

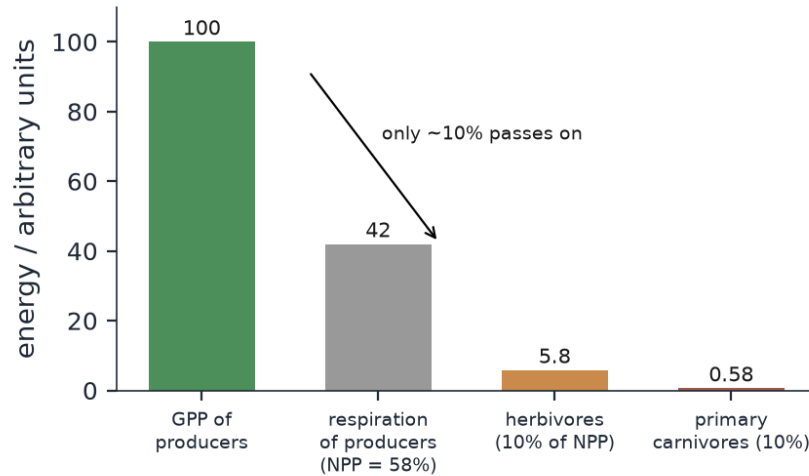
Exercise walk-through

4.6

Culturing microorganisms and growth curves (statements 6.1–6.4, core practical 13)

Pearson Edexcel · International A-Level · Biology

Ten per cent, four losses



- 1 **Fix** grassland fixes 45 000 kJ per square metre per year
- 2 **Subtract** respiration spends 19 000, so NPP = 26 000
- 3 **Transfer** cattle keep about 2 600; humans eating cattle keep 260

Selection filters, isolation splits

Directional : one extreme favoured,
the mean shifts - resistance alleles spread

Stabilising : the average favoured, both extremes trimmed

Isolation : barrier (allopatric) or behaviour (sympatric) stops gene flow

Speciation : diverged populations can no longer interbreed

Check yourself

Your turn

Grassland NPP is 40 000 kJ per square metre per year. At 10% per transfer, what reaches second-order consumers?

- A. 400 kJ - two transfers of 10%
- B. 4 000 kJ - one transfer
- C. 40 kJ - three transfers
- D. 400 000 kJ - the food chain multiplies energy

Exercises 2.1·2.3

2.1 Name the four phases of a bacterial growth curve in order. [2]

2.2 State why plates are incubated at 25 °C, not 37 °C, in school laboratories. [1]

2.3 Give one advantage of viable counts over direct microscope counts. [1]

Exercises 2.1·2.3

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2.1 Lag, log (exponential), stationary, death.

2.2 State why plates are incubated at 25 °C, not 37 °C, in school laboratories. [1]

2.2 Human pathogens multiply best at body temperature (37 °C); 25 °C keeps any accident from growing dangerously.

2.3 Give one advantage of viable counts over direct microscope counts. [1]

2.3 Viable counts count only living, dividing cells; microscope counts include dead cells.

Exercises 3.1·3.2

3.1 A student estimates bacterial concentration by spreading 0.1 cm^3 of a 10^{-4} dilution onto a plate; 46 colonies grow. Calculate the concentration in the original culture, showing your working, and explain why a second plate at the same dilution might give a different count. [4]

3.2 A culture in nutrient broth is followed over 24 hours. Optical density rises slowly for 2 hours, exponentially for 5, then flattens. Name the three phases, explain what limits growth in the last phase, and state why optical density counts dead cells too. [5]

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3.1 Concentration in the diluted sample = $46/0.1 = 460 \text{ cm}^{-3}$; original = $460 \times 10^4 = 4.6 \times 10^6 \text{ cm}^{-3}$. Different count: colonies arise from clumps as well as single cells, and pipetting/dilution errors plus randomness of distribution vary the plate count.

3.2 A culture in nutrient broth is followed over 24 hours. Optical density rises slowly for 2 hours, exponentially for 5, then flattens. Name the three phases, explain what limits growth in the last phase, and state why optical density counts dead cells too. [5]

3.2 Lag, log, stationary. Stationary: nutrients exhausted and metabolic waste accumulates, so death rate rises to equal division rate. Optical density is scattering from ALL cells present, dead or alive.

Exercise 3.3

3.3 A liquid culture grows from 8×10^3 to 2×10^7 cells per cm^3 between 2 and 8 hours. Calculate k and the doubling time, and predict the count at 10 hours if exponential growth continued. [5]

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3.3 Log difference $= \log_{10}(2 \times 10^7 / 8 \times 10^3) = \log_{10} 2500 = 3.398$; $k = 3.398 / (0.301 \times 6) = 1.88 \text{ h}^{-1}$; doubling $= 1 / 1.88 \approx 0.53 \text{ h} \approx 32 \text{ min}$. At 10 h (2 more hours): $2 \times 10^7 \times 2^{2 \times 1.88} \approx 2 \times 10^7 \times 13.8 \approx 2.8 \times 10^8 \text{ cm}^{-3}$.