Glenlola Collegiate School

excellence through commitment, contribution and caring

1.7 ECOLOGICAL RELATIONSHIPS & ENERGY FLOW

Booklet A

NAME _____

LEARNING OUTCOMES
CCEA GCSE BIOLOGY: 1.7.1 - 1.7.14 & 1.7.16
UNIT 1.7A: Ecological Relationships and Energy Flow

	LEARNING OUTCOMES	PUPIL SELF-EVALUATION		
	Pupils should be able to:	Good	Average	Requires Attention
1.7.1	Use appropriate sampling techniques to investigate changes in the distribution of organisms within a sample area, limited to quadrats, pitfall traps, pooters and nets			
1.7.2	Use and construct keys to identify organisms and classify them into major groups based on the observable features			
1.7.3	Use observations of organisms to help describe the main features of the five kingdoms (protoctista, bacteria, fungi, plants and animals), to include:			
	• mode of nutrition			
	• cell wall			
	• cellular organisation			
1.7.4	Understand the difficulties in classifying:			
	• species as a group of organisms, with shared features, which can breed together to produce fertile offspring			
	• viruses, which lack cellular organisation and are therefore considered by many biologists as non-living			
	Understand that classification systems change over time			
1.7.5	Understand why classification is needed for:			
	• identification			
	• the study of how organisms have changed through time			
	• the comparison of biodiversity			
	• conservation of species			
1.7.6	Understand the meaning of the terms biodiversity, population, habitat, environment, community and ecosystem			
1.7.7	Measure biotic and abiotic factors, such as wind speed, water, pH, light, temperature and biodiversity (the number of plant and animal species)			
1.7.8	Use data collected (primary or secondary) as evidence to account for the distribution of organisms			
1.7.9	Account for this distribution in terms of the adaptations of the organisms found to their environment and competition for resources, which can affect population growth, (water, light, space and minerals in plants and water, food, territory and mates in animals			
1.7.10	Evaluate the validity and reliability of data collected during fieldwork when drawing conclusions about the methods of data collection and environment;			

1.7.11	Use mathematical models to explain changes in populations			
	Explain the consequences of changes in population density on the environment, to include birth and death rates, emigration and immigration			
1.7.12	Understand that the Sun is the source of energy for most ecosystems on Earth			
	and understand the role of green plants as producers in capturing this energy and making it available to other organisms;			
1.7.13	Understand food chains and webs and be able to identify producers, consumers and trophic levels;			
1.7.14	Construct pyramids of numbers and biomass as models of food chains and explain the difference			
	● explain the advantages and disadvantages of each type of pyramid			
	● understand the difficulties caused by organisms feeding at two different trophic levels.			
1.7.16	Use data to interpret and explain in terms of the amount of energy available at each trophic level, decreased due to heat from respiration, excretion and egestion and uneaten structures			
	and understand why shorter food chains are more efficient			

Terminology
quadrats, pitfall trap, pooter, key, classify, protoctista, bacteria, fungi, nutrition, autotrophic, heterotrophic, saprophyte, species, population, community, environment, biotic, abiotic, ecosystem, habitat, biodiversity, competition, validity, reliability, immigration, emigration, birth rate, death rate, producer, consumer, primary, secondary, tertiary, trophic level, pyramid of numbers, inverted pyramid of numbers, biomass, pyramid of biomass, energy flow

UNIT TEST RESULT: % GRADE:	
COMMENT	

Ecological definitions

ECOLOGY =

COMMUNITY =

POPULATION =

SPECIES =

ENVIRONMENT =

ABIOTIC FACTORS =

BIOTIC FACTORS =

ECOSYSTEM =

BIODIVERSITY =

HABITAT =

The living organisms are all dependent on each other through _____

However, all life on Earth relies on energy from _____

ENERGY FLOW

Life can exist on earth because of sunlight energy. Plants capture light energy through the process of _____ and make _____ such as _____

Compounds made by plants are eaten by other organisms, so _____

_____

PRODUCERS =

CONSUMERS =

PRIMARY CONSUMER	SECONDARY CONSUMER	TERTIARYCONSUMER

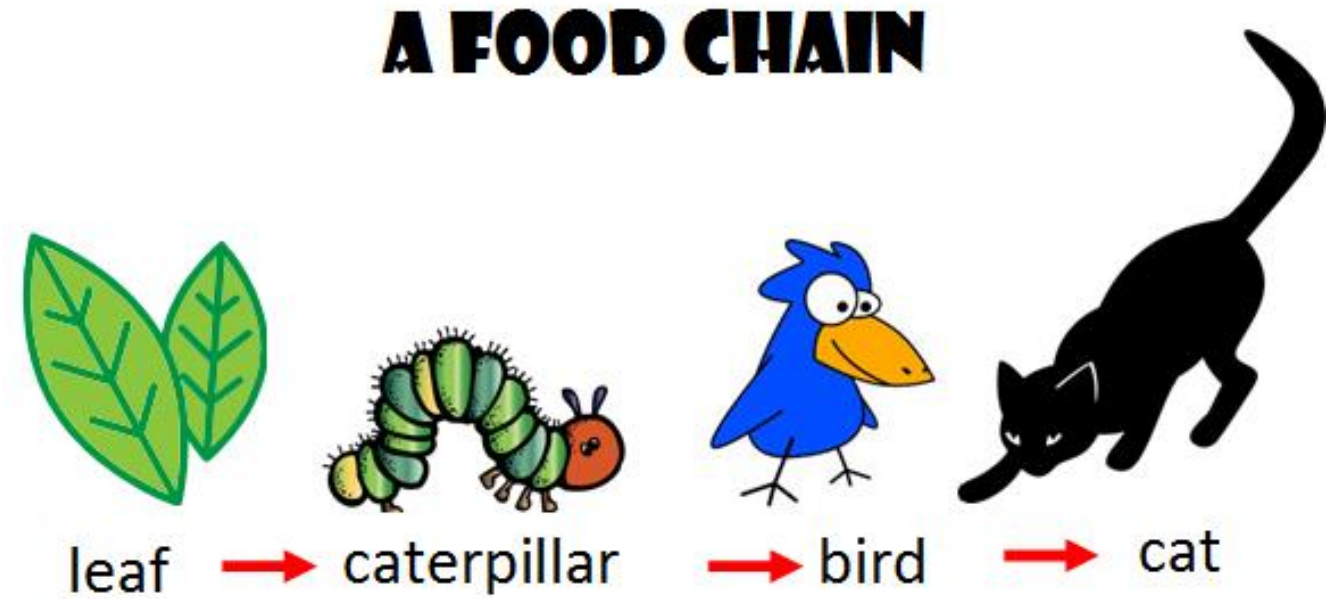
The sequence of producers trapping the Sun's energy and this energy then passing on to other organisms as they feed is known as _____

The sequence can be drawn as a _____ with _____ from producer to consumers.

The arrows _____

_____

Label the producer and consumers on the food chain below.



HERBIVORES =

CARNIVORES =

OMNIVORES =

TROPHIC LEVELS

The different stages in the feeding sequence are called _____ or feeding levels. The first organisms in a food chain, the producer, is _____ The second organisms in the food chain, the primary consumer is _____

Complete the table below, labelling the trophic levels and the feeding position of the organisms.

