Edexcel GCSE Biology

Your notes

Feeding Relationships

Contents

Your notes

Trophic Levels & Food Chains

Trophic levels

- Trophic levels are used to describe the **feeding relationships between organisms**
- The Sun is the source of energy for nearly all life on Earth
- Energy flows from the Sun to the **first trophic level** (**producers**) in the form of **light**
- **Producers** then convert **light energy into chemical energy** and it **flows** in this form **from one consumer to the next**
  - For example, **plants** (one type of **producers**) convert a small percentage of the light energy that falls on them into glucose, some of which is used immediately in respiration and some of which is **stored** as **biomass**
  - When a **primary consumer** (e.g. a herbivore such as a rabbit) feeds on a plant, **the chemical energy stored in the plant's biomass is passed on to the primary consumer**
- Eventually, **all energy is transferred to the environment** – energy is passed on from one level to the next with some being used and lost at each stage
  - Energy is lost to the environment when heat energy is transferred from organisms to their surroundings

Trophic Levels Table

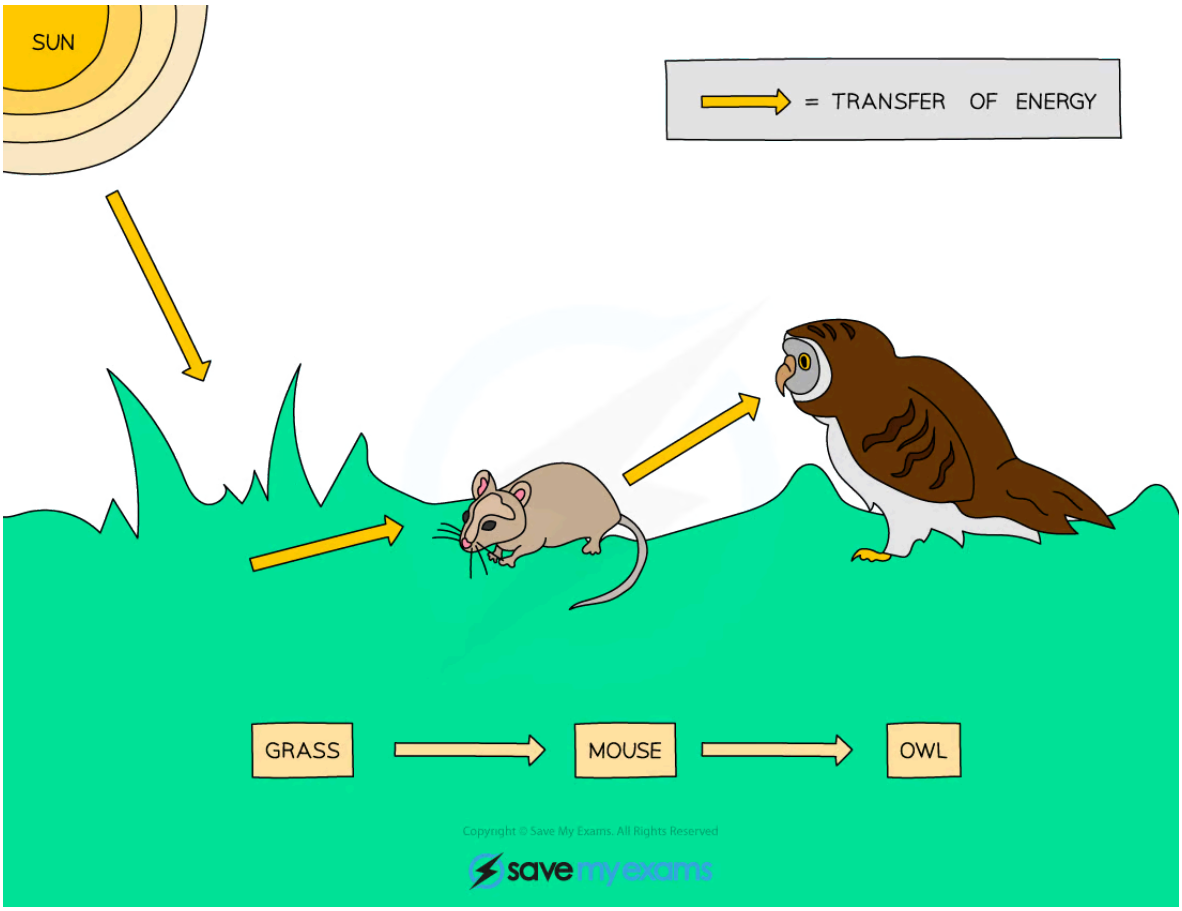
TROPHIC LEVEL	REASON
PRODUCERS	THEY PRODUCE THEIR OWN ORGANIC NUTRIENTS USUALLY USING ENERGY FROM SUNLIGHT
PRIMARY CONSUMERS	HERBIVORES – THEY FEED ON PRODUCERS (PLANTS)
SECONDARY CONSUMERS	PREDATORS THAT FEED ON PRIMARY CONSUMERS
TERTIARY CONSUMERS	PREDATORS THAT FEED ON SECONDARY CONSUMERS
QUATERNARY CONSUMERS	PREDATORS THAT FEED ON TERTIARY CONSUMERS

