made up of populations of fish, frogs, newts, pond snails, damselflies and dragonflies and their larvae, pondweed, water lilies, and all other populations living in the pond

Ecosystem

- Communities interact with the **non-living components** of the **habitat** they live in, forming **ecosystems**

- An ecosystem can be defined as **a community and its interactions with the non-living parts of its habitat**
  - There is a flow of energy within an ecosystem and nutrients within it are recycled
  - There are both biotic and abiotic **components** within an ecosystem
  - Ecosystems **vary greatly in size and scale**
    - A small pond in a back garden and the open ocean could both be described as ecosystems
  - Ecosystems **vary in complexity**
    - A desert is a relatively simple ecosystem
    - A tropical rainforest is a very complex ecosystem
  - No ecosystem is completely self-contained as organisms from one ecosystem can often move to another
    - E.g. birds and aquatic animals are able to migrate long distances to feed from multiple ecosystems



Your notes

Individual members of a species together in a habitat form a population, populations interact within a community, and communities interact with each other and with non-living components of their habitat to form an ecosystem.

Your notes

Your notes

Factors Affecting Populations

- The abundance and distribution of a species within a habitat are determined by a combination of biotic and abiotic factors
- **Biotic factors** are **living** factors that influence populations within their community; biotic factors come about as a result of the **activity of other organisms** e.g.
  - Predation
  - Food availability
  - Intraspecific competition, arising when individuals of the **same** species compete for resources
  - Interspecific competition, arising when individuals of **different** species compete for resources
  - Cooperation between organisms
  - Parasitism
  - Disease

The Impact of Biotic Factors on a Community Table

Your notes

BIOTIC FACTOR	HOW BIOTIC FACTOR AFFECTS COMMUNITY	EXAMPLE
AVAILABILITY OF FOOD	MORE FOOD MEANS ORGANISMS HAVE A HIGHER CHANCE OF **SURVIVING** AND **REPRODUCING**. THIS MEANS THEIR **POPULATIONS CAN INCREASE**	RAINFOREST ECOSYSTEMS HAVE A RICH FOOD SUPPLY AND THIS ALLOWS MANY SPECIES TO LIVE THERE. DESERTS HAVE A POOR FOOD SUPPLY AND THIS ALLOWS FEWER SPECIES TO LIVE THERE
NEW PREDATORS	IN **BALANCED** ECOSYSTEMS, PREDATORS CATCH ENOUGH PREY TO SURVIVE BUT NOT SO MANY THAT THEY WIPE OUT THE PREY POPULATION. IF A NEW PREDATOR IS I NTRODUCED TO THE ECOSYSTEM, IT MAY BECOME **UNBALANCED**	RED FOXES WERE INTRODUCED FOR RECREATIONAL HUNTING IN AUSTRALIA IN THE 1800S BUT HAVE SINCE CAUSED THE DECLINE OF MANY NATIVE SPECIES THAT THEY FEED ON, SUCH AS SMALL MAMMALS AND BIRDS. THIS HAS ALSO REDUCED THE FOOD SUPPLY FOR NATIVE PREDATORS
NEW PATHOGENS	IF A NEW PATHOGEN ENTERS AN ECOSYSTEM, THE POPULATIONS LIVING THERE WILL HAVE **NO IMMUNITY OR RESISTANCE** TO IT AND THE POPULATION MAY DECLINE OR BE WIPED OUT	CORONAVIRUS CAUSED A GLOBAL PANDEMIC AND A DECLINE IN MANY HUMAN POPULATIONS AROUND THE WORLD BECAUSE IT WAS A NEW PATHOGEN
COMPETITION	IF TWO SPECIES COMPETE FOR THE SAME RESOURCE(S) AND ONE IS BETTER ADAPTED TO TAKE ADVANTAGE OF THESE RESOURCES, THEN THAT SPECIES WILL **OUTCOMPETE** THE OTHER. THIS MAY CONTINUE UNTIL THERE ARE TOO FEW MEMBERS OF THE LESSER ADAPTED SPECIES TO BREED SUCCESSFULLY	NORTH AMERICAN GREY SQUIRRELS WERE INTRODUCED TO THE UK IN THE 1800S AND HAVE SINCE CAUSED THE DE-CLINE IN OUR NATIVE RED SQUIRREL POPULATION. GREY SQUIRRELS HAVE **OUTCOMPETED** RED SQUIRRELS FOR RESOURCES SUCH AS FOOD AND NEST-SITES. THEY ALSO CARRY A VIRUS **(A NEW PATHOGEN)** THAT RED SQUIRRELS HAVE NO RESISTANCE TO