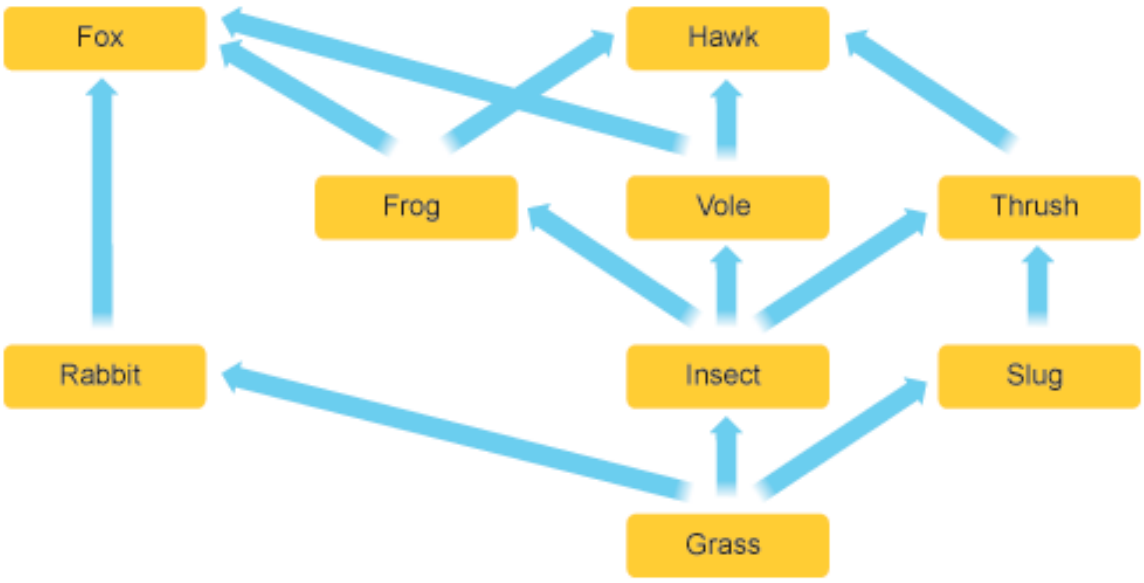
		ECOSYSTEM		
TROPHIC LEVEL	FEEDING POSITION	GRASSLAND	POND	OCEAN
		Grass	Algae	Phytoplankton
		Grasshopper	Mosquito larva	Zooplankton
		Rat	Dragonfly larva	Fish
		Snake	Fish	Seal
		Hawk	Racoon	White shark

FOOD WEBS

Most organisms will not feed on only one other organism. This means that food chains are _____ to form **food webs**.

FOOD WEB JIGSAW

CHANGES TO FOOD WEBS



What would happen if the grass died?

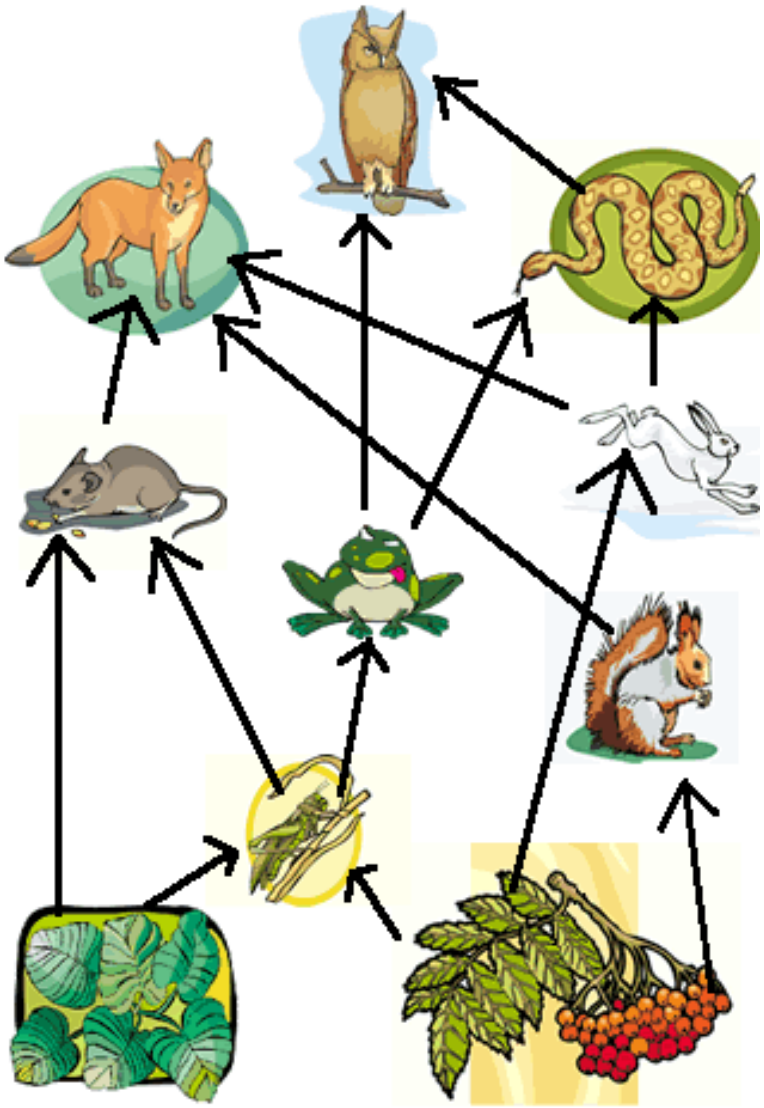
- The grass is the producer, so if it died the consumers that feed on it - rabbits, insects and slugs - would have no food.
- They would starve and die unless they could move to another habitat.
- All the other animals in the food web would die too, because their food supplies would have died out.
- The populations of the consumers would fall as the population of the producer fell.

What would happen if the population of slugs decreased?

- Slugs, rabbits and insects all eat grass.
- If there were fewer slugs there would be more grass for the rabbits and insects.
- With more food the populations of rabbits and insects would increase.
- However, the thrushes would have to eat more insects to maintain their population, so it is also possible that the population of insects could decrease.
- This in turn may reduce the populations of voles and frogs.

What would happen if the population of insects decreased?

- There would be more food for the rabbits and slugs, so their populations would increase.
- However, there would be less food for the frogs and voles, so their populations would decrease.
- This means less food for the foxes and hawks.
- However, there are likely to be more rabbits and thrushes for them to eat, so their populations are likely to stay the same.



What would happen if a disease killed all of the snakes?

_____

_____

_____

_____

_____

What effect would there be if, due to poor spring weather, the rowan flowers were not fertilised?

_____

_____

_____

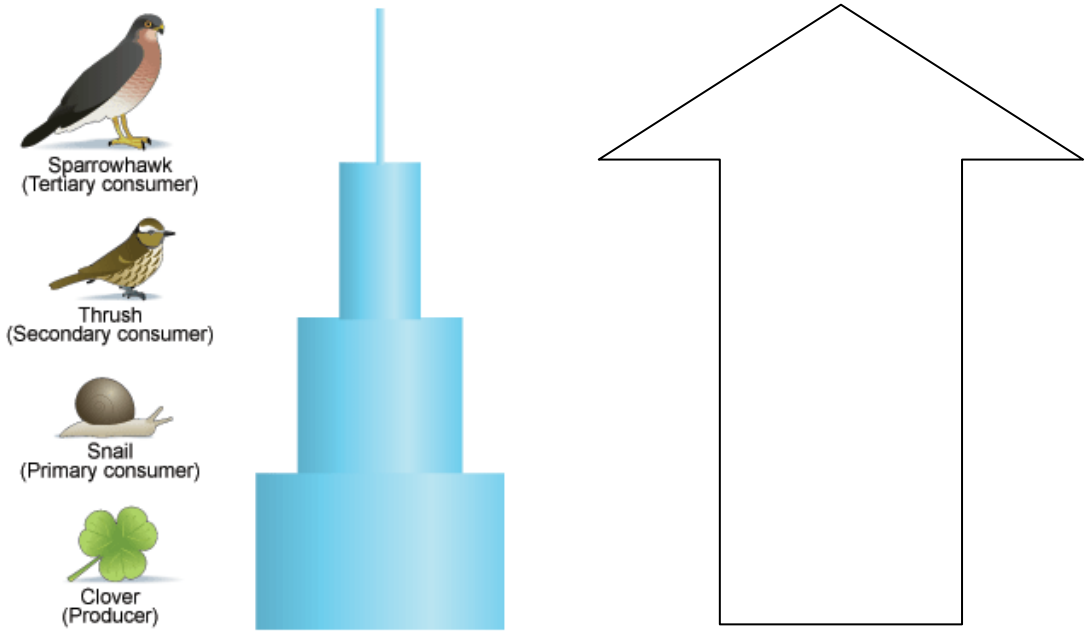
_____

_____

ECOLOGICAL PYRAMIDS

PYRAMIDS OF NUMBERS

- The _____ at each stage of a food chain (i.e. at each trophic level) can be represented by a _____
- Each _____ represents a _____ and is drawn the same height.
- The _____ of the bar represents the _____ at that trophic level.
- There are fewer organisms at each level because _____



Draw Pyramids of Numbers for the following data.

