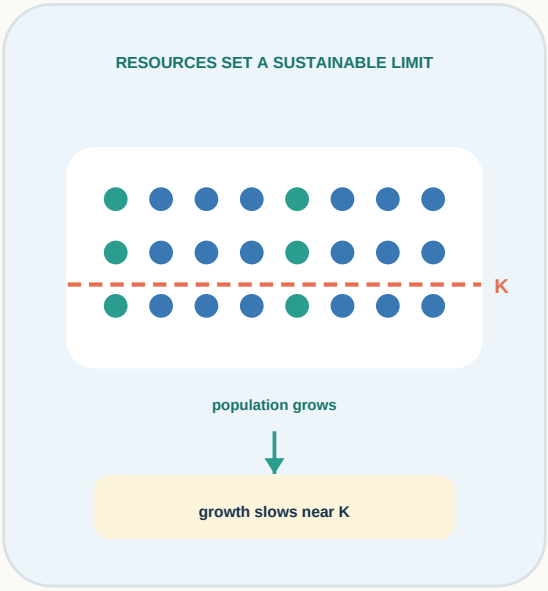
AP BIOLOGY | UNIT 8

TOPIC 8.4

Effect of Density on Populations

Resource availability helps determine population density, the strength of limiting factors, and the carrying capacity of an ecosystem.



THE DENSITY-REGULATION CHAIN

RESOURCES → amount available

DENSITY → individuals per area

LIMITS → competition and disease

GROWTH → slows near K

BY THE END, YOU SHOULD BE ABLE TO...

1. Distinguish density-dependent and density-independent factors.
2. Explain how resources affect demographic rates and carrying capacity.
3. Interpret the logistic-growth equation and S-shaped curve.

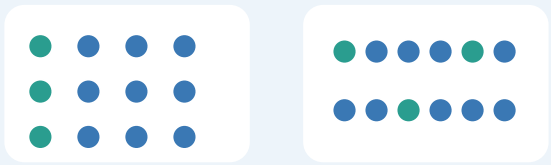
CENTRAL IDEA

Carrying capacity is not a fixed property of a species. It depends on the resources and environmental conditions available in a particular ecosystem.

1 Density changes how strongly some limits act

Population density is the number of individuals per unit area or volume. It is distinct from total population size N.

SAME N, DIFFERENT DENSITY



smaller area = higher density

larger area = lower density

RESOURCE AVAILABILITY

Food, water, shelter, nutrients, and space determine how many individuals an ecosystem can sustain.

Less resource per individual strengthens competition and can change demographic rates.

TWO TYPES OF LIMITING FACTOR

DENSITY-DEPENDENT

The factor's effect becomes stronger or changes as density rises.

- competition for limited food or space
- disease or parasites spread more easily
- predation can increase with prey density

DENSITY-INDEPENDENT

The initial effect is not determined by population density.

- hurricane, freeze, flood, or wildfire
- pollution or abrupt habitat destruction
- the same event can still have unequal outcomes

HOW LIMITS CHANGE POPULATION SIZE

BIRTH RATE

fewer resources can reduce reproduction

DEATH RATE

stress or disease can increase mortality

IMMIGRATION

available habitat can attract arrivals

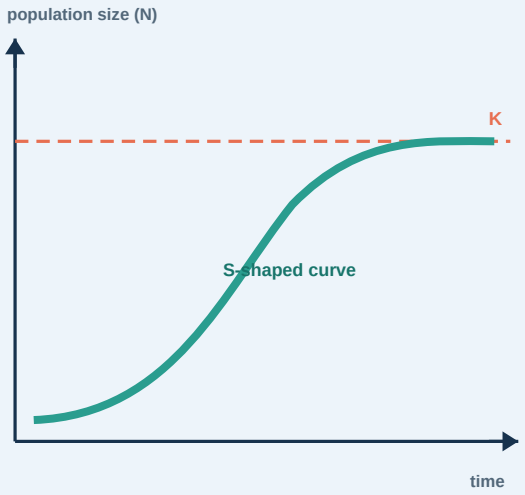
EMIGRATION

scarce resources can promote departure

2 Logistic growth includes resource limitation

As N approaches carrying capacity K, the fraction of unused capacity shrinks and population growth slows.

THE LOGISTIC MODEL



$$\frac{dN}{dt} = r_{max} \times N \times \left(\frac{K - N}{K}\right)$$

$r_{max} \times N$	potential exponential increase
$(K - N) / K$	unused fraction of carrying capacity
K	sustainable abundance supported by resources

READ THE THREE REGIONS

N IS FAR BELOW K

resources per individual are abundant

growth is close to exponential

N APPROACHES K

competition and other limits intensify

growth rate slows

N EQUALS K

the correction factor equals zero

model predicts no net growth

K CAN CHANGE

Season, climate, habitat quality, disturbances, and resource supply can raise or lower carrying capacity. Real populations may fluctuate around K or temporarily overshoot it.

MODEL CHECK

WHEN N << K	the correction factor is near 1, so growth is rapid
WHEN N = K	the correction factor is 0, so dN/dt = 0
IN REAL DATA	estimate K from the long-term pattern, not one point