- **Abiotic factors** are **non-living** factors that influence populations within their community e.g.
  - Light intensity and wavelength
  - Temperature
  - Turbidity, or cloudiness, of water
  - Humidity
  - Soil or water pH
  - Soil or water salinity
  - Soil composition
  - Oxygen or Carbon dioxide concentration

The impact of Abiotic Factors on a Community Table

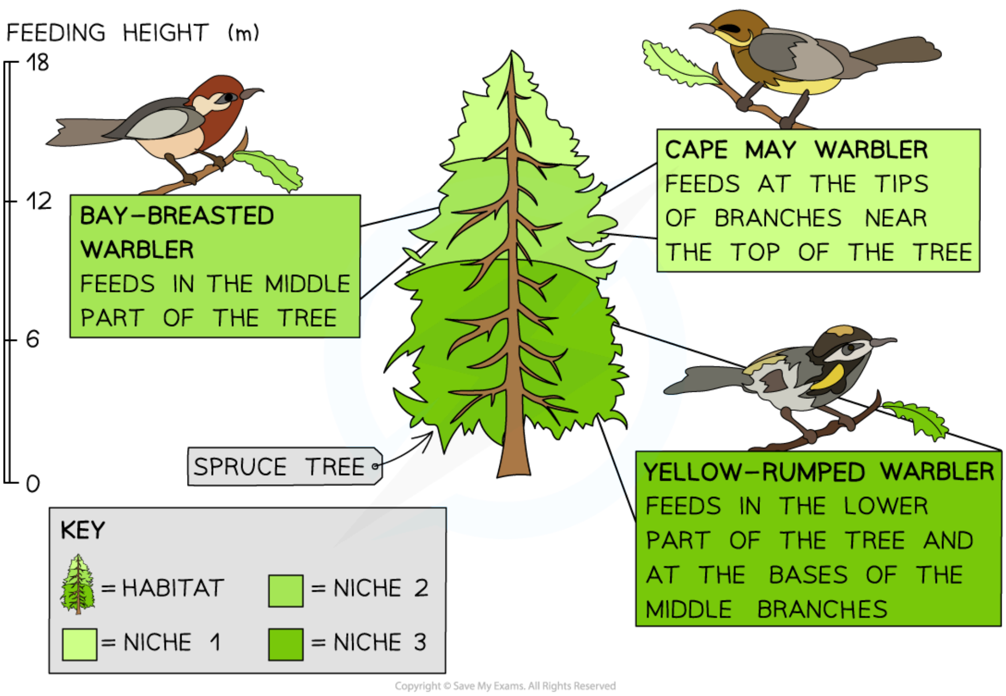
Your notes

ABIOTIC FACTOR	HOW ABIOTIC FACTOR AFFECTS COMMUNITY
LIGHT INTENSITY	LIGHT IS NEEDED BY PLANTS FOR **PHOTOSYNTHESIS.** MORE LIGHT LEADS TO AN INCREASE IN RATE OF PHOTOSYNTHESIS AND AN INCREASE IN **PLANT GROWTH RATE**
TEMPERATURE	AFFECTS THE RATE OF PHOTOSYNTHESIS IN PLANTS
MOISTURE LEVELS	PLANTS AND ANIMALS REQUIRE WATER TO SURVIVE
SOIL pH AND MINERAL CONTENT	DIFFERENT SPECIES OF PLANTS ARE ADAPTED TO DIFFERENT SOIL pH LEVELS AND NUTRIENT CONCENTRATION LEVELS
WIND INTENSITY AND DIRECTION	WIND SPEED AFFECTS **TRANSPIRATION RATE** IN PLANTS. TRANSPIRATION **AFFECTS THE RATE OF PHOTOSYNTHESIS** AS IT ENSURES WATER AND MINERAL IONS ARE TRANSPORTED TO THE LEAVES
CARBON DIOXIDE LEVELS FOR PLANTS	CO_2 IS REQUIRED FOR PHOTOSYNTHESIS IN PLANTS. CO_2 CONCENTRATION AFFECTS THE RATE OF PHOTOSYNTHESIS
OXYGEN LEVELS FOR AQUATIC ANIMALS	SOME AQUATIC ANIMALS (SUCH AS FISH) CAN ONLY SURVIVE IN WATER WITH HIGH OXYGEN CONCENTRATIONS