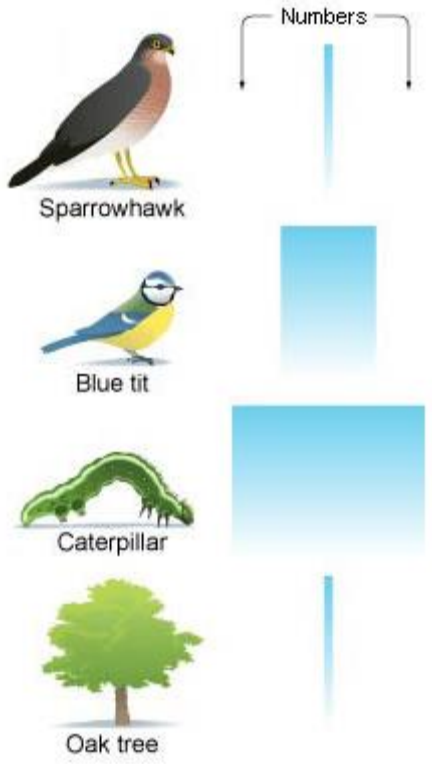
Organism	Stinging nettle plants	Caterpillars	Robin
Numbers	15	12	1

Organism	Single hawthorn bush	Caterpillars	Dunnock
Numbers	1	12	1

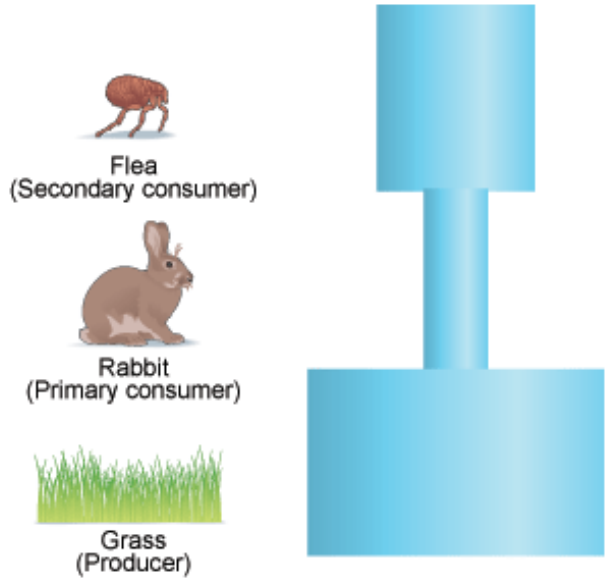
The problem with a pyramid of numbers is that it is not always pyramid shaped, as

_____

_____



Inverted pyramid of numbers



parasite pyramid of numbers

Pyramids of numbers that include **parasites** may appear top heavy, _____

_____

Advantages & Disadvantages of Pyramids of Numbers

ADVANTAGES	DISADVANTAGES

PYRAMIDS OF BIOMASS

Biomass represents _____

_____

The units of a pyramid of biomass are

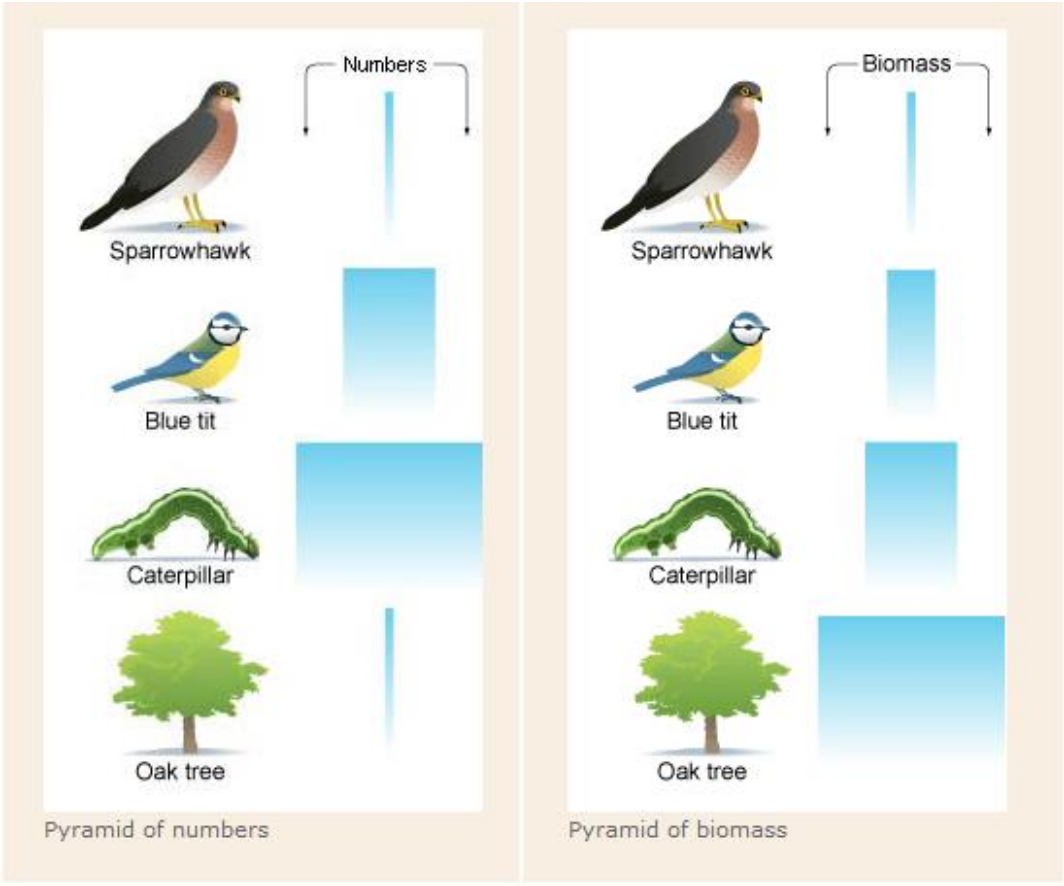
- ☐ _____

  _____

- ☐ as energy content, (joules, J)

