

Exercise walk-through

# 1.10

## **Energy Flow and the 10% Rule**

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AP Environmental Science

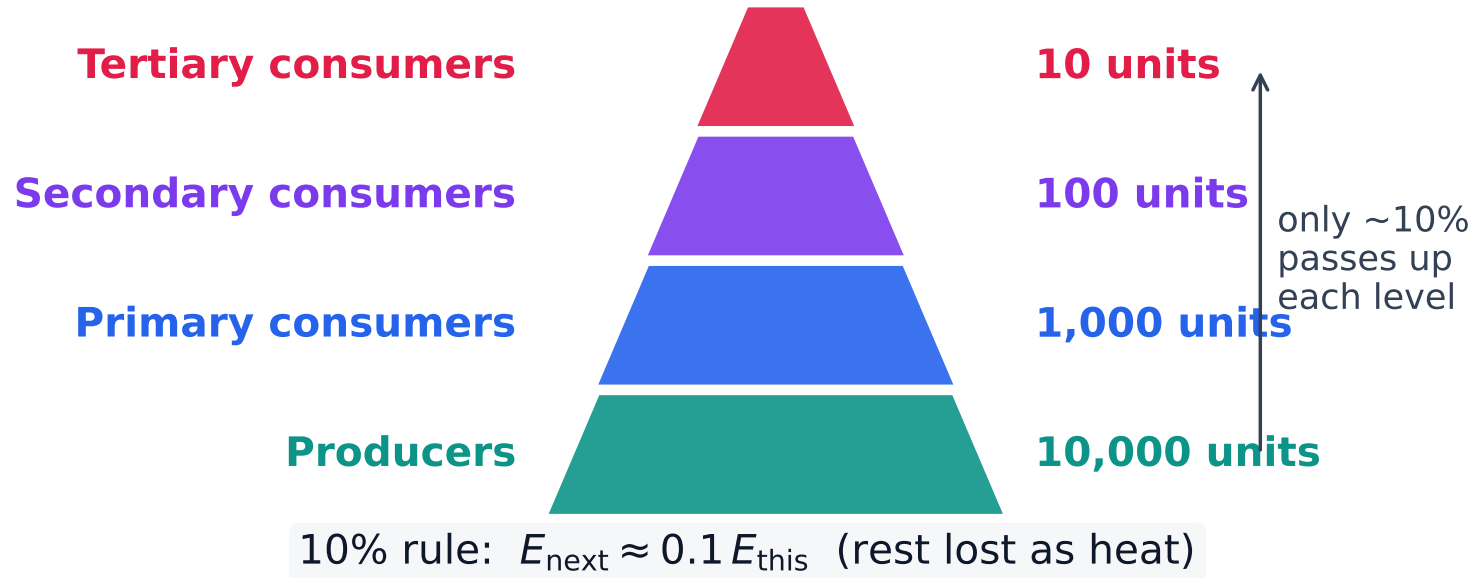
# Energy flow and the 10% rule

Energy flows *one way* up the **trophic levels** and is lost as heat.

■ **producers** → **consumers** → **decomposers**

Only  $\sim 10\%$  passes up each level (2nd law of thermodynamics) – so chains stay short.

# Energy flow and the 10% rule, in detail



Energy flows *one way* up the **trophic levels**

and is lost as heat.