Your notes

The Concept of Ecological Niche

- The place where a species lives is known as its **habitat**
- Species will occupy a specific **niche** within a habitat
- The term niche can be defined as **the role of a species within its habitat**
- The role of a species includes
    - What it eats
    - Which other species depend on it for food
    - What time of day a species is active
    - Exactly where in a habitat a species lives
    - Exactly where in a habitat a species feeds
- **No two species can fill the same niche within a habitat**; if this ever happens the two species will be in **direct competition** with each other for resources, and one of the two species will **out-compete** the other, causing it to die out in that particular habitat
    - It can sometimes seem as though species are occupying the same niche, but there will still be subtle differences in their role; e.g. they might feed at **different times of day**, or have **different food sources**
- The niche filled by a species determines its **abundance** within a habitat
    - The term abundance can be defined as **the number of individuals of a particular species living in a habitat**
    - If two species occupy a similar niche within a habitat they will be **competing with each other**, so their **populations will be smaller**, and their **abundance will therefore be lower**
- The niche filled by a species determines its **distribution**
    - The term distribution can be defined as **where a species lives**
    - Species can only survive in habitats to which they are **well adapted**; if they are not well suited to a habitat's **biotic** and **abiotic** factors then they will move to a more suitable habitat and their **distribution** will change



Feeding location is an example of a feature that may differ between niches.

Your notes

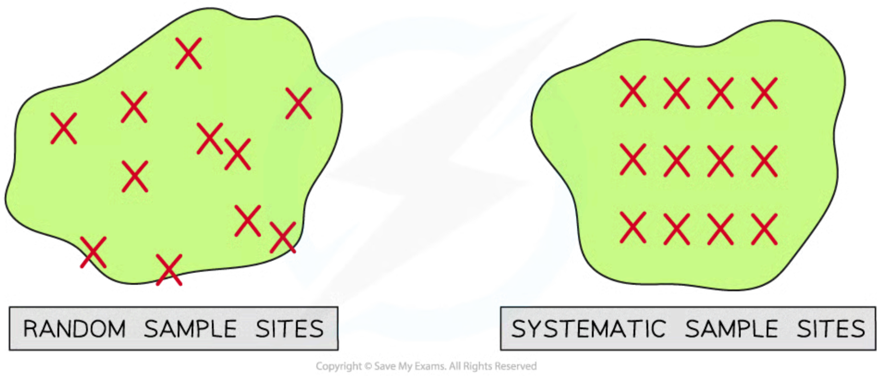
Quadrat & Transect Study

- Finding out about the abundance and distribution of species can be achieved by counting all of the organisms present in a habitat
- This is possible for areas that are very small or where the species are very large
- For larger and more complex habitats it is not possible to find, identify, and count every organism that is present
- When this is the case **sampling** can be used to make an **estimate** for the total species numbers

Sampling

- Sampling is a method of investigating the **abundance and distribution of species and populations**
- There are two different types of sampling
  - **Random**
  - **Systematic**
- In **random sampling** the positions of the sampling points are selected **at random**
  - This method avoids **bias** by the person that is carrying out the sampling
  - Bias **can affect the results** e.g.
    - A student might choose to carry out samples in a particular location because it looks interesting, and this might give the impression that the habitat contains more species than it really does
- In **systematic sampling** the positions of the sampling points are located at **fixed intervals** throughout the sampling site
  - This avoids accidentally missing out sections of habitat due to chance
  - Systematic sampling allows researchers to investigate the **effect of the presence of certain environmental features** on species distribution e.g. by taking samples **along a line** that extends away from an environmental feature such as a river
    - A line of this type is known as a **transect**
- When a sampling area is **reasonably uniform** then **random sampling** is the best choice
- Random sample sites can be selected by
  - Laying out a **grid** over the area to be studied
  - Generating **random number co-ordinates**

- Placing sample sites in the grid squares that match the random number co-ordinates



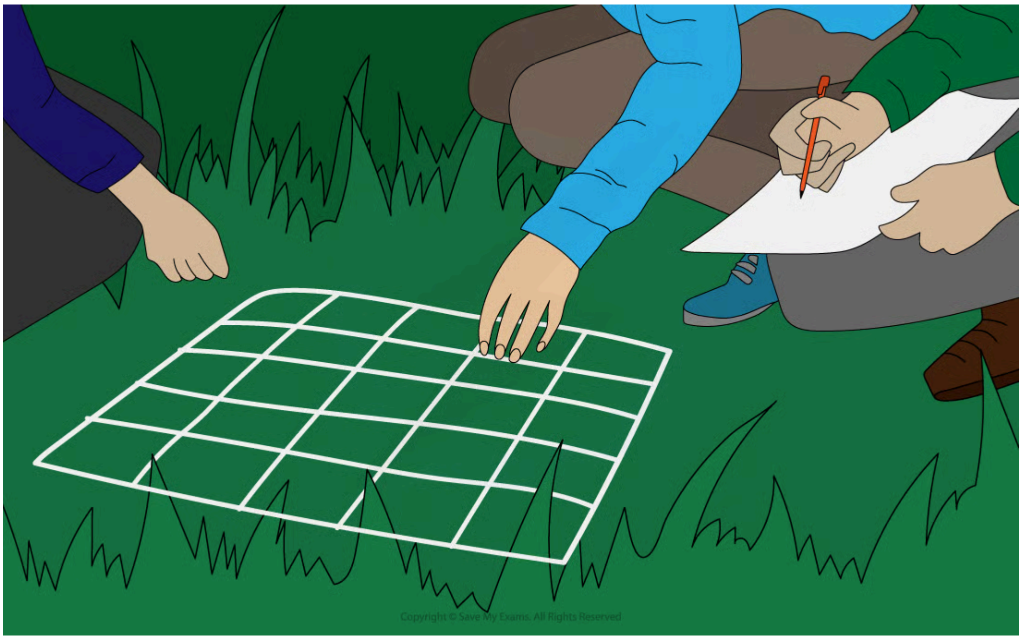
Random sampling involves selecting sample sites at random while systematic sampling involves placing sample sites at regular intervals.