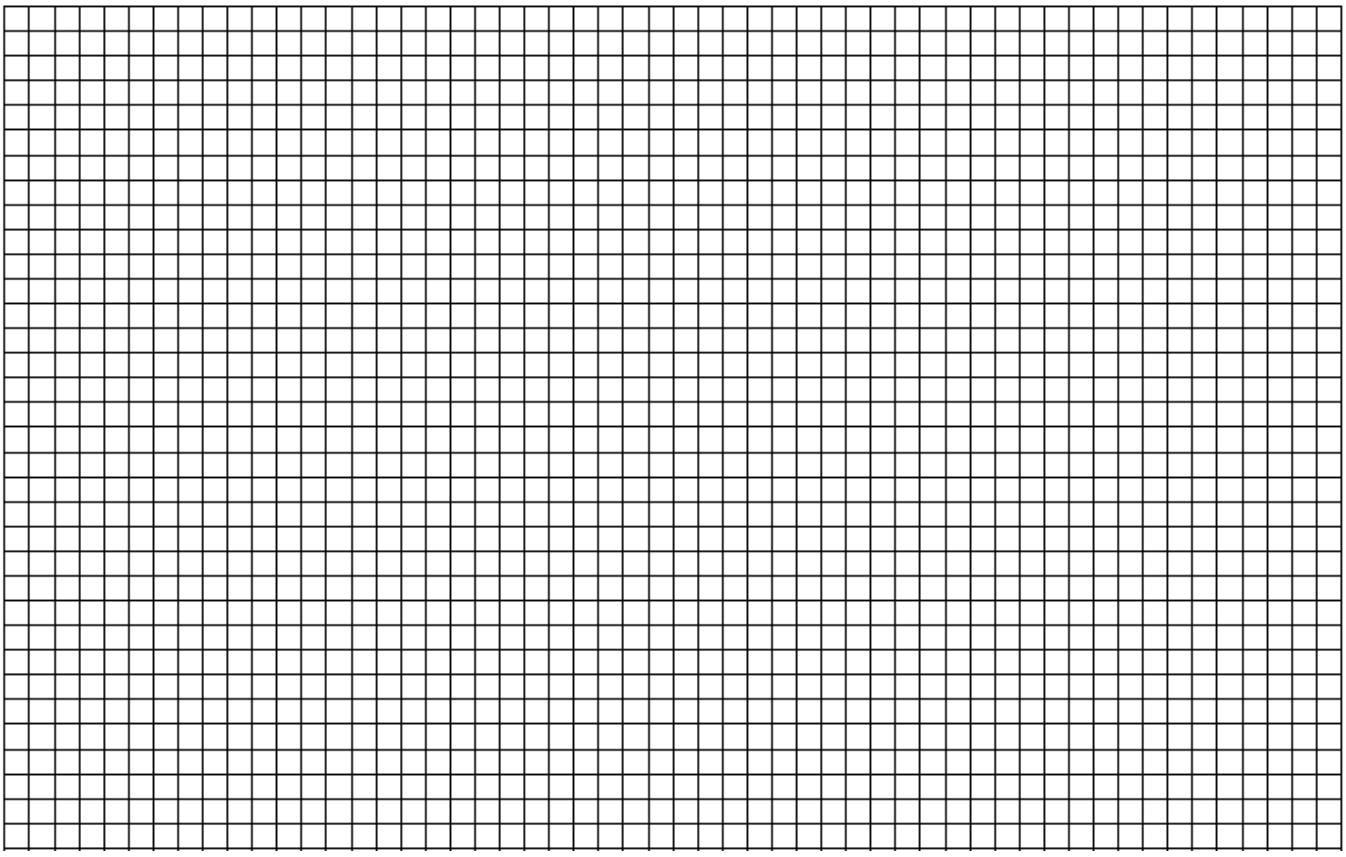
The biomass is found by _____

of the organisms at each trophic level. This requires killing the organisms.



Use the data below to draw a Pyramid of Biomass for the Hawthorn Pyramid of Numbers you drew previously.

Organism	Single hawthorne bush	Caterpillars	Dunnock
Biomass/J	**75 000**	**7 200**	**680**



Advantages & Disadvantages of Pyramids of Biomass

ADVANTAGES	DISADVANTAGES

Another disadvantage in producing both pyramids of numbers and biomass arises if organisms feed at 2 different trophic levels, e.g. an organism eats both plants and animals.

WHERE DOES ALL THE ENERGY GO?

The energy released from the food that an organism eats is used for a variety of purposes:

1. it is used to make new body tissue
2. changed into **heat or thermal energy** in respiration to keep animals warm

   _____

   _____
3. changed into **kinetic energy** for movement

   _____

   _____
4. energy is lost through **excretion**

   _____
5. energy is used in **reproduction** to produce new organisms

Most food chains are relatively short, with just four organisms.

This is because at each stage of energy transfer (including trophic level 1), some **energy is lost**.

At Trophic Level 1 not all of the energy from the Sun is trapped by producers. This is because:

- ☐ _____
- ☐ _____
- ☐ _____

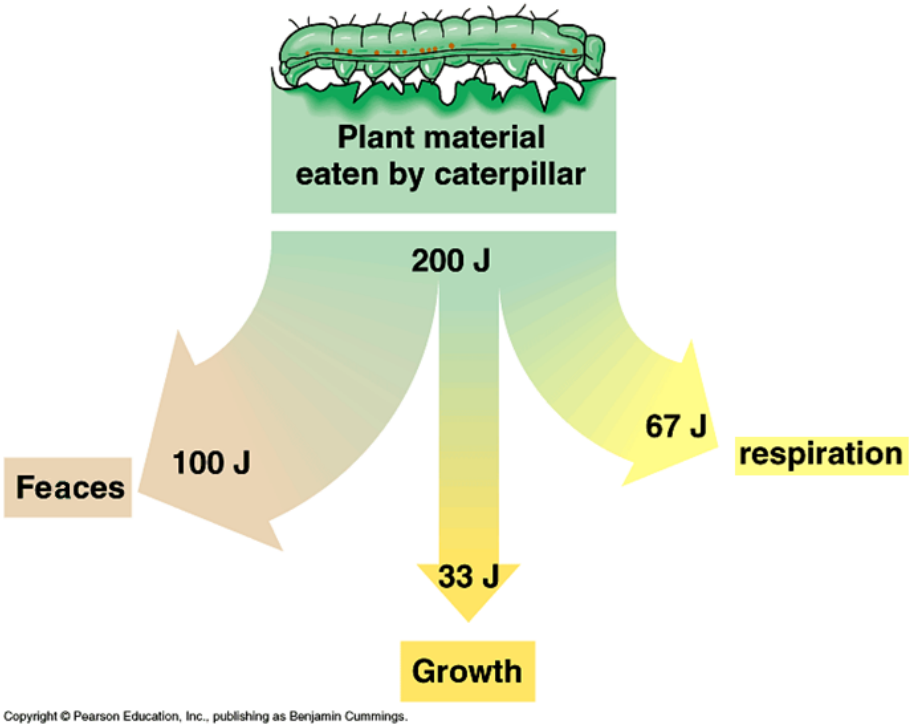
The transfer of energy between plants and animals and between animals of different trophic levels is usually _____ This means that for every 100g of food material available, only between 10 and 20g is used to _____ (as 'biomass') in the primary consumer's body.

The loss of energy between plants and consumers and between consumers is due to three main reasons:

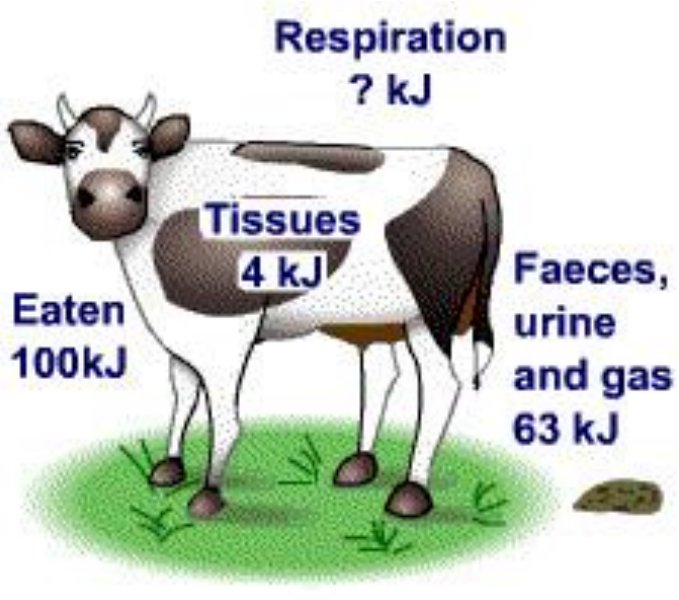
1. Not all the available food is eaten.
Most carnivores do not eat the skeleton or fur of their prey, for example.

2. Not all the food is digested
some is lost as faeces in egestion.

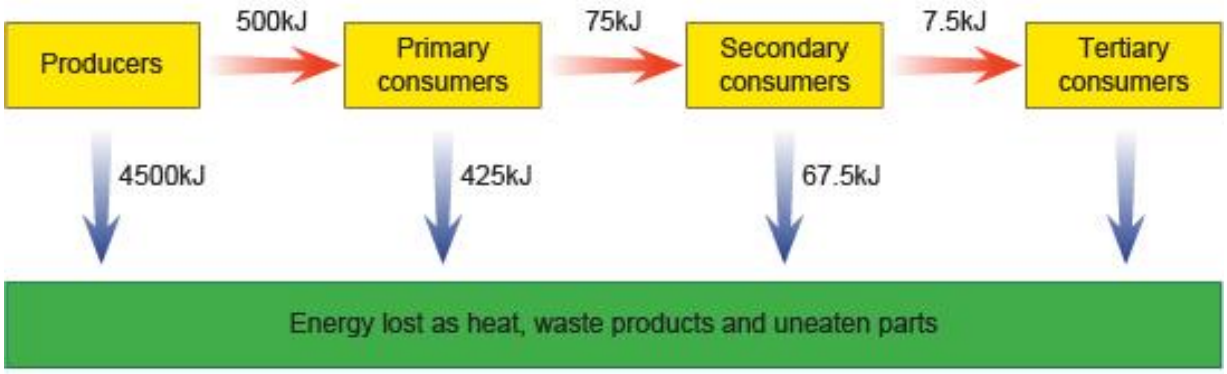
3. A lot of energy is lost as heat in respiration. Respiration provides the energy for movement, growth, reproduction etc. Heat is produced as a by-product of respiration. Heat is lost and cannot be passed on to the next trophic level.