## Worked example – the 10% rule, level by level

**With 12,000 kcal/m<sup>2</sup>/yr of NPP at the producers, how much reaches the secondary consumers?**

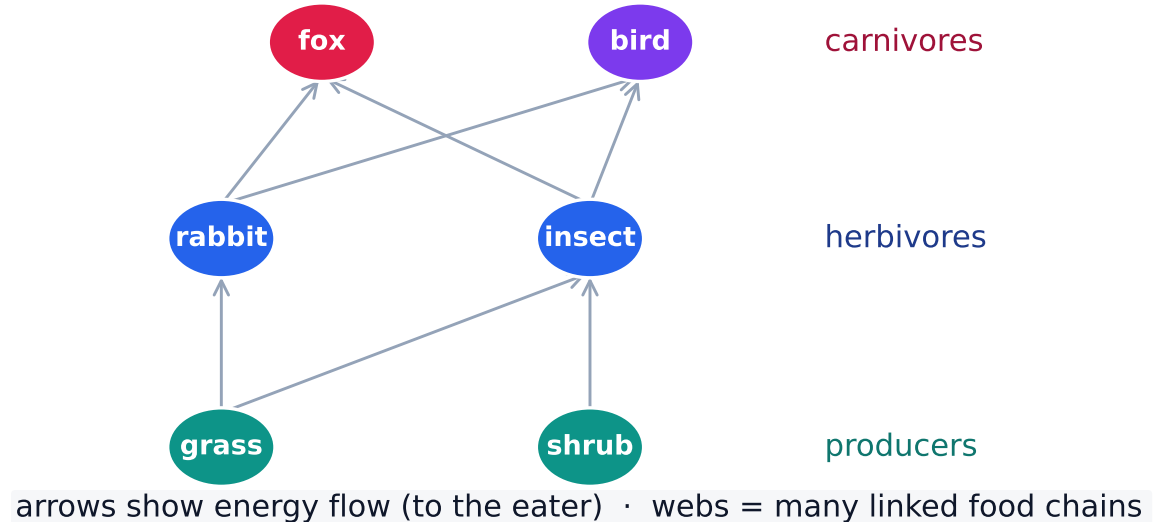
- primary consumers:  $10\% \times 12,000 = 1,200$
- secondary consumers:  
 $10\% \times 1,200 = 120 \text{ kcal/m}^2/\text{yr}$
- the other 90% leaves as **heat**, waste and unconsumed tissue

Each level keeps about a tenth. That is why food chains are **short** and why eating lower down feeds more people.

# Food chains and food webs

A **food chain** is one path; arrows point the way energy flows (food → eater). A **food web** links many chains.

A **keystone species** (sea otter) shapes the whole web; an **indicator species** warns of stress.



# Terrestrial Biomes



A desert : very low precipitation, so only sparse drought-adapted life survives

## Exercises 2.1-2.3

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**2.1** What percentage of energy passes to the next trophic level? [1]

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**2.2** Producers have 8000 kcal. How much reaches the primary consumers? [1]

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**2.3** Where does the “lost” energy go? [1]

## Exercises 2.1-2.3

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**2.1** What percentage of energy passes to the next trophic level? [1]

**2.1**

- About 10%
- 

**2.2** Producers have 8000 kcal. How much reaches the primary consumers? [1]

**2.2**

- 800 kcal
- 

**2.3** Where does the “lost” energy go? [1]

**2.3**

- Lost as heat and used in life processes (respiration, movement)

## Exercise 3.1

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**3.1** By the 10% rule, energy passed from producers to primary consumers is [1]

☐

**A** 1%

**B** 10%

**C** 90%

**D** 100%

## Exercise 3.1

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**3.1** By the 10% rule, energy passed from producers to primary consumers is [1]

☐

**A** 1%

**B** 10%

**C** 90%

**D** 100%

**3.1 B**

- 10%

## Exercise 3.2 (a)

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**3.2** Producers in an ecosystem store  $30\,000 \text{ kcal/m}^2/\text{yr}$ .

(a) Calculate the energy reaching the tertiary consumers.

[3]

## Exercise 3.2 (a)

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**3.2** Producers in an ecosystem store 30 000 kcal/m<sup>2</sup>/yr.

(a) Calculate the energy reaching the tertiary consumers.

[3]

(a)

- primary = 3000; secondary = 300; tertiary = 30 kcal/m<sup>2</sup>/yr

## Exercise 3.2 (b)

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**3.2** Producers in an ecosystem store  $30\,000 \text{ kcal/m}^2/\text{yr}$ .

(b) Explain why so little reaches this level.

[1]

## Exercise 3.2 (b)

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**3.2** Producers in an ecosystem store  $30\,000\text{ kcal/m}^2/\text{yr}$ .

(b) Explain why so little reaches this level.

[1]

(b)

- About 90% of the energy is lost at each of the three transfers

## Exercise 3.3

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**3.3** Explain why energy flow limits the number of trophic levels an ecosystem can support. [2]

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### 3.3

- Because ~90% of energy is lost at each level, after a few levels there is too little energy left to support another, limiting the number of levels