Determining distribution and abundance

- The distribution and abundance of a species in an area can be assessed using different practical methods:
  - Frame and point **quadrats**
  - Line and belt **transects**

Frame quadrats

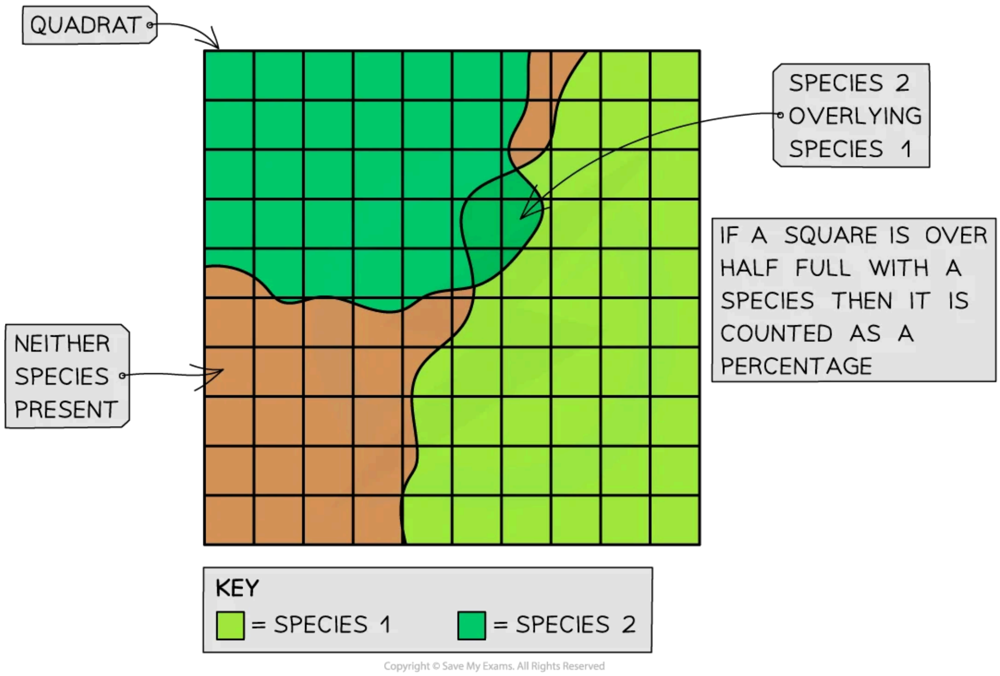
- A **frame quadrat** is a **square frame** that is placed within the area to be studied to provide a **sample**
  - Quadrats are used to study the **distribution** of sessile organisms
  - Quadrats can be **different sizes** depending on the species being studied
    - A 1 m^2 quadrat can be used to study small organisms such as herbaceous plants in a grassland or limpets on a rocky shore
    - A 400 m^2 quadrat can be used to study large organisms such as trees
      - Quadrats like this will usually be marked out with string rather than a frame!
- Frame quadrats can be placed in a habitat **randomly,** e.g. using random co-ordinates, or **systematically,** e.g. along a transect



A frame quadrat can be used to measure abundance and distribution

- Scientists can record **different types of data** from a frame quadrat depending on the aim of a study and the species involved
  - **Presence or absence** of a species
  - **Species frequency**; how many individuals are in the quadrat
  - **Species abundance**; measured on a scale called the **ACFOR** scale on which species are recorded as being abundant, common, frequent, occasional, rare, or none
  - **Percentage cover**; the percentage of the quadrat covered by a species
    - Quadrats can be divided up into smaller squares to allow percentage cover to be assessed more easily