Calculate the percentage of the energy taken in by the caterpillar which is used for growth



Calculate the energy lost in respiration and the percentage used to make new tissue.



Calculate the percentage of energy transferred from the producers to the primary consumers Calculate the percentage of energy transferred from the primary consumers to the secondary consumers

Energy efficiency

This is _____

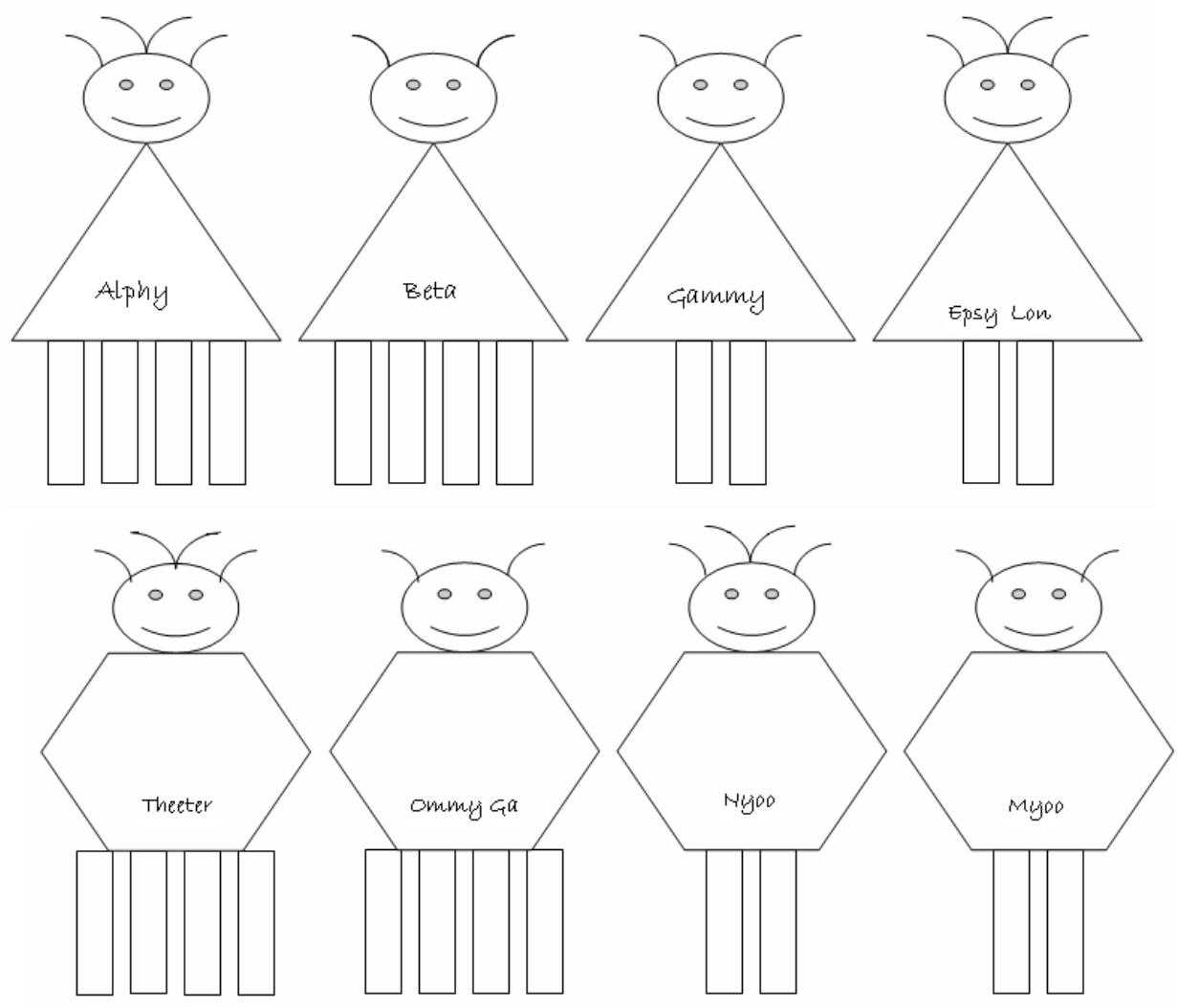
_____

Shorter food chains

Food production is more efficient if the food chain is short, because a higher percentage of energy is available to us.

Using and constructing keys

- Keys are used to _____
- _____, used in biology, consist of a series of ***two part statements*** that describe _____ of organisms.
- At each step of a dichotomous key you are presented with two choices. As you make a choice about a particular feature or characteristic of an organism you are led to a new branch of the key. Eventually you will be led to the name of the organism that you are trying to identify.



alien key

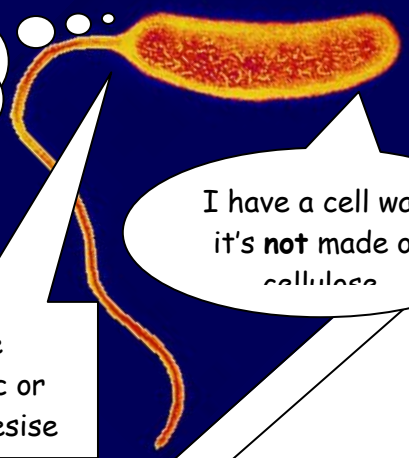
Carefully examine and think about the ***observable features*** of the 8 aliens and create a dichotomous key using some of these characteristics.

HOMEWORK

Find an example of a branched key and a numbered key, print and stick below.

5 kingdom classification

bacteria

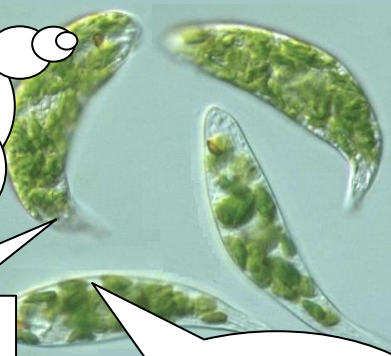


I don't have a nucleus

I have a cell wall; it's **not** made of cellulose

I can be saprophytic or photosynthesise

protoctista



animals

fungi

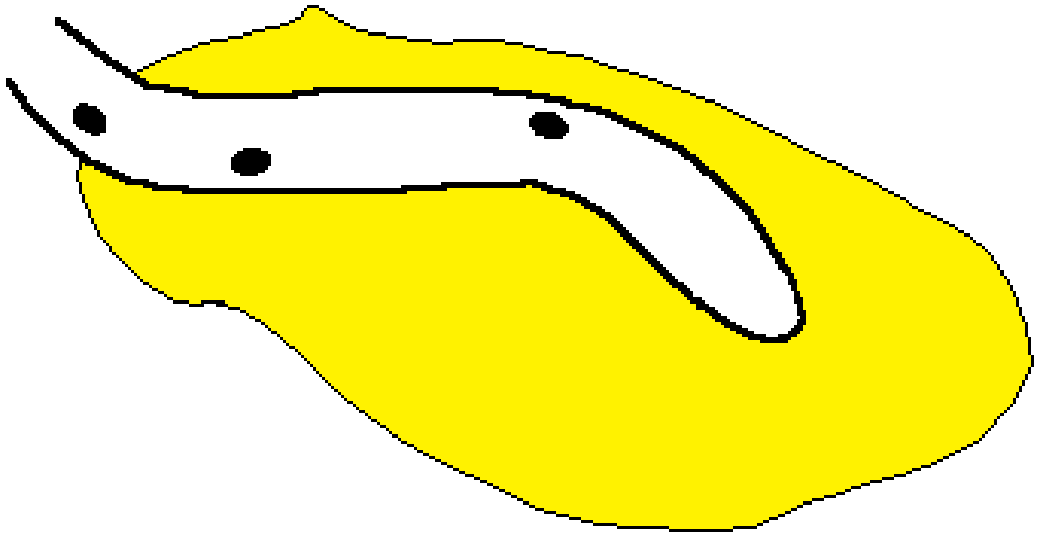
plants

The diagram shows that all the organisms in each kingdom have specific features in common. These include:

1. their mode of nutrition (_____)
2. whether they have a _____
3. _____

how fungi feed

Fungi are saprophytes, this means they feed on dead organic material. They do this by releasing enzymes from their cells which digest the food. The soluble digested materials can then be absorbed.



difficulties With classification

1. Some organisms are difficult to classify e.g. *Euglena*, which has both plant and animal characteristics. This is why single-celled plants and animals are classified in a separate group called the **Protoctista**.
2. Sometimes it is difficult to identify which species an organism belongs to or where one species merges into another.
   Definition – **a species is a group of organisms, with shared features, which can breed together to form fertile offspring**.
3. **Viruses** are a complex group and are very difficult to classify. All viruses, e.g. the HIV virus that causes AIDS, lack proper cellular organisation. They have a DNA/RNA core (DNA and RNA are nucleic acids – the building blocks of chromosomes) and an outer protein coat without the typical cytoplasm of other cells. They can only live if they gain access to other cells and many biologists therefore regard them as **non-living.**

FINDING OUT ABOUT POPULATIONS IN A HABITAT

Fieldwork provides information about what plants and animals live in a particular habitat and their numbers. This can be used to measure biodiversity. It is therefore necessary to be able to **identify** organisms, using **keys** and understand the different **sampling techniques** used to count them.
We cannot actually count every plant or animal in a particular place, so _____

_____

SAMPLING POPULATIONS

You should understand the importance of _____ This is essential to avoid _____
This means that the person collecting the data does not affect the result deliberately, e.g. _____

_____

USING A QUADRAT

Quadrats are usually used to_____, but can also be used to count slow moving animals such as snails.

- Lay out two tapes at right-angles in the area you want to sample.
- Use random number tables to pick co-ordinates:
    - quadrats should be placed randomly so that a **representative** sample is taken.
- Place a quadrat (of suitable size) at that point and count the organisms within it.
- Repeat using using at least 20 quadrats, at other random coordinates across the grid:
    - repeating increases the reliability.
    - Collecting across the whole grid area **reduces the effect of an unusual distribution**
- Calculate the **average** number of organisms in each quadrat
- Use the average to calculate **an estimated total number of organisms** in the grid area.

Quadrats can be used to estimate a population in an area which is **fairly uniform**. Examples include lawns, woods and open ground.

There are three ways to count organisms to estimate population size:

1. Density (_____)
2. Frequency (_____)
3. Percentage cover (_____)

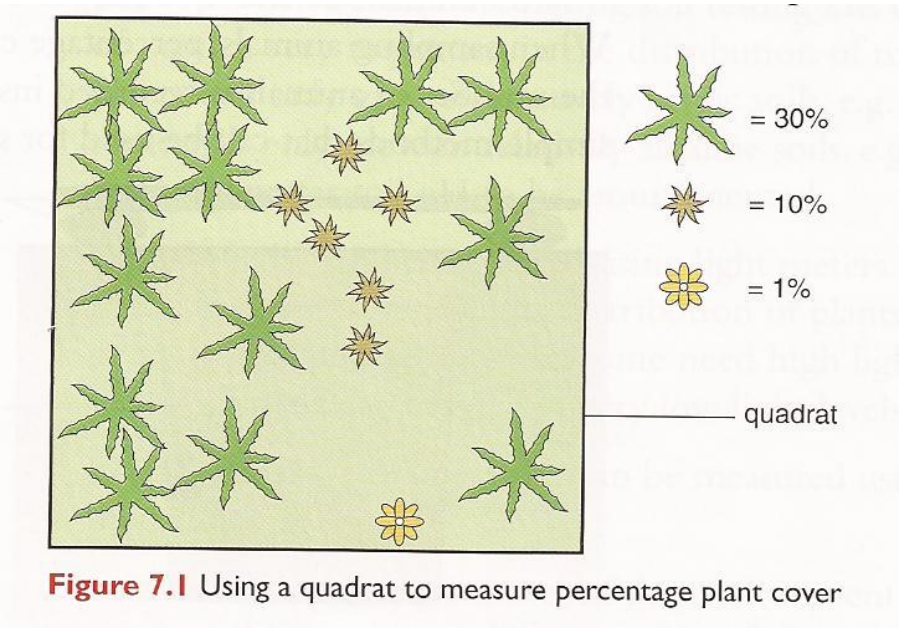


Figure 7.1 Using a quadrat to measure percentage plant cover

Percentage cover – do you agree with these estimates?

- Percentage cover is an easy way to estimate population size.
- However, a **disadvantage** is that it is difficult to estimate exactly what percentage of the quadrat is actually covered by a particular type of plant, so it is normal to round up to the nearest 10%. An exception is if there are any plants with a percentage cover of 1 -5% - this is recorded as 1 and not 0.
- This makes the results **less reliable** than estimating the density.

A BELT TRANSECT

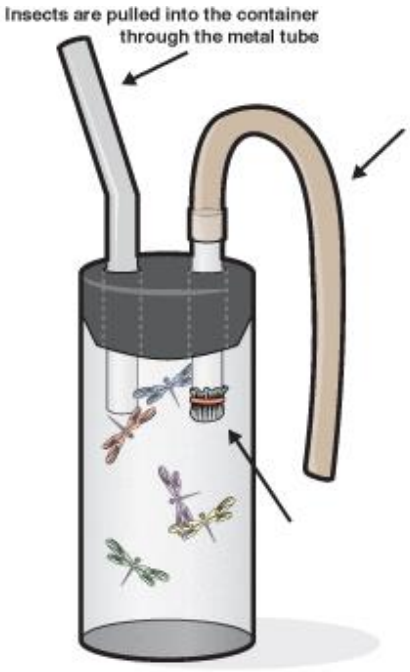
Belt transects can be used to investigate _____ of organisms along a particular habitat, e.g. due to changing abiotic factors such as _____

_____

On the seashore a belt transect can be used to investigate the effect **drying out**, due to **tidal changes**, has on the different species found as you move inshore.

SAMPLING ANIMAL POPULATIONS

USING A POOTER



_____

_____

USING A SWEEP NET

This technique allows you to collect _____

_____

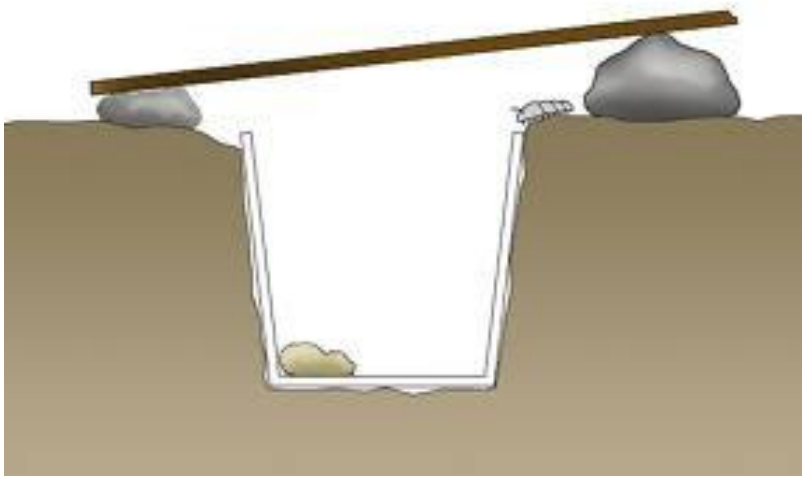
_____

Sweep netting involves making a large rapid sweep with a net in between large paces. This is done through areas of tall grass that are likely to contain lots of insects.