- Animals (known as consumers) can be at **different trophic levels within the same food web** as they may eat both primary, secondary and/or tertiary consumers

Your notes

Food chains

- A simple way to illustrate the feeding interactions between the organisms in a **community** is with a **food chain**
- A food chain shows the **transfer of energy** from one organism to the next
- The source of all energy in a food chain is **light energy from the sun**
- The **arrows** in a food chain show the **transfer of energy from one trophic level of the food chain to the next**



An example of a food chain (the sun is not included in food chains as it is not a living organism)

- You need to know the terms given to **each step in a food chain** (the sun is **not included** in food chains as it is not a living organism):

1. **Producer**: food chains always begin with a producer
2. **Primary consumer**: producers are eaten by primary consumers (herbivores/omnivores)
3. **Secondary consumer**: primary consumers are eaten by secondary consumers (**carnivores/omnivores**)
4. **Tertiary consumer**: secondary consumers are eaten by tertiary consumers (**carnivores/omnivores**)

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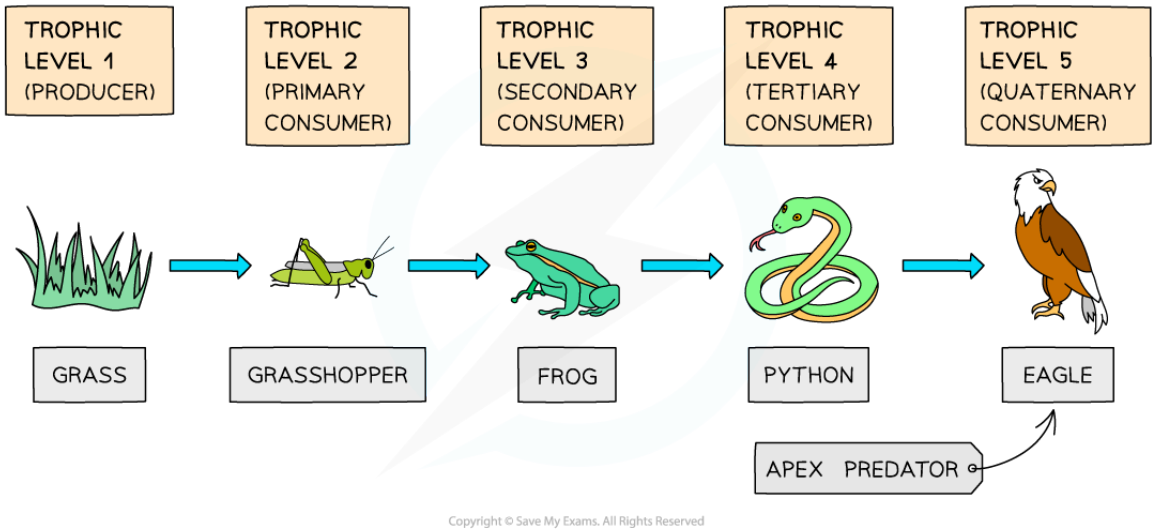

Trophic levels for a simple food chain

Food Webs

- A **food web** is a network of **interconnected food chains**
- Food webs are more realistic ways of showing connections between organisms within an ecosystem (compared to individual food chains) as **animals rarely exist on just one type of food source**

Food Web Definitions Table

TERM	DEFINITION
PRODUCERS	ORGANISMS THAT PRODUCE **THEIR OWN ORGANIC NUTRIENTS USUALLY USING ENERGY FROM SUNLIGHT.** PLANTS ARE PRODUCERS AS THEY CARRY OUT PHOTOSYNTHESIS TO MAKE GLUCOSE
HERBIVORE	AN ANIMAL THAT GETS ITS ENERGY BY **EATING PLANTS**
CARNIVORE	AN ANIMAL THAT GETS ITS ENERGY BY **EATING OTHER ANIMALS**
PRIMARY CONSUMERS	HERBIVORES – THEY **FEED ON PRODUCERS** (PLANTS)
SECONDARY CONSUMERS	PREDATORS THAT **FEED ON PRIMARY CONSUMERS**
TERTIARY CONSUMERS	PREDATORS THAT **FEED ON SECONDARY CONSUMERS**
DECOMPOSERS	BACTERIA AND FUNGI THAT GET THEIR ENERGY FROM **FEEDING OFF DEAD AND DECAYING ORGANISMS AND UNDIGESTED WASTE** (SUCH AS FAECES) BY SECRETING ENZYMES TO BREAK THEM DOWN

