Unit 2 · Life and Life Process

HARDER PRACTICE QUESTIONS

Full marks 43

Write your answers on separate paper. Show your working. Use $N = N_0 \times 2^n$ only for the stretch where bacteria double steadily.

1 Dal on the kitchen shelf [4]

At 11 a.m., a pot of warm dal has about 200 bacteria in it, and they divide every 20 minutes.

i. How many generations does it take for the number first to pass a million?
ii. At what time does that happen?
iii. How many bacteria are there then?
iv. How does the time change if the bacteria first take 40 minutes to get used to the dal, without dividing?

2 Work backwards [3]

At 2 p.m. a culture has 12,800 cells. It has been doubling every 30 minutes all day.

i. How many cells were there at noon?
ii. At what time were there just 100 cells?

3 Check the claim [5]

A class counts the bacteria in a flask of broth.

Time (min)	0	30	60	80	100	120	140	200	240	300
Bacteria	1,000	1,000	2,000	4,000	8,000	16,000	32,000	60,000	62,000	61,000

Rabina says: “By the formula, 300 minutes at a 20-minute generation time means 15 generations, so there should be 32,768,000 bacteria. We must have counted wrongly.”

i. Name the stretches of growth shown from 0 to 30 minutes, from 60 to 140 minutes, and from 200 to 300 minutes.
ii. Use the table to find the generation time in the middle stretch.
iii. Check Rabina’s arithmetic.
iv. Is she right that the count is wrong? Explain.

4 Phage against bacteria [4]

One T4 phage is added to a flask of 10,000 *E. coli*. Each cycle takes 30 minutes, every burst releases 100 phages, and each phage infects a fresh cell. Ignore any new bacteria.

i. How many cells have been killed after 30 minutes, and after 60 minutes?
ii. How many phages are there at 60 minutes, and how many living cells are left?
iii. What happens in the next cycle?
iv. If the flask held only the bacteria from dahi, what would happen to the phage, and why?

5 Predict, then explain [3]

Write your prediction first, then explain it.

Two batches of T4 are prepared. In Batch A the phages’ DNA is radioactive; in Batch B their protein coats are radioactive. Each batch infects *E. coli*, and after a few minutes the empty coats are shaken off the cells and separated from them. Predict where the radioactivity is found in each case. What would this show about what carries the phage’s instructions?

6 Which is it? [4]

Four samples are studied. Name what each most probably is, and give the evidence.
P: threads with no cross walls and many nuclei, with black pinheads on upright stalks.
Q: oval cells about 7 μm long, each with a nucleus; some have a small bump and ring-shaped marks on the wall.
R: rods about 2 μm long with no nucleus, some with a wall growing across the middle.
S: seen only with an electron microscope, about 200 nm long; it does nothing in clean broth but multiplies when *E. coli* is added.

7 Correct the misconceptions [4]

The paragraph has four mistakes. Write each mistake and correct it.

Yasmin wrote: "*Mucor* is anchored to bread by root-like rhizoids. Its hyphae are divided by many cross walls. Its sporangiospores are diploid, because they are made by meiosis. Its + strain is male and its − strain is female."

8 Reading pairs of cultures [4]

Lhamu repeats Blakeslee's test with four pure cultures of a heterothallic mold, A to D, each from a single spore. She looks for zygospores along the line where two cultures meet.

Pair	A + B	A + C	A + D	B + C	B + D	C + D
Zygospores?	yes	no	yes	yes	no	yes

i. Sort the four cultures into two strains.
ii. A fifth culture, E, makes zygospores with A. Predict E with B, with C and with D.
iii. Can she say which strain is + from these results? Give a reason.
iv. Why must each culture start from a single spore?

9 Design a fair test [4]

Ashish wants to know whether damp roti molds faster than dry roti. He has roti, water, plastic boxes with lids and a warm cupboard.

i. What will he change, and what will he measure?
ii. Name three things he must keep the same.
iii. Why should he leave both pieces in the air for the same time before closing the boxes?
iv. Give one safety rule he must follow, and the reason.

10 Estimate it [3]

Take an *E. coli* cell as a box 2 μm by 1 μm by 1 μm.

i. About how many cells would fill a cube 1 mm on each side?
ii. If one cell doubled every 20 minutes and food never ran out, about how long would it take to fill that cube?

11 Think [3]

A patch of *Mucor* on a heap of dung has grown from one spore, and it is all one strain.

i. Can it make zygospores on its own? Give a reason.
ii. All its threads die if a new fungicide reaches them. Why are its offspring from sporangiospores no help?
iii. How could the zygospores of a mixed patch of + and − strains be different in this case?

12 Make your own [2]

Write your own problem about bacteria whose answer is exactly 5,120 cells after 3 hours. Give the starting number and the generation time, and show that it works. Why can't the generation time be 25 minutes?