USING A PITFALL TRAP

Pitfall traps must be properly set up:

- the top of the yoghurt carton/pot should be _____
- cover the trap with a stone or piece of wood to keep out the rain, _____
  _____
- the traps must be checked often to _____
  _____
- as with most methods a _____ of traps makes results more _____ and minimises the effects of unusual results



Case Study
Plant distribution in a sand dune system

Each organism is adapted (suited) to the environment in which it lives.

This case study tries to explain why specific plants live at different distances from the seashore.

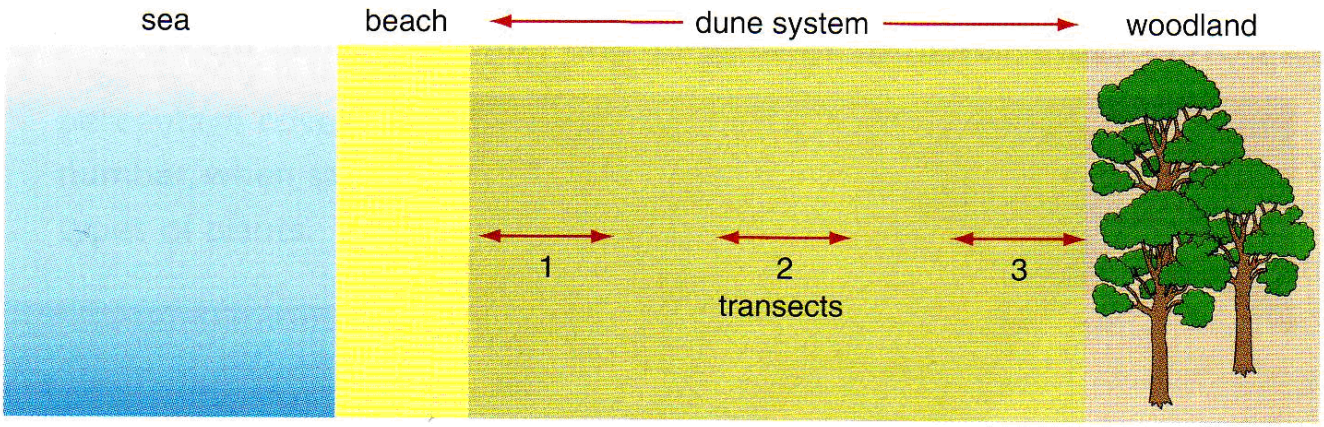


Figure 7.6 Investigating plant distribution in a sand dune system

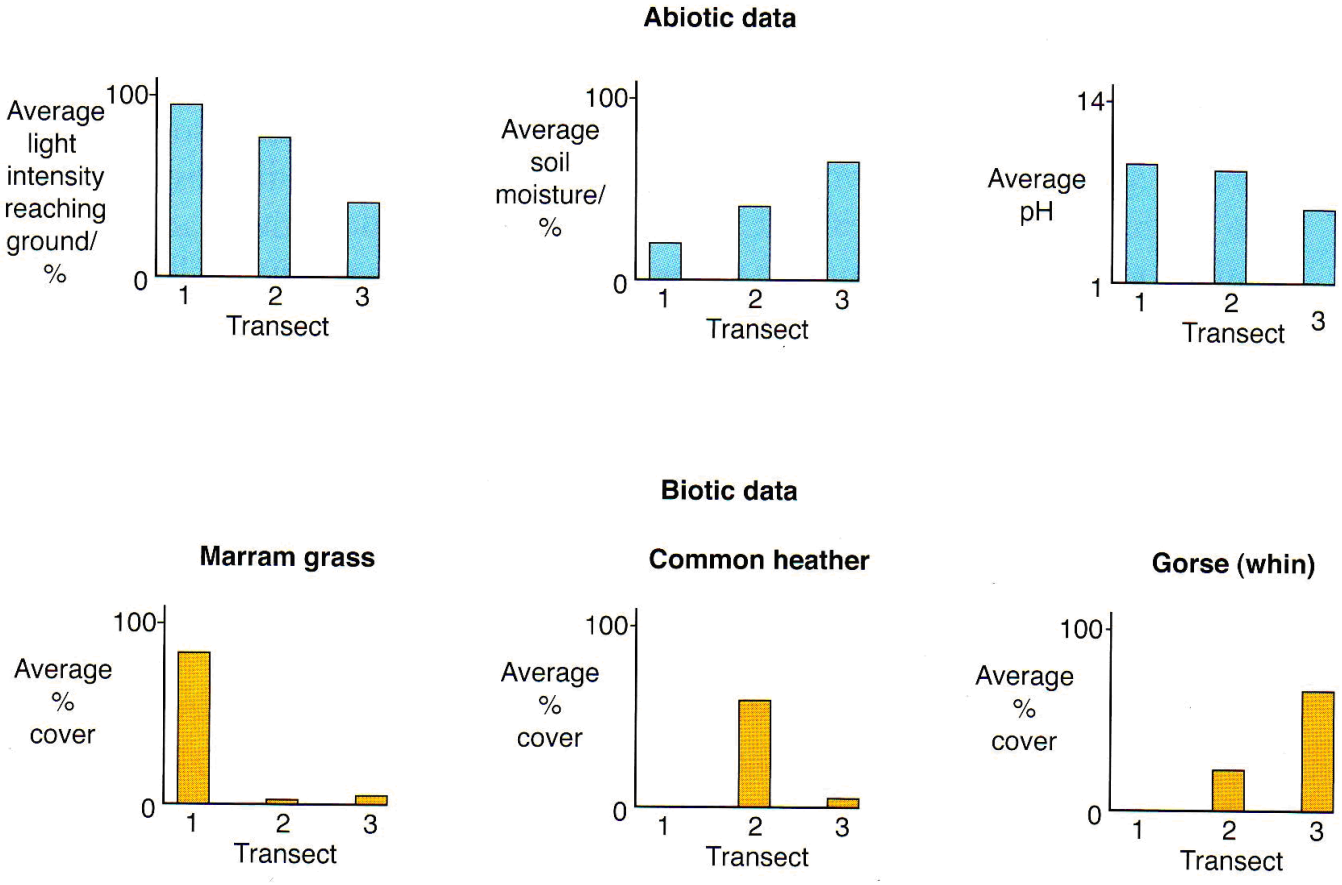


Figure 7.7 Abiotic data and plant distribution

1. Describe the area that was being studied.

2. What sampling method was used to study the distribution of plants along the sand dunes?

3. How many samples were taken?

4. Name the biotic data collected.

5. Name the abiotic data collected

6. Describe the conditions in which each of the plants prefers to grow.

7. Describe the trends shown by the graphs.

8. Use the biological knowledge about the 3 plants and the abiotic data to explain the trends.

What features of this investigation make the results reliable?

_____

_____

9. Explain why you think this a fair test?

_____

10. State the following:

- ☐ the independent variable _____
- ☐ the dependent variable _____
- ☐ the controlled variables _____

It was not possible to keep the wind, light intensity, soil moisture or pH controlled. However these factors were measured and helped to explain the presence or absence of the plants at the different transects.

POPULATION CHANGES

Population numbers change over time.
Many factors can contribute to population change but they can be summarised by:

_____ _____

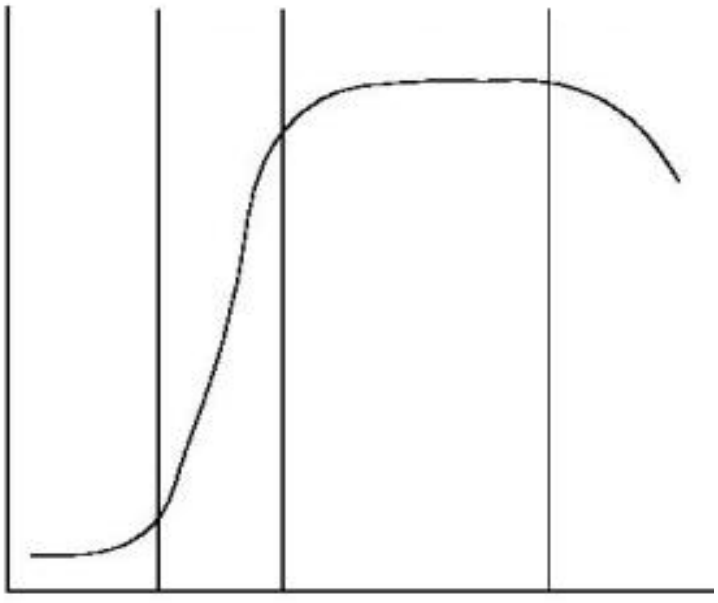
_____ _____

This can be written as an equation:

Describe how these will bring about:

a decreasing population	an increasing population

A population growth curve shows the numbers of organisms in a population over time.