Your notes

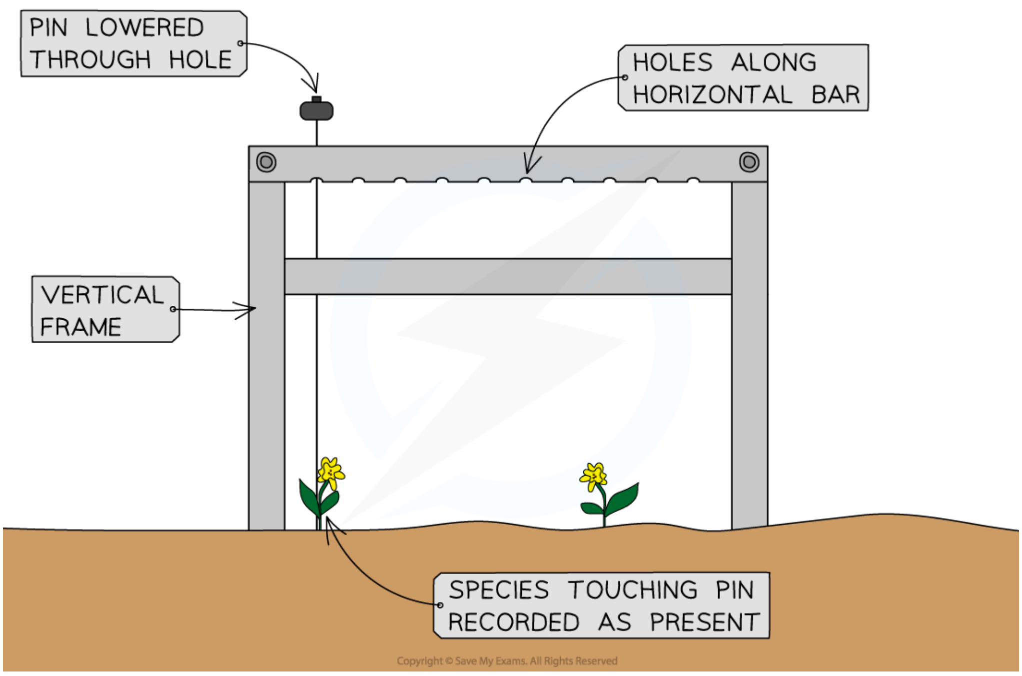


Abundance in a frame quadrat can be assessed by measuring percentage cover

Point quadrats

- A **point quadrat** is a vertical frame with holes across the top through which **pins** are lowered
    - This is useful in areas with **dense plant cover** as the ground may be difficult to study using a frame quadrat
    - Point quadrats can be placed in a habitat **randomly,** e.g. using random co-ordinates, or **systematically,** e.g. along a transect
- When a lowered pin touches a species, that species is recorded as being present
    - If several species are touching the pin then all of those species are recorded
- Point quadrats can be used to measure abundance in the following ways
    - The **number of individuals** of a species present
        - Each individual that touches a pin is recorded
    - **Percentage cover** of a species
        - The number of pins touched by a species is divided by the total number of pins used
        - Most point quadrats have ten pins, so if all the pins are used then a species touching one pin counts as 10 percent cover

Your notes

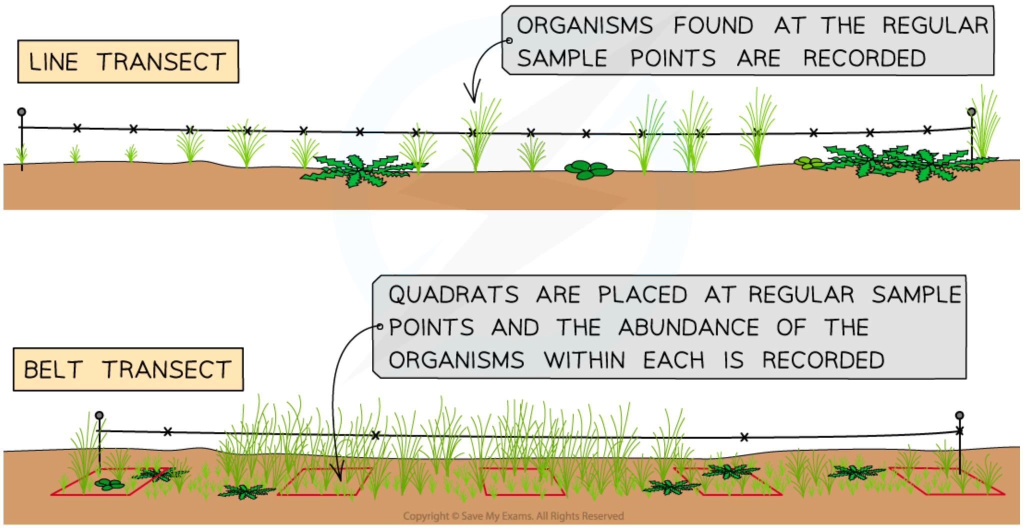


Point quadrats can be used to measure the the number of individuals of a species or percentage cover

