

Decomposition

4.7.2.3 · Ecology · revision notes

How temperature, water and oxygen affect the rate at which microorganisms decay dead material, how gardeners make compost and how biogas generators make methane. It includes the decay of milk required practical, so expect rate calculations and graph work. This subtopic is in GCSE Biology only, not Combined Science.

Key facts

- Faster decay: warm, moist, plenty of oxygen
- Compost = decayed waste used as a natural fertiliser
- Rate of decay = $\text{change in mass (or pH)} \div \text{time}$
- Lipase: fat $\rightarrow$ fatty acids + glycerol, so the pH falls
- Too hot $\rightarrow$ decomposer enzymes denature $\rightarrow$ decay slows
- Anaerobic decay $\rightarrow$ methane $\rightarrow$ fuel (biogas generators)
- Rate from a timed end point = $1 \div \text{time}$

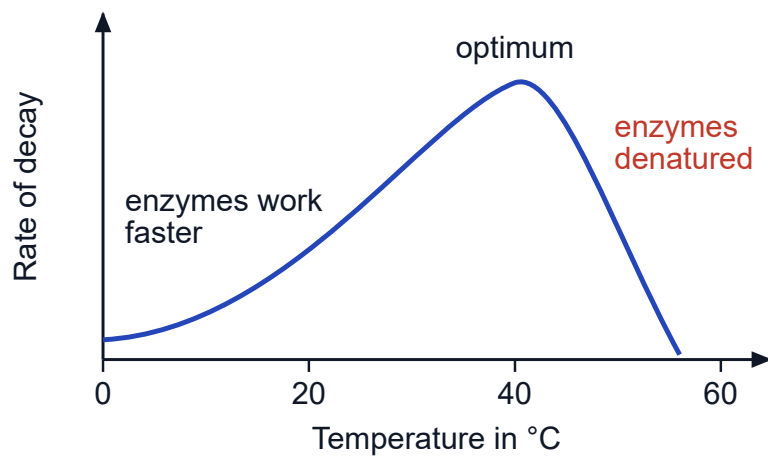
Notes

Decomposers

- Decomposers are microorganisms, such as bacteria and fungi, that break down dead plants, dead animals and waste.
- They secrete enzymes onto the material. The small soluble molecules produced diffuse into their cells.
- Their respiration releases carbon dioxide, and mineral ions are returned to the soil.

Factors affecting the rate of decay

- **Temperature:** warmth speeds up the decomposers' enzyme-controlled reactions, so decay is faster. If it is too hot, the enzymes are denatured and decay slows or stops. Cold slows decay, which is why a fridge keeps food fresh for longer.



Decay speeds up as it gets warmer, until the decomposers' enzymes denature.

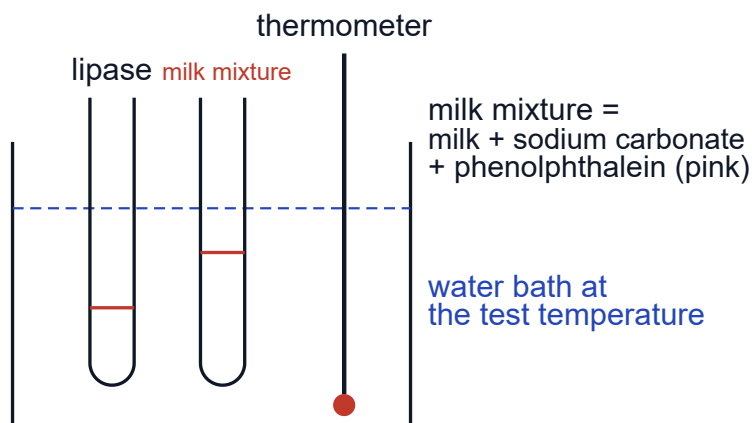
- **Water:** decomposers need moist conditions for their reactions and to digest their food. Dry material decays very slowly.
- **Oxygen:** most decomposers respire aerobically, which releases more energy, so they grow and multiply faster. With little oxygen, decay is slower.

Compost and biogas

- Gardeners and farmers try to give waste the best conditions for rapid decay: warm, moist and with plenty of oxygen (heaps are turned to let air in).
- The finished **compost** is spread on gardens and fields as a natural fertiliser.
- **Anaerobic decay** (decay without oxygen) produces **methane** gas.
- **Biogas generators** use the anaerobic decay of waste, such as animal manure or food waste, to produce methane, which is used as a fuel.

Required practical: decay of milk

- Mix milk, sodium carbonate solution (an alkali) and phenolphthalein indicator. The mixture is pink.
- Add lipase. It breaks down the fat in milk into fatty acids and glycerol, and the fatty acids lower the pH.
- Time how long the pink colour takes to disappear. Use water baths to repeat at different temperatures, warming the milk mixture and the lipase to the test temperature before mixing.



Warm both tubes to the test temperature, mix them and time how long the pink colour takes to go.

- Rate = $1 \div \text{time}$ (or $1000 \div \text{time}$). A pH probe gives a clearer end point than judging a colour change by eye.
- Keep the volumes and concentrations of milk, lipase and sodium carbonate the same.

Don't lose marks

- ✗ Saying high temperatures 'kill' enzymes. Enzymes are not alive: they are denatured.
- ✗ Writing 'biogas' when asked to name the gas. Name methane.
- ✗ Forgetting to bring the lipase and the milk mixture to the test temperature before mixing them.
- ✗ Leaving out units in rate answers (e.g. g per day).

More tips

Memory tricks

- Decay needs WOW: Warmth, Oxygen, Water.
- No oxygen, methane made: anaerobic decay gives a gas you can burn as fuel.
- Sense check a rate: a decay rate is a positive number describing how fast mass is lost.

Exam technique

- For each factor, name the organisms (decomposers or microorganisms) and the process (enzymes or respiration) in your answer.
- In rate questions, check the time units: hours, days or weeks.
- The colour change is gradual, so a common improvement is to use a pH probe or data logger.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

State what decomposers do

Microorganisms such as bacteria and fungi break down dead organisms and waste.

Grade 4

Name the three factors affecting decay rate

Temperature, water (moisture) and the availability of oxygen.

Grade 5

Describe how compost and biogas are produced

Waste decays in warm, moist, well-aerated heaps to make compost; anaerobic decay in a biogas generator makes methane.

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