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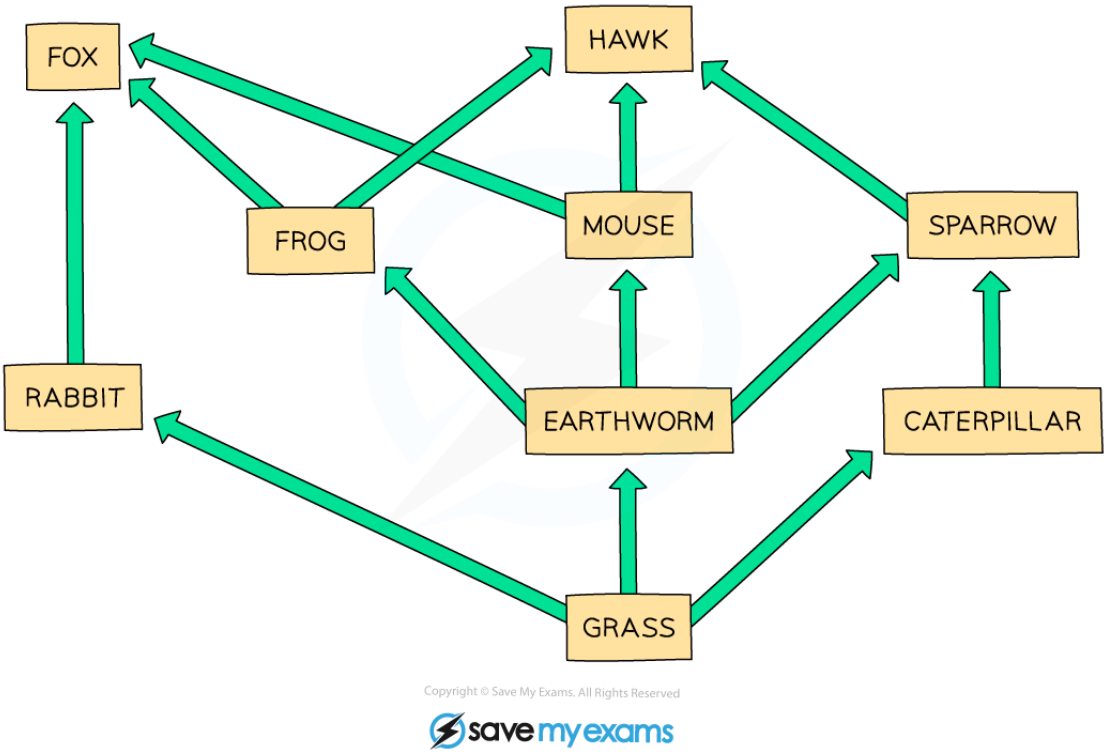


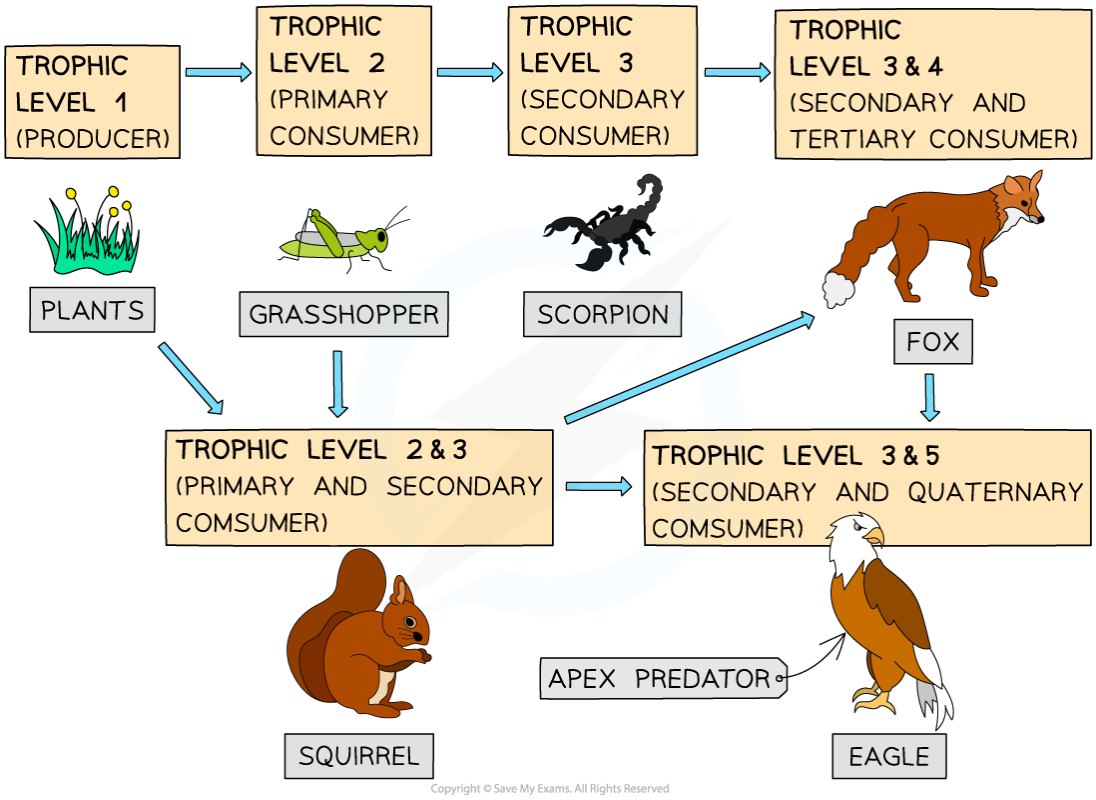
A food web shows the interdependence of organisms

- Food webs give us a lot of information about the **transfer of energy in an ecosystem**
- They also show **interdependence** - how the change in one population can affect others within the food web
- For example, in the food web above, if the **population of earthworms decreased**:
  - The population of **grass plants would increase** as there are now fewer species feeding off them
  - The populations of **frogs and mice would decrease significantly** as earthworms are their only food source
  - The population of **sparrows would decrease slightly** as they eat earthworms but also have another food source to rely on (caterpillars)

Examiner Tips and Tricks

Your notes

Don't forget – animals (known as consumers) can be at **different trophic levels within the same food web** as they could be omnivores (animals that can eat both plants and animals) or could be predators that eat both primary, secondary and/or tertiary consumers!