Label the axis and 4 areas on the graph.

Describe and explain what is happening to the population in each area of the graph:

Lag phase _____

_____

Exponential phase _____

_____

Stationary phase _____

_____

Death phase _____

_____

Population numbers will also be affected by:

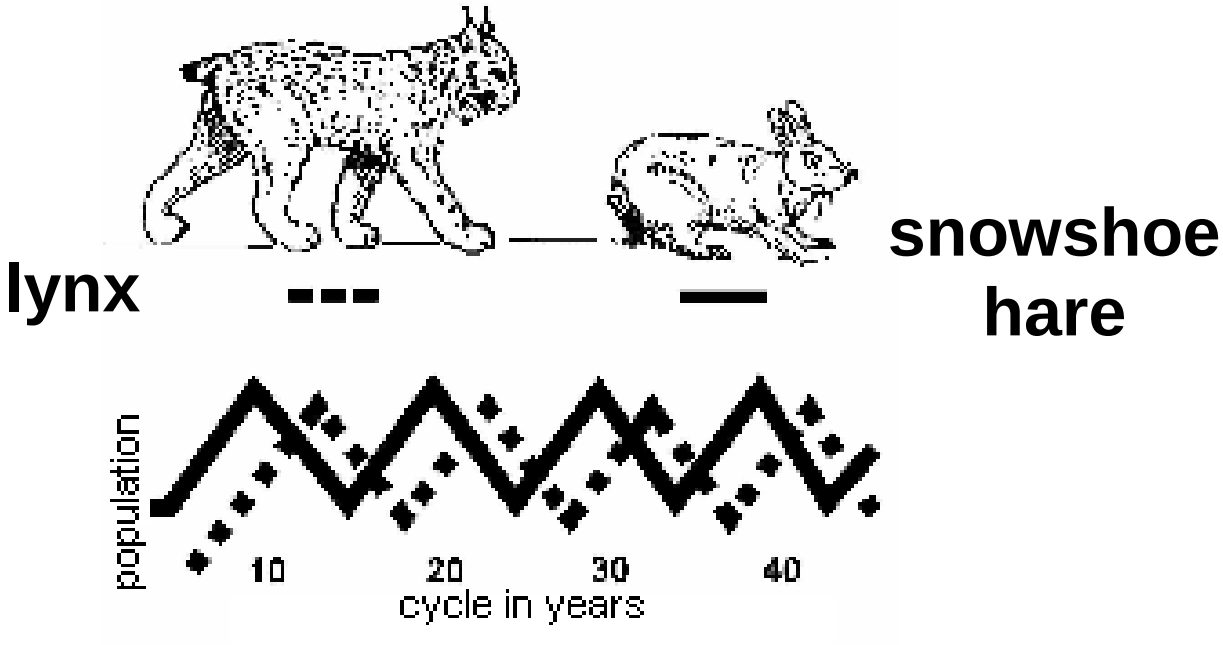
_____

_____

_____

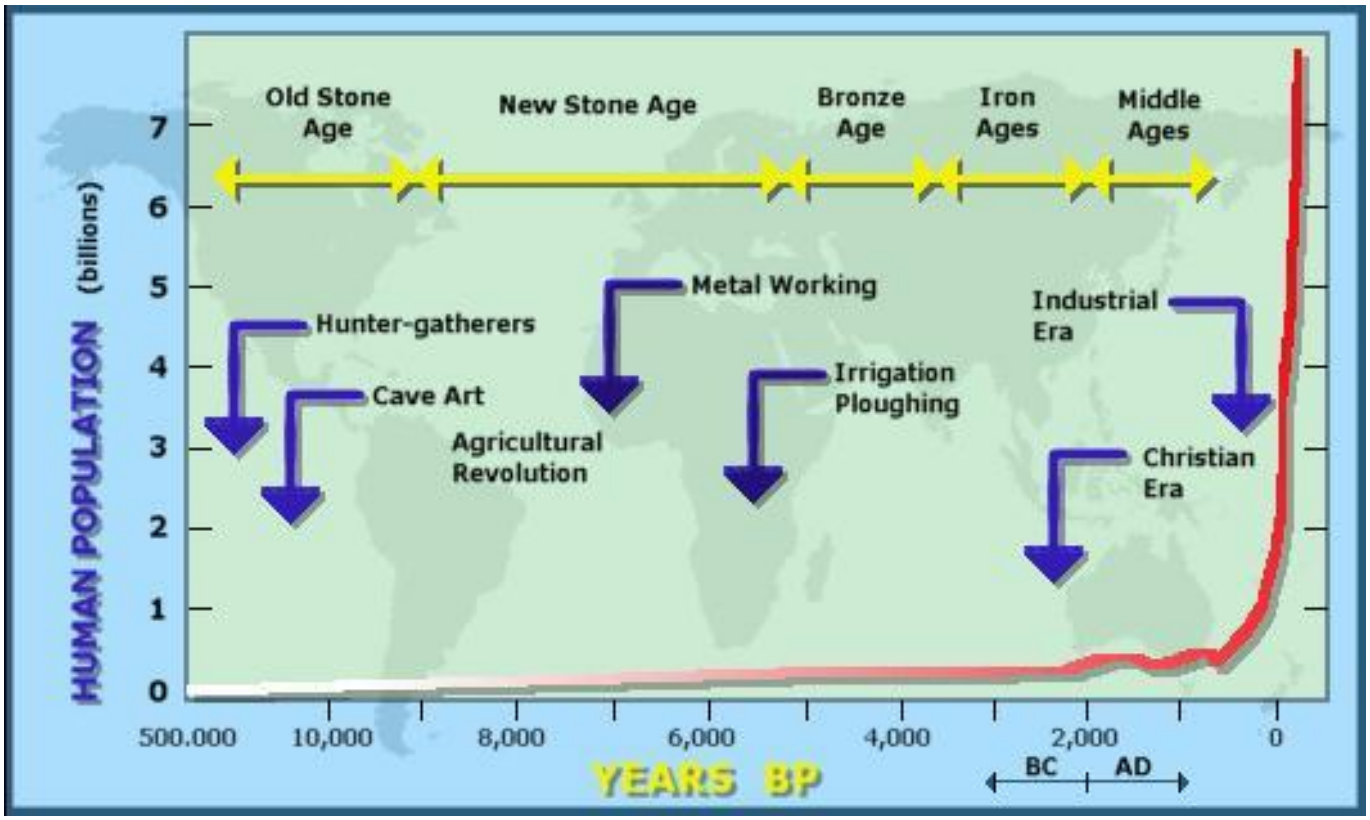
predator prey populations

Some animals are **prey** to others, e.g. rabbits are the prey of foxes. The fox is a predator. The predator must kill the prey for food. This increases the population of predator but will decrease the population of prey.
The populations of a predator and its prey can be measured over many years. The following graph shows the changes in populations of hares and lynxes over 40 years.



Describe and explain the trends in the graph.

HUMAN POPULATION GROWTH



Explain the factors that have led to increased growth of the human population.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

HUMAN POPULATION GRAPHS

A

B

In box A sketch the Age-Sex distribution for an expanding population, such as developing countries in Asia, Latin America and Africa.

The large percentages of the population in the youngest ages assures that these populations will expand as most of its population moves into the reproductive ages.

In box B sketch the Age-Sex distribution for a stable population, such as U.S., Western Europe and other developed countries

The bulge of the population in the middle ages means most of the population will be leaving the reproductive ages and growth will slow.