Transects

- **Transects** are lines laid out across a site that can be used to measure abundance and distribution **across a habitat**
    - Transects are useful for determining **how species abundance and distribution might change along a gradient** e.g. at increasing distances from a field margin or perpendicular to the water's edge on a rocky shore
- To carry out a **transect**, a tape measure is laid out along the gradient of interest, and samples are taken along the line
- There are different ways of carrying out transect studies
    - **Continuous line transect**
        - **Every species** touching the tape measure is recorded
    - **Interrupted line transect**
        - Species touching the line **at regular intervals**, e.g. every metre, are recorded
    - **Continuous belt transect**
        - Frame quadrats are placed **end-to-end** along the line
    - **Interrupted belt transect**
        - Frame or point quadrats are placed **at regular intervals**, e.g. every metre, along the line

Your notes



Interrupted line and belt transects can be used to measure abundance and distribution of species along a line across a habitat

Measuring abiotic factors

- The distribution and abundance of species in a habitat are affected by abiotic factors
- When investigating the impact of an abiotic factors on species abundance and distribution it is important to **measure the relevant abiotic factors** at the sample sites
  - It is only necessary to record relevant abiotic factors
    - A study may only be interested in one particular abiotic factor
    - Some abiotic factors may not be relevant in certain habitats e.g. water turbidity (cloudiness) will not be relevant in a woodland habitat
- Abiotic factors can be measured using **specialised equipment** and **techniques**

Measuring Abiotic Factors Table

Your notes

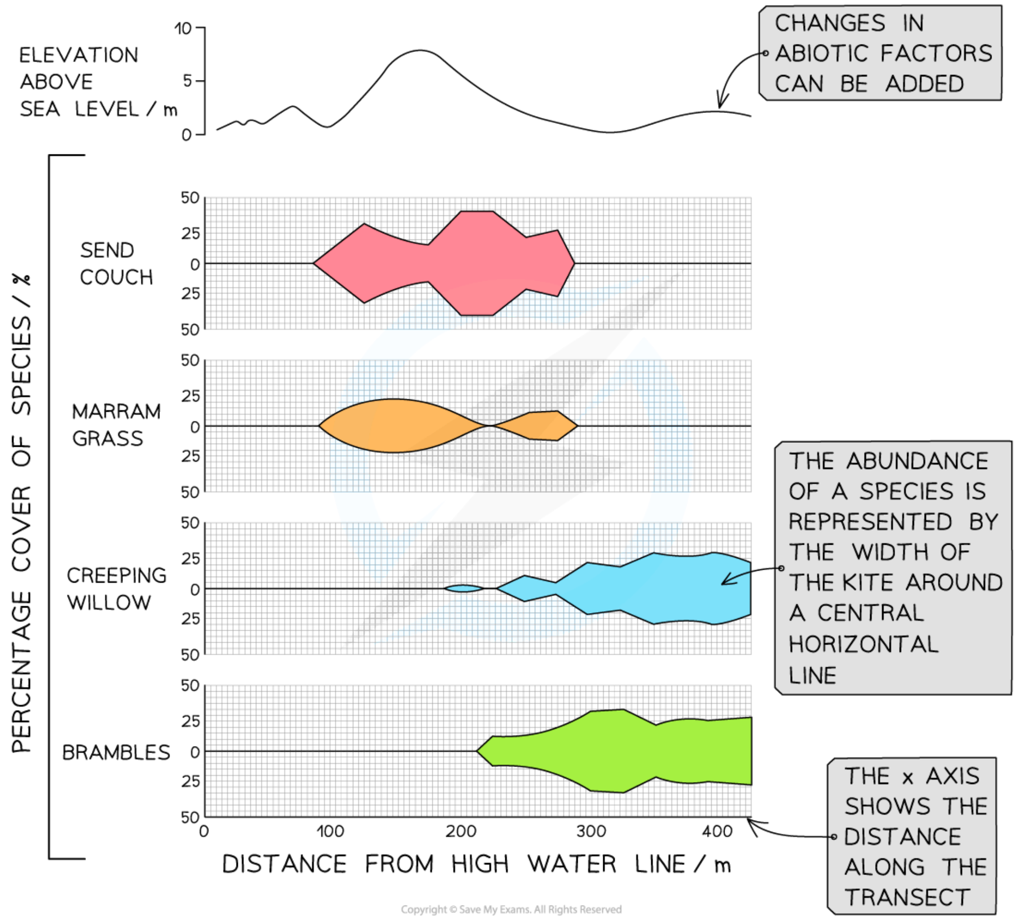
Abiotic factor	How it is measured
Air temperature	Thermometer
Rainfall	Rain gauge; a funnel collects water in a measuring cylinder and the volume of water collected is recorded
Humidity	Hygrometer; an electronic device that measures water vapour content of air
Dissolved oxygen	Electronic oxygen sensor
Water turbidity (cloudiness)	A turbidity meter measures light scatter by particles in the water, or a Secchi disc is lowered into the water and the depth at which it is no longer visible is recorded
Light intensity	Electronic light meter
Landscape relief (changing height of land)	Map contour lines or GPS meter
Site aspect (direction that site faces)	Compass
Slope incline	Clinometer; the angle of a slope is measured using a specialised protractor and the incline calculated using the principles of trigonometry
Soil or water pH	Indicator solution mixed with soil or water sample
Soil water content	Calculating the difference in mass between a a moist soil sample and the same sample after it has been dried