Trophic levels for a simple food web – note that some organisms can belong to more than one trophic level (such as the squirrel, fox and eagle in this food web)

Your notes

Food Pyramids

- There are three forms of 'food pyramids' that you need to be aware of and to understand:
  - Pyramids of **number**
  - Pyramids of **biomass**
  - Pyramids of **energy transfer**

Pyramids of number

- A pyramid of numbers shows **how many organisms** are at each level of a food chain
- The **width of the box** indicates the **number of organisms** at that trophic level
- For example, consider the following food chain:

Grass → Vole → Owl

- Ask yourself the following questions:
  - Is it likely that there would be more voles in an area than grass plants?
  - How many voles might one barn owl need to eat per day? If it's more than one, is it likely that there are more barn owls in an area than voles?
- So, a pyramid of numbers for this food chain would look like this:

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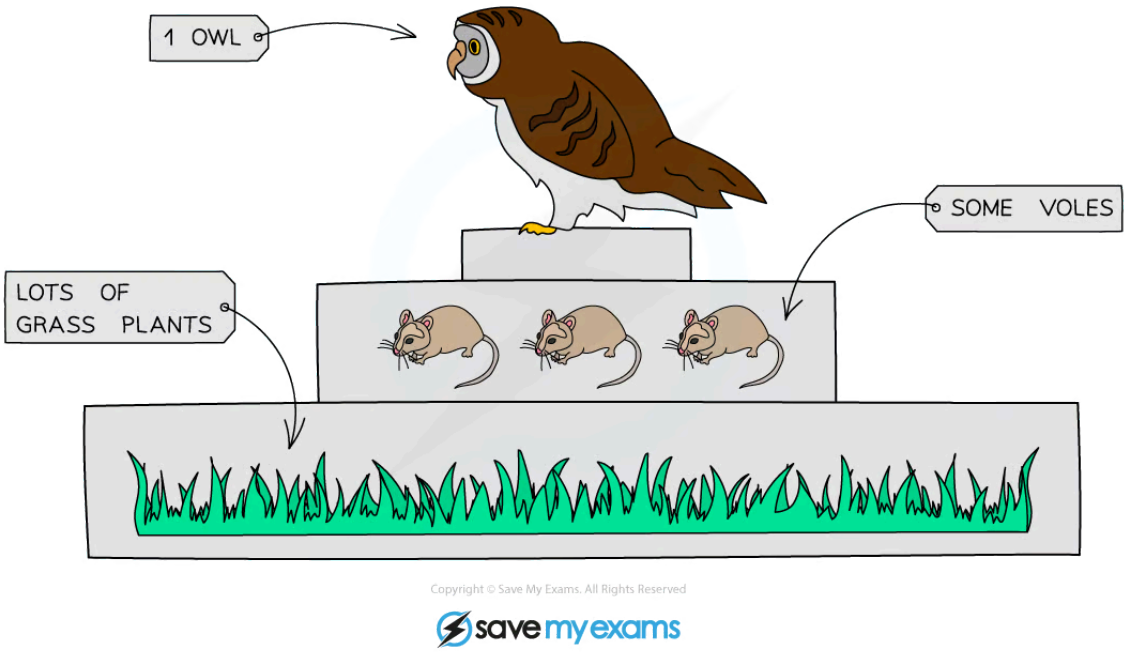

A pyramid of numbers

- Despite the name (and the example above), **a pyramid of numbers doesn't always have to be pyramid-shaped**, for example:

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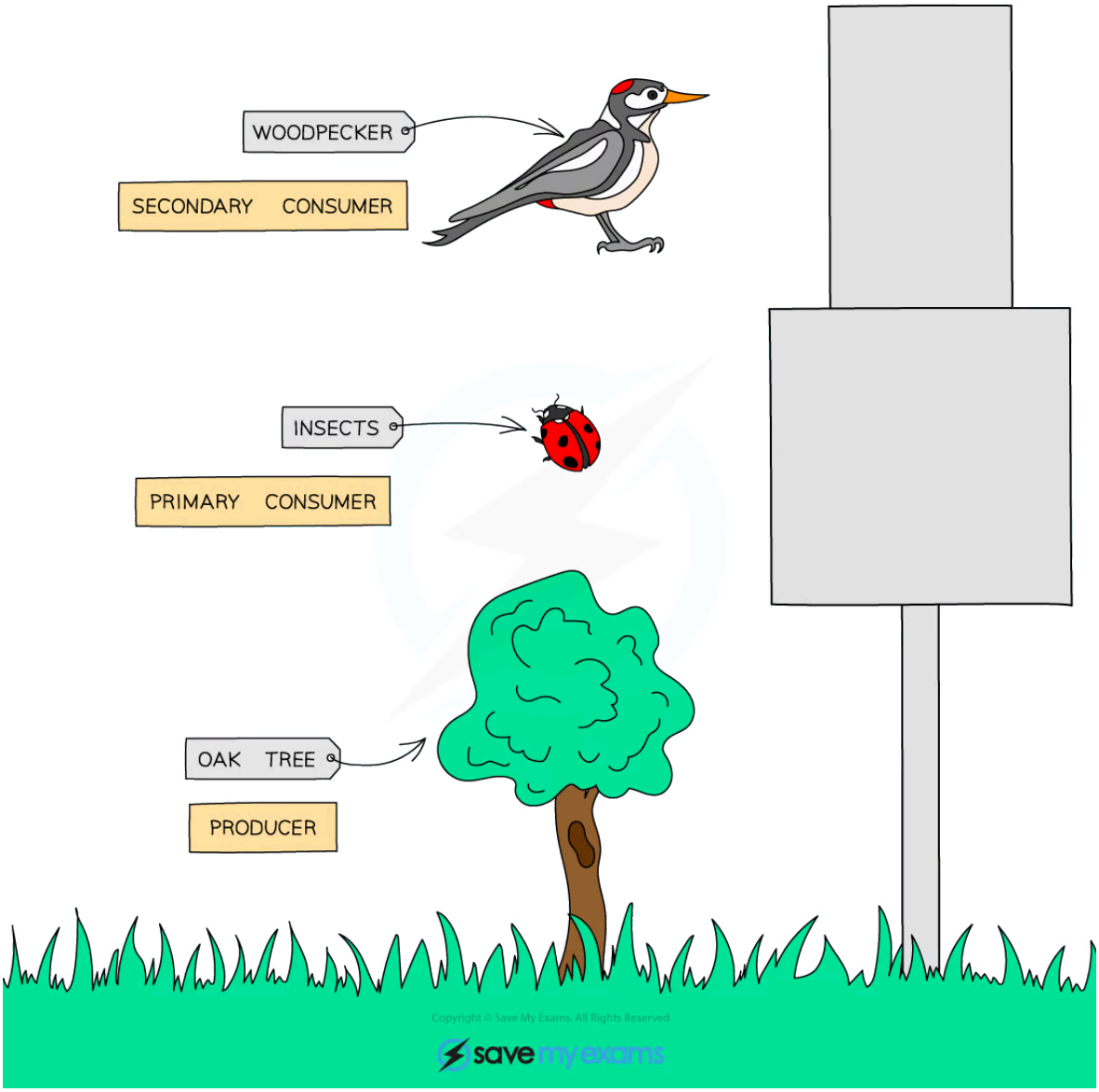


Pyramids of numbers are not always pyramid-shaped

- This is because the **size of the organism is also important**
  - **One large organism**, like the oak tree in the pyramid above, **contains enough energy** to support **many smaller organisms** (the insects)
- There are some rules to remember when drawing a pyramid of numbers:

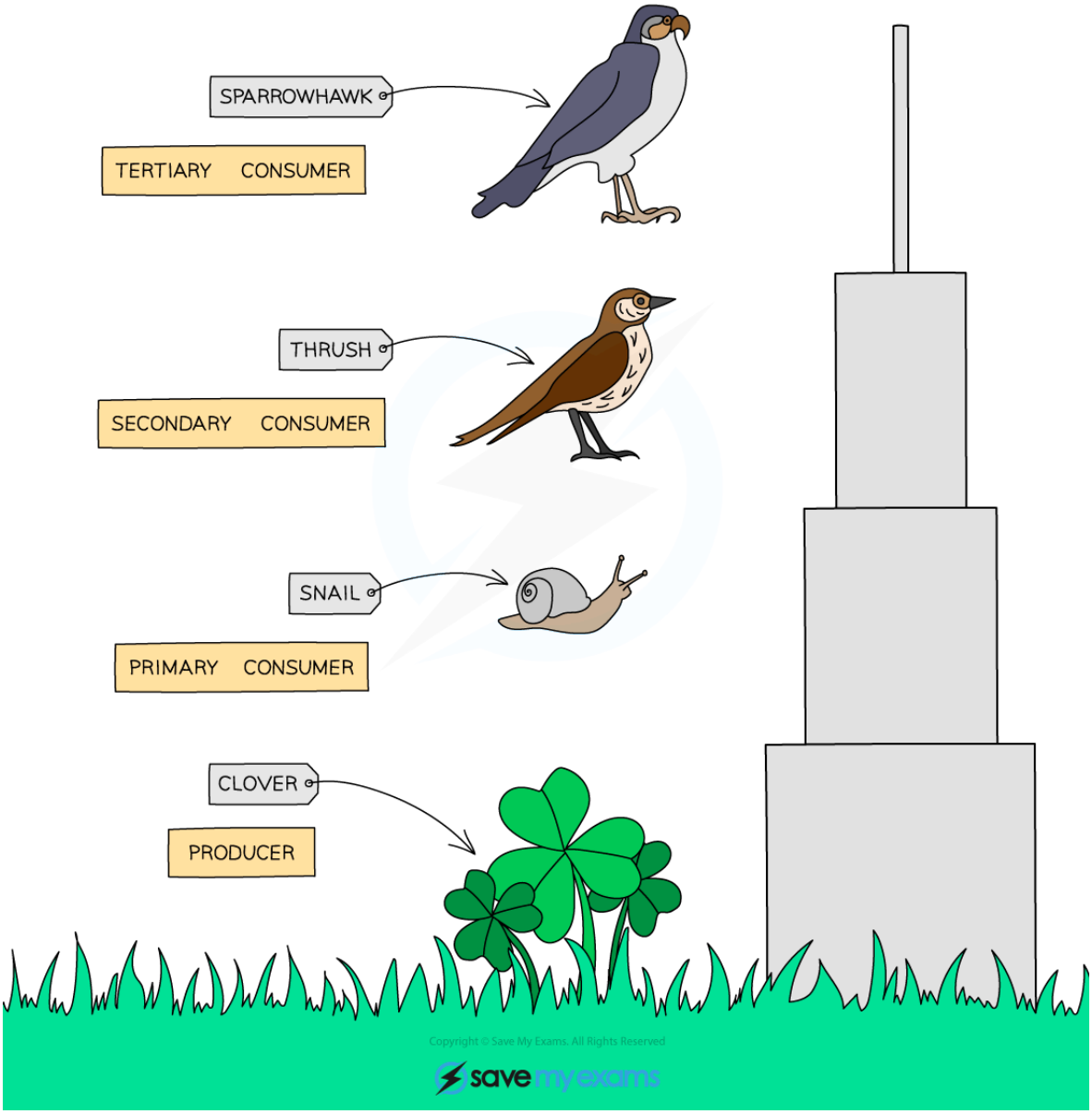
- You **cannot change the trophic level of the organisms** - they must stay in the same order as in the food chain with producers on the bottom, followed by primary consumers, then secondary consumers, then tertiary consumers
- Generally, the **larger an individual organism** is, the **fewer of them** there are


Your notes

Pyramids of biomass

- A pyramid of biomass shows **how much mass the creatures at each level would have without including all the water that is in the organisms** (their 'dry mass')
- Pyramids of biomass are **always pyramid-shaped**, regardless of what the pyramid of numbers for that food chain looks like
- This is because the **mass of organisms has to decrease as you go up a food chain** – if we take our first food chain as an example, it would be impossible to have 10kg of grass feeding 50kg of voles feeding 100kg of barn owls

Your notes



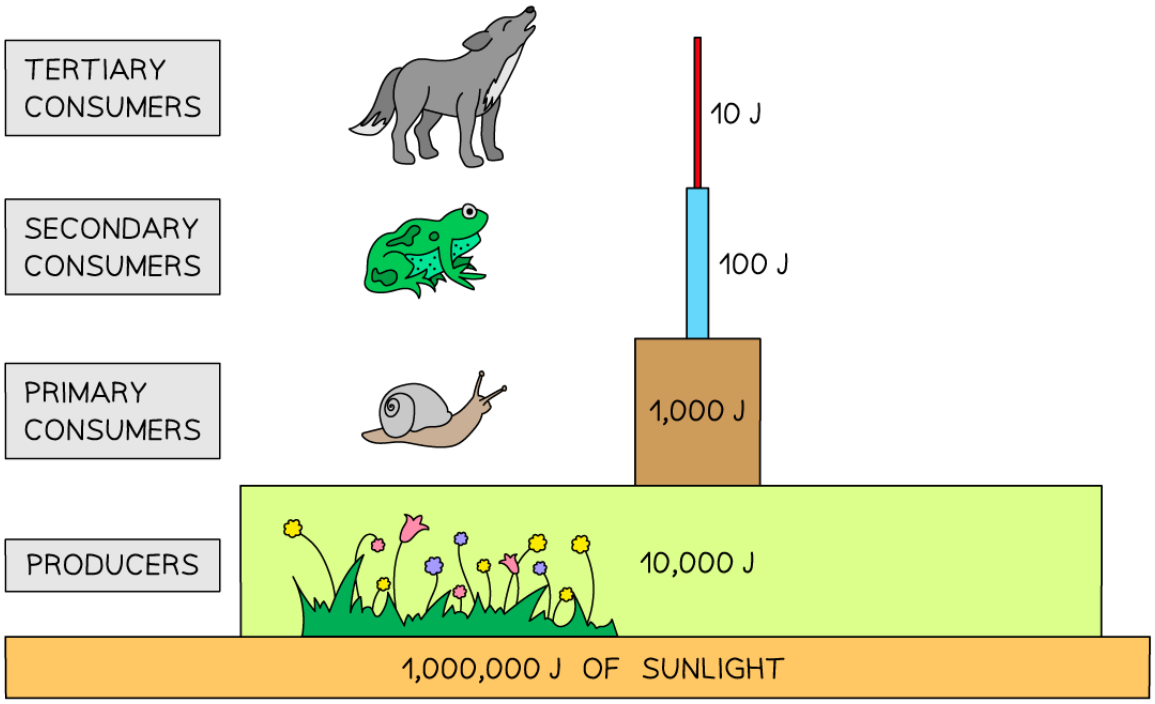
A pyramid of biomass

- Pyramids of biomass provide a much better idea of the **quantity of the plant or animal material at each level of a food chain** and therefore are a better way of representing interdependence within the food chain

