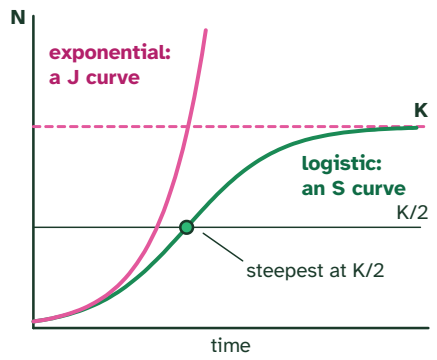
AP BIOLOGY | UNIT 8 | TOPICS 8.3 TO 8.5 | REVISION ON TWO PAGES

Populations *grow*, communities interact

What to know, what to draw and what to say. Nothing else.

THE ONE IDEA

Births minus deaths set how a population grows, until resources hold it near K. Interactions between species drive the sizes of their populations.



Draw it like this. K as a dashed line; the S curve levels off at it, the J curve never does.

8.3.A 8.4.A START HERE

Three equations, two *curves*

- **Growth: dN/dt = B − D**, births minus deaths per unit time. Positive, N grows; zero, it holds. Divide by N for a **per capita** rate.
- **Exponential: dN/dt = rmaxN**. With no constraints the per capita rate stays at its maximum, but the number added keeps rising: a **J curve**.
- **Logistic: dN/dt = rmaxN (K − N)/K**. The bracket is the share of K still free, so growth slows to zero at K: an **S curve**, steepest at K/2.
- All three are on the **formula sheet**: use them, do not learn them.

DENSITY-DEPENDENT FACTORS — *Crowded People Dislike Waiting*

C	**Competition** less food and space each	**P**	**Predation** prey easier to find	**D**	**Disease** spreads faster up close	**W**	**Wastes** build up in a crowd

8.3.A ONE SPECIES, ONE PLACE

A *population*

- The individuals of **one species in one area**, interacting with each other and their environment. Its size is **N**.
- Adaptations for getting and using **energy and matter** set how fast a species breeds and how long it lives.
- **Example:** 800 frogs, 240 born and 180 dead in a year.

60 dN/dt, frogs per year

0.075 per frog per year

8.3.A NOTHING IN THE WAY

Exponential growth

- It happens when a few individuals have **plentiful resources**: a new island, a fresh flask. It never lasts.
- With rmax = 0.5 per year, 1,200 add 600 a year and 2,400 add 1,200.
- Doubling each generation from 1 gives 1,024 after 10 generations and over a million after 20.
- On a **log scale** the J curve is a straight line: the easiest way to spot it.

29 reindeer, St. Matthew Island, 1944

6,000 about, by 1963

8.4.A WHAT STOPS IT

Carrying capacity

- **K**: the number of a species its environment's resources can sustain. It can change.
- A population that **overshoots K** can crash: St. Matthew's reindeer ate their lichen and only 42 were alive in 1966.

Density-dependent bites harder when crowded
A larger share is affected the denser the population.

Density-independent the same share
A frost kills 30% at any density. It is not harmless.

8.4.A FILL IN THE BRACKET FIRST

Logistic growth, *worked*

N	(K − N)/K	RMAXN	DN/DT PER YEAR	WHAT IT MEANS
100	0.9	40	**36**	Few breeders, plenty of room.
500	0.5	200	**100**	Half of K: the fastest growth.
900	0.1	360	**36**	Many breeders, little room.
1,000	0	400	**0**	At K births equal deaths; they have not stopped.
1,200	−0.2	480	**−96**	Above K, N falls back toward K.

K = 1,000 and rmax = 0.4 per year.

