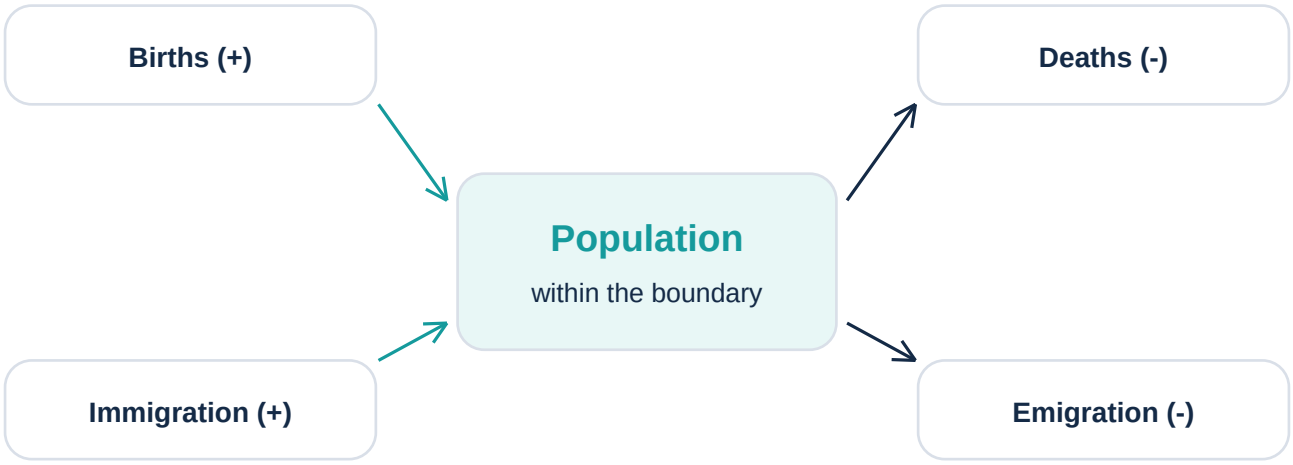
Track additions and losses

Human population dynamics describe changes in population size, age structure and distribution. Choose a boundary and time interval before counting people entering or leaving.

1. FOUR PROCESSES CHANGE POPULATION SIZE



Change = (births + immigrants) - (deaths + emigrants)

2. DISTINGUISH NATURAL AND TOTAL CHANGE

Natural increase is births minus deaths; it excludes migration. Total change adds net migration, which is immigration minus emigration. A city can grow even when deaths exceed births if net immigration is large enough. Migration redistributes people within the world; it does not add to the global total.

3. EXPLAIN WHY THE RATES CHANGE

Health care, sanitation and adequate nutrition can reduce mortality. Education and voluntary family planning can affect the timing and number of births. Age structure also matters: a large young generation can sustain many births as it enters reproductive ages.

Growth rate and population size are different. If growth falls from 2% to 1% per year, the population is still growing; only a negative net growth rate indicates decline.

Population processes and rate influences: College Board, EIN-1.C.1.
Natural increase and net migration: Population Reference Bureau, glossary.

Scope: College Board AP Environmental Science CED, Topic 3.8, p. 72.

Calculate growth and doubling time

Keep counts, rates per 1,000 and percentages separate. Use the same population and year for every input; the examples below are invented for teaching.

1. CONVERT NATURAL INCREASE TO PERCENT

Crude birth rate (CBR) = 24 births per 1,000 people per year. Crude death rate (CDR) = 9 deaths per 1,000 people per year.

$$\text{RNI (\%)} = \frac{\text{CBR - CDR}}{10} = \frac{24 - 9}{10} = 1.5\% \text{ per year}$$

15 per 1,000 equals 1.5 per 100. Divide by 10 only when the input rates are per 1,000; do not divide again if they are already percentages.

2. INCLUDE MIGRATION WHEN FINDING TOTAL GROWTH

Start with 100,000 people. During one year: 2,400 births, 900 deaths, 800 immigrants and 300 emigrants.

Change = 2,400 - 900 + 800 - 300 = 2,000 people

$$\frac{2{,}000}{100{,}000} \times 100 = 2.0\% \text{ annual growth}$$

Final count = 102,000. This example uses the starting population as the denominator. Follow any denominator specified in a dataset or question.

3. RULE OF 70: AN APPROXIMATE DOUBLING TIME

$$\text{Doubling time (years)} \sim \frac{70}{\text{annual growth rate (\%)}}$$

70 / 2 = 35 years

Enter 2 for 2%, not 0.02. This estimate assumes a sustained, positive percentage growth rate. A changing rate changes the estimate; zero or negative growth has no forward doubling time under this model.

RNI and rule of 70: College Board, EIN-1.C.4.
Growth measures and doubling time: PRB, Population Handbook.

Scope: College Board AP Environmental Science CED, Topic 3.8, p. 72.

Human populations still face limits

Earth has finite resources and waste-absorbing capacity. Technology and social systems can change what is supportable, but they do not remove ecological limits.

1. TWO TYPES OF LIMITING FACTORS

Density-dependent

The per-person effect tends to change with crowding. Examples include competition for food or clean water and transmission of some infectious diseases. More demand on a limited water supply can reduce access per person.

Density-independent

The disturbance need not arise from crowding: storms, droughts, heat waves and fires can strike populations of different densities. Actual harm still depends on exposure, infrastructure and vulnerability.

2. MALTHUS: POPULATION CAN OUTRUN FOOD SUPPLY

Malthus contrasted potentially exponential population growth with slower, arithmetic growth in food supply. If population outpaces subsistence, shortages and famine or disease can increase mortality; delayed reproduction can reduce births. This is a historical model, not proof of an inevitable crisis on a fixed date.

3. CARRYING CAPACITY IS NOT ONE FIXED HUMAN NUMBER

Agriculture, public health and technology can support more people, while soil loss, pollution and resource depletion can erode that support. Sustainable population size also depends on consumption per person and how resources are distributed. Higher yields do not guarantee food access for everyone.

Apply the mechanism: drought reduces a city's water supply; crowding increases competition for what remains. One situation can combine a density-independent trigger with density-dependent effects.

Malthusian theory, carrying capacity and limits: College Board, EIN-1.C.2-3.
Human carrying capacity: OpenStax, Biology 2e 45.5.

Scope: College Board AP Environmental Science CED, Topic 3.8, p. 72.