Pyramids of energy transfer

- Pyramids of energy transfer illustrate the **amount of energy contained** within the biomass of individuals within different trophic levels
- The **area** of each box represents the **quantity of energy present**
- These pyramids always have a **wide base** (due to the large amount of energy contained within the biomass of producers)
- As you move up the pyramid to higher trophic levels the quantity of energy decreases as **not all energy is transferred** to the biomass of the next trophic level (roughly only **10 %** of the energy is passed on)
- For this reason, pyramids of biomass are also **always pyramid-shaped**

Your notes



A pyramid of energy transfer

Examiner Tips and Tricks

Remember that pyramids of biomass and pyramids of energy transfer are **always** pyramid-shaped, so they are simple to draw, but pyramids of number can be **any shape** - so make sure you learn the rules for drawing a pyramid of numbers.

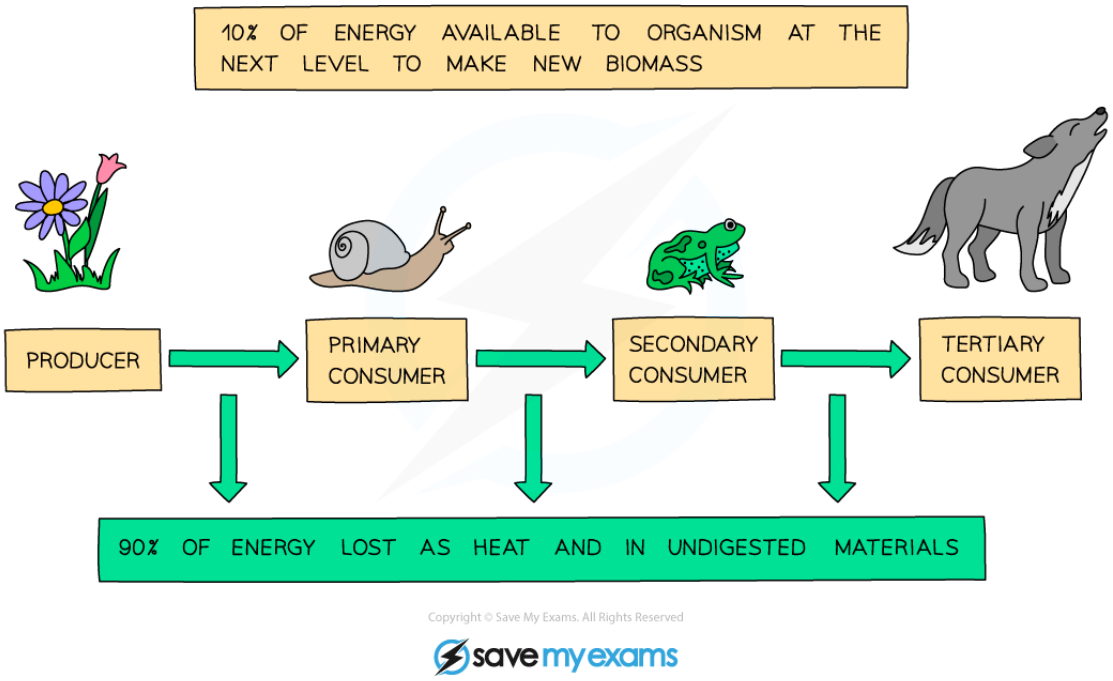
Transfer of Energy

- Energy flows from the **sun** to the **first trophic level** (**producers**) in the form of **light**
- **Producers** convert **light energy into chemical energy**
  - This occurs during photosynthesis, when producers convert carbon dioxide and water into **glucose** and oxygen
- Producers use this glucose (during **respiration**) to produce their own **biomass**
  - Biomass is a **store of chemical energy**
- When **primary consumers** consume (eat) producers, they break down the biomass of the producer (**digestion**) and use the **chemical energy** to **increase or sustain their own biomass**
- When **secondary consumers** consume (eat) primary consumers, they break down the biomass of the primary consumer (**digestion**) and use the **chemical energy** to **increase or sustain their own biomass**, and so on
- In this way, as **chemical energy** is **transferred** from one trophic level to the next, **biomass is also transferred**