From data: 400 adding 96 with K = 2,000 gives rmax = 0.3

Communities: who gains, who loses, and *diversity*

8.5.B HELPED, HARMED OR UNAFFECTED

Five interactions, scored for *each side*

INTERACTION	SIGNS	EXAMPLE	WHAT IT DOES TO POPULATIONS
Competition	**– / –**	Two *Paramecium* on one food	Both get less; one may be lost.
Predation	**+ / –**	Lynx and hare; herbivory too	Each drives the other's numbers.
Parasitism	**+ / –**	A tick on a deer	Host deaths rise or births fall.
Mutualism	**+ / +**	Coral and the zooxanthellae in its cells	Lose the partner and K falls.
Commensalism	**+ / 0**	Barnacles riding on a whale	One gains; the other barely changes.

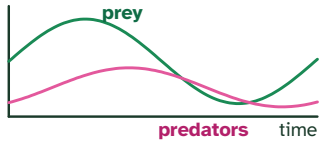
A **community**: interacting populations of different species in one place.

The three symbioses: *My Cat Purrs*

8.5.B EACH DRIVES THE OTHER

Predator and *prey*

- More prey, more predators; more predators, fewer prey; then the predators starve and the prey recover. **Predator peaks lag the prey's**.
- Isle Royale's moose: 840 in 2024, about 524 in 2026, a change of **–38%**.



8.5.B SHARING A RESOURCE

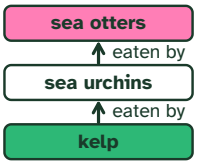
Competition and *niches*

- **Gause:** *P. aurelia* drove out *P. caudatum*, though nothing ate it; *P. bursaria*, eating yeast at the bottom, lived beside it.
- **Niche partitioning**: using different parts of a resource, as MacArthur's five warblers did in one spruce forest.
- **Connell:** with *Semibalanus* gone, *Chthamalus* lived lower: competition can **set where a species lives**.

8.5.B AND COOPERATION

Trophic cascades

- A **trophic cascade**: a change at one level passes down the chain, **each level moving the other way**.
- **Cooperation** changes what a population can reach: a wolf pack brings down a moose.



8.5.A ON THE FORMULA SHEET

Species *diversity* as a number

- **Composition:** which species. **Species diversity**: how many, how evenly shared.
- **Simpson's Diversity Index = 1 – Σ(n/N)²**: 0 for one species, toward 1 for many evenly shared.

0.75
counts 5, 5, 5, 5: squares sum to 0.25

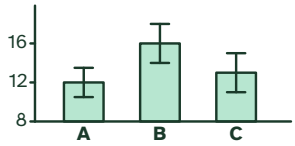
0.27
counts 17, 1, 1, 1: squares sum to 0.73

0.54
a stream net of 12, 6 and 2

8.5.A ERROR BARS

Do two means *differ*?

- Error bars of **± 2 standard errors** give about a 95% confidence interval.
- **No overlap:** the means probably differ. **Overlap:** no evidence of a difference, not proof of none.



WATCH OUT

Six mistakes that *cost points*

- ✕ **dN/dt is not per capita** until it is divided by N.
- ✕ **Exponential growth:** rmax is constant, not the number added.
- ✕ **Births do not stop at K.** They are matched by deaths.
- ✕ **Competition is – / –:** even the winner loses out.
- ✕ **Diversity is not the number of species.** Evenness counts too.
- ✕ **Symbiosis is not another word for mutualism.** A parasite and its host are a symbiosis too.

COVER THE SHEET

Can you *answer these?*

1. Calculate dN/dt for 400 animals, 60 born and 60 dead.
2. Calculate dN/dt with rmax 0.4, N 250 and K 1,000.
3. Identify a flood as density-dependent or not. Justify it.
4. Predict what the hares do if the lynx are trapped out.
5. Explain how sea otters decide whether kelp grows.
6. Explain how niche partitioning lets competitors coexist.
7. Calculate Simpson's index for counts of 10, 6 and 4.
8. Identify which pair of sites in the graph differs.

IN THE EXAM

Equation, numbers, units: "individuals per year". For an interaction, give each species its sign and say which rate it changes, births or deaths.

GO FURTHER

Animated figures, a dry lab and a marked Check are in the full guide online.