Representing results

- The results of an investigation into the distribution and abundance of organisms can be represented visually using a type of graph known as a **kite diagram**
- Kite diagrams can show both **distribution** and **abundance**
  - The distribution of a species along a transect can be shown by its **position along a central horizontal line** in each section of a kite diagram
    - Each section represents a different species
    - The **distance along the transect is given on the x-axis**, to which the horizontal line is parallel
  - The abundance of a species can be shown by the **width of the 'kite'** around the central horizontal line
    - The shape is referred to as a kite because it extends an **equal distance** on each side of the central horizontal line

- Additional sections can be added to a kite diagram to show the **changes in abiotic factors** at different points along a transect e.g. the height above sea level or the pH of soil

Your notes



Kite diagrams can be used to provide a visual representation of both abundance and distribution of species, as well as changes to abiotic factors such as elevation

Examiner Tips and Tricks

You could be asked to describe or design an investigation that could be used to measure the effect of a specific abiotic factor on species abundance or distribution, so make sure that you know the circumstances in which each sampling technique would be used, and how to use it.

Remember that when describing a practical you should always consider:

- How you will change the **independent variable**
  - In this context you might be measuring a change in the independent variable, or abiotic factor, rather than causing the change yourself
  - Note that this might not be relevant if you have just been asked to measure the abundance of a species in one habitat

- How you will measure the **dependent variable**
- How you will ensure that your **results are valid**

