Each transfer leaves less energy

The 10% rule estimates that roughly one tenth of the energy at one trophic level is transferred into production at the next. Actual transfer efficiencies vary.

1. APPLY THE MODEL ONE TRANSFER AT A TIME

Illustrative production rates, all in kJ m^{-2} yr^{-1}

Producers	**20,000**
× 0.10	
Primary consumers	**2,000**
× 0.10	
Secondary consumers	**200**
× 0.10	
Tertiary consumers	**20**

Three feeding transfers reduce 20,000 to 20: only 0.1% of the starting rate. Boxes show sequence, not proportional energy amounts.

2. COUNT TRANSFERS, NOT ORGANISMS

Producer to primary consumer is one transfer. Producer to secondary consumer is two; producer to tertiary consumer is three. Do not count the starting producer as a transfer.

3. KEEP THE STARTING QUANTITY CLEAR

The producer value here is net production, not all incoming sunlight. The 10% rule describes trophic transfer; it is not the percentage of sunlight captured by photosynthesis or the percentage of organisms that survive.

Approximate trophic transfer: College Board, ENG-1.C.1.
Production and transfer efficiency: OpenStax, Biology 2e 46.2.

Scope: College Board AP Environmental Science CED (2025), Topic 1.10, p. 45.

Calculate in either direction

Use the stated efficiency when one is supplied. Use 10% only when requested or when applying this approximation. Match units, area and time before comparing rates.

1. MULTIPLE TRANSFERS

$$E_{final} = E_{start} \times (0.10)^{n}$$

n is the number of feeding transfers. E values must represent comparable energy amounts or production rates.

Two transfers: $20{,}000 \times (0.10)^{2} =$ **200 kJ m^{-2} yr^{-1}**

The proportion is 0.01; as a percentage, this is 1%.

2. WORK BACK TO THE LOWER LEVEL

$$E_{start} = E_{final} / (0.10)^{n}$$

To support 50 kJ m^{-2} yr^{-1} at the secondary-consumer level:
$50 / (0.10)^{2} =$ **5,000 kJ m^{-2} yr^{-1}** at the producer level.

3. CALCULATE AN OBSERVED EFFICIENCY

$$\text{Efficiency (\%)} = \frac{\text{production at higher level}}{\text{production at lower level}} \times 100$$

If adjacent levels produce 1,600 and 240 kJ m^{-2} yr^{-1}:
(240 / 1,600) × 100 = 15%

Use 0.15 for this measured transfer, not 0.10. All numerical examples on these pages are invented teaching examples.

Approximation and numerical scope: College Board, ENG-1.C.1; skill 6.C.
Ratio of adjacent production rates: OpenStax, Biology 2e 46.2.

Scope: College Board AP Environmental Science CED (2025), Topic 1.10, p. 45.

Explain where the energy goes

A smaller transfer does not mean energy has vanished. Follow its destination and distinguish energy retained as new biomass from energy released as heat.

1. FIRST LAW: ENERGY IS CONSERVED

Organisms do not create energy or destroy it. They transform chemical energy from food into forms used for cellular work, retained in organic matter, or released as heat. "Lost from the food chain" means unavailable to the next consumer in that pathway.

2. SECOND LAW: LESS ENERGY REMAINS USABLE

Energy transformations increase the total entropy of organisms plus their surroundings. Metabolism disperses energy as heat. That heat cannot be recycled by the food web into an equivalent supply of usable chemical energy; continual input is needed.

3. THE OTHER 90% IS NOT ALL IMMEDIATE HEAT

Not eaten	Some organic matter remains uneaten or dies.
Not assimilated	Some ingested material leaves as waste.
Respiration	Assimilated energy supports metabolism and releases heat.

Dead matter and waste can feed detrital pathways; their chemical energy is not instantly destroyed.

4. CONNECT TRANSFER TO ECOSYSTEM STRUCTURE

Less production is available along successive feeding links, limiting food-chain length. Energy pyramids represent a flow per area per time. Do not read them as organism counts or as the amount of biomass present at one instant.

Conservation and entropy: OpenStax, Biology 2e 6.3.
Transfer pathways and ecological pyramids: OpenStax, Biology 2e 46.2.

Scope: College Board AP Environmental Science CED (2025), Topic 1.10, p. 45.