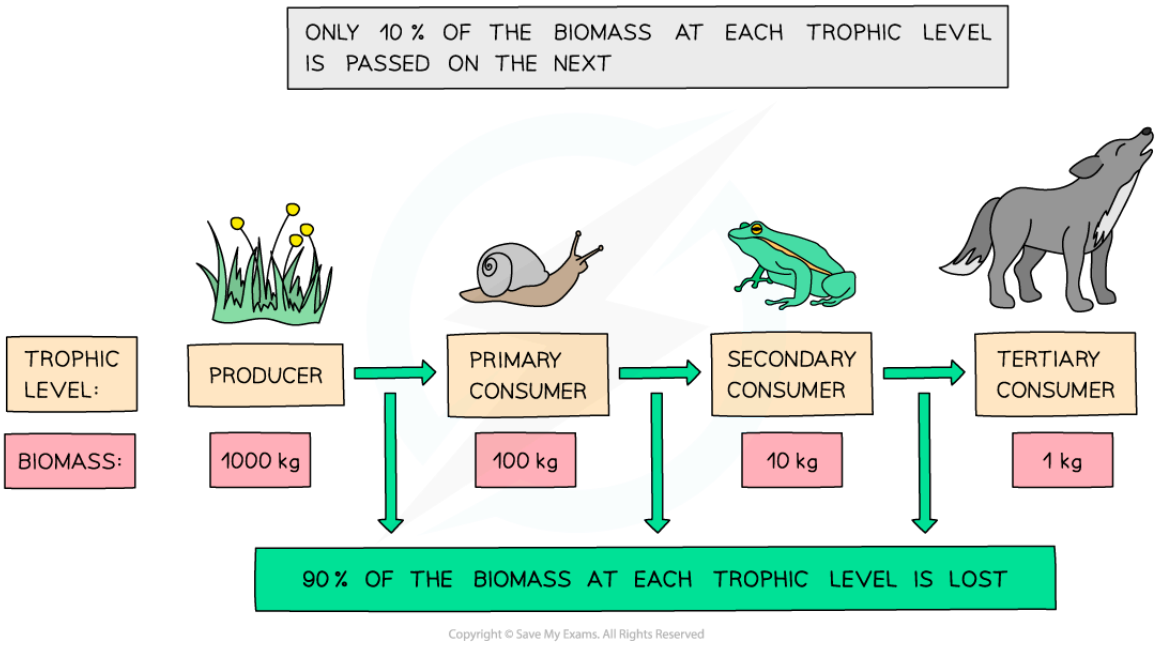
Losses of energy (leading to losses of biomass)

- **Not all energy** is transferred from one trophic level to the next
- **Approximately**, **only 10%** of the energy of each trophic level is **passed on** to the next
- This is why food chains are rarely made up of more than six trophic levels – the total amount of energy available eventually becomes too small to support another trophic level
- As some of the energy transferred is needed by higher trophic levels to **generate biomass,** the **gradual loss of energy** up the food chain means that **biomass also decreases the higher up the food chain you go**

Your notes



Energy is lost at each trophic level



Biomass is also lost at each trophic level

- **These losses of energy** (and therefore **biomass**) occur for several reasons:
  - Organisms **rarely eat every part** of the organism they are consuming – some of the biological material of plants and animals may be **inedible** (eg. many predators do not consume the bones of their prey)
  - **Not all the ingested material is digested** and absorbed, some is **egested** as **faeces**
  - Energy is used for **movement**
  - Energy is used to **generate heat**
  - Energy is used for **metabolic processes**
  - Some absorbed material is lost as **waste**:
    - **Carbon dioxide and water** are waste products of respiration
    - **Water and urea** are the waste products in **the urine**, which is produced when proteins are broken down

Your notes

Calculating the efficiency of energy and biomass transfers

- You may be asked to calculate the efficiency of energy and biomass transfers between trophic levels using percentages

Worked Example

Figure 1 shows:

- A food chain with four trophic levels
- The total biomass of the organisms at each trophic level

Figure 1

	Clover	⟶	Snail	⟶	Thrush	⟶ Sparrowhawk
Biomass in kg:	1450		138		14.1	1.18

Calculate the efficiency of biomass transfer from the first to the

second trophic level.Give your answer to 3 significant figures.Use the equation:

$$\text{Percentage efficiency transfer} = \frac{\text{biomass in higher trophic level}}{\text{biomass in lower trophic level}} \times 100$$

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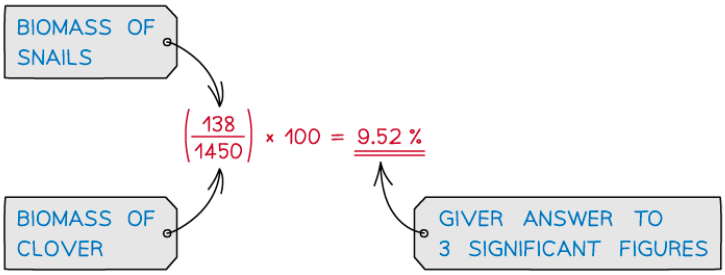
Answer:



Examiner Tips and Tricks

This is a complicated concept but by learning the main ways in which energy is lost between trophic levels, you will be able to answer most questions on this topic.Make sure you read the question carefully and tailor your answer to the specific organism you are being asked about – e.g. plants do not produce urine or faeces so you could not give this as one of the ways in which they use energy that cannot be passed on!