Your notes

Your notes

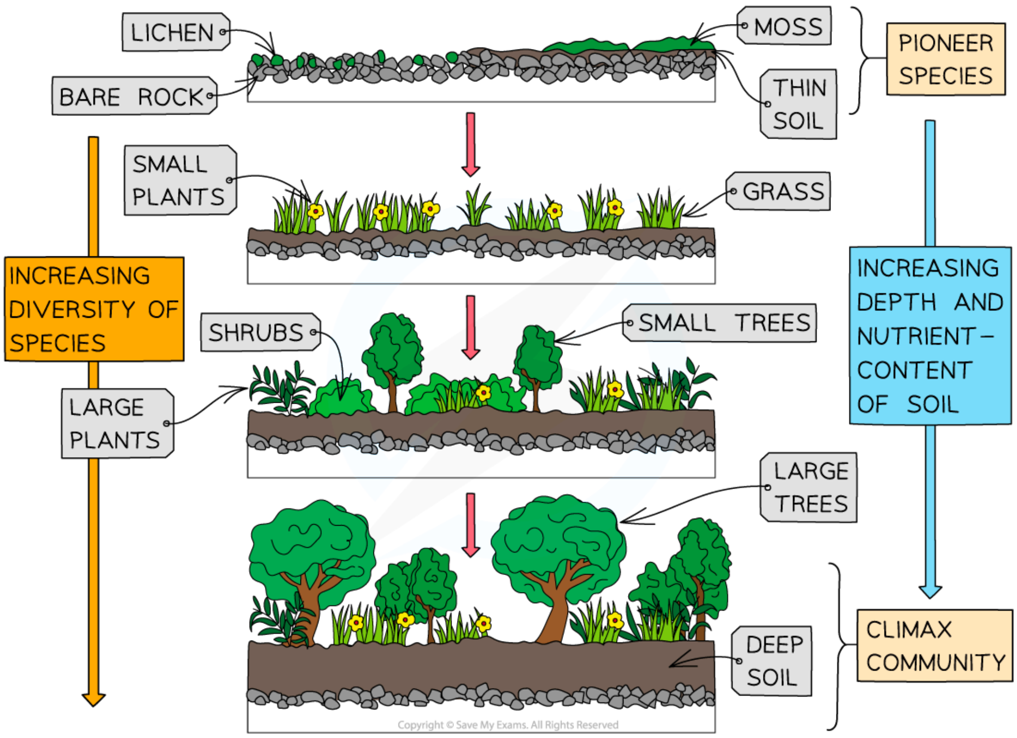
Ecological Succession

- Ecosystems are **dynamic**, meaning that they are constantly **changing**
- The **process of ecosystem change over time** is known as **succession**
  - During succession, the biotic and abiotic conditions change
- **Primary succession** is the process that occurs when **newly formed** or **newly exposed** land is inhabited by an increasing number of species
  - Newly formed land can be created by e.g.
    - The magma from erupting **volcanoes** cooling and forming **new rock** surfaces or new rocky **islands** in the sea
  - Newly exposed land can form by e.g.
    - A **landslide** that exposes bare rock
    - A **glacier that retreats** to reveal bare rock
- The arrival of organisms on bare land is known as **colonisation**, and the bare land is said to be **colonised**

Primary succession occurs in a series of stages

- **Primary succession** can occur on any type of bare land, including sand dunes at the edge of the ocean, and on exposed rock
- Primary succession on bare rock involves the following stages
  - **Seeds** and **spores** that are carried by the **wind** land on exposed rock and begin to grow
    - The first species to colonise the new land, often **mosses** and **lichens,** are known as **pioneer species**
    - Pioneer species can **germinate easily** and **withstand harsh conditions** such as low nutrient and water availability
  - As pioneer species die and decompose, the dead **organic** matter forms **soil**
  - Seeds of **small plants and grasses** land on this soil and begin to grow
    - The plants at this early stage of succession are **adapted** to survive in **shallow**, **nutrient-poor** soils
  - The **roots** of these small plants form a network that helps to **hold the soil in place** and prevent it from being washed away
  - As these small plants die and decompose, the soil becomes **deeper** and more **nutrient-rich**

- **Larger plants and shrubs**, as well as **small trees** can now begin to grow
  - These larger plants and small trees also require **more water**, which can be stored in **deeper soils**
- Over time the soil becomes sufficiently deep, contains enough nutrients, and can hold enough water to support the growth of **large trees**
- The **final species** to colonise the new land become the **dominant species** of the now **complex ecosystem**
- The **final community** formed, containing all the different plant and animal species that have now colonised the land, is known as the **climax community**
  - The type of climax community that forms depends on the location of the original bare land; in the tropics the climax community would be a rain forest, while in temperate regions it might be deciduous woodland
  - A climax community is not always the most biodiverse stage of succession, but it is a **stable** community



Primary succession is the process of ecosystem change over time, beginning with newly formed or newly exposed land

Succession changes the biotic and abiotic conditions

- At each **stage** in **succession** the newly arriving species **change** the **local environment** so that it becomes **more suitable** for **other species** that have not yet colonised the new land e.g.

Your notes

Your notes

    - **Pioneer species** such as **lichens** help to slowly **break apart** the top surface of bare rock; this fragmented rock, along with the dead organic matter left behind when the lichens die and are broken down, forms a **basic soil**
    - Species such as grasses grow roots that **stabilise the soil**, enabling it to hold more moisture and nutrients
- Often the new colonising species then change the environment in such a way that it becomes **less suitable** for the **previous species** e.g.
    - Lichens cannot grow on soil so they **disappear** from the **ecosystem** once soil begins to form; the new species change the environment in such a way that it becomes **less suitable** for the lichens
        - Pioneer species may not be found in a climax community as they will be **out-competed** for light and other resources by the species that arrive during the later stages of succession
        - Pioneer species are well adapted for harsh conditions but are often poor competitors
    - As soil deepens and **trees** are able to grow, they may block out the light to shrubs and other smaller plant, out-competing them and causing them to die

Secondary succession

- There is also a type of succession called **secondary succession** which takes place on previously occupied land e.g. after a wild fire or deforestation
    - Secondary succession is very similar to primary succession except that **soil is already present** so the process begins at a later stage

Humans can prevent succession

- **Human activities** often **prevent** or **interrupt** the process of succession
- This stops a **climax community** from developing e.g.
    - Regular **mowing** prevents woody plants from establishing themselves in a lawn
    - The **grazing** activity of livestock such as sheep and cattle prevent new plants from establishing
- Climax communities that develop as a result of human intervention are known as a **plagioclimax**; these communities are stable but would not have occurred without human intervention, e.g. heathland

Examiner Tips and Tricks

You could be presented with an example of succession other than the one provided here e.g. succession on a sand dune. As long as you understand the principles of the stages of succession you should be able to apply your knowledge to any example that an exam question might throw at you.

Your notes