Microbes in Human Welfare

Standard difficulty · 20 questions · 40 marks · Time: 42 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. Curd is formed from milk by:

(a) Aspergillus **(b)** Streptococcus only

(c) yeast **(d)** lactic acid bacteria (Lactobacillus)

2. Which microbe is used for cyclosporin A, an immunosuppressant for organ transplants?

(a) Trichoderma polysporum **(b)** Glomus

(c) Rhizobium **(d)** Bacillus thuringiensis (Bt)

3. What is Trichoderma polysporum used for?

(a) Controlling butterfly caterpillars

(b) Fermenting dough for bread, and ethanol

(c) Turning milk into curd, which also raises its vitamin B_{12}

(d) Cyclosporin A, an immunosuppressant for organ transplants

4. Secondary treatment lowers the BOD of sewage from 200 mg/L to 10 mg/L. The percentage reduction is:

(a) 95% **(b)** 5% **(c)** 85% **(d)** 100%

5. Yeast ferments 720 g of glucose ($C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$). The mass of ethanol formed is: ($C_6H_{12}O_6$ = 180, C_2H_5OH = 46, CO_2 = 44)

(a) 368 g **(b)** 176 g **(c)** 184 g **(d)** 352 g

6. A biogas plant makes 250 m^3 of biogas a week, of which 70% is methane. The volume of methane is:

(a) 17.5 m^3 **(b)** 75 m^3 **(c)** 250 m^3 **(d)** 175 m^3

7. Lactic acid bacteria double every 20 minutes. Starting from 500 cells, how many are there after 120 minutes?

(a) 16,000 **(b)** 32,000 **(c)** 6,000 **(d)** 64,000

8. Assertion (A): Rum is made by distilling the fermented broth.
Reason (R): All alcoholic beverages are distilled after fermentation.

(a) Both A and R are true, and R is the correct explanation of A.

(b) Both A and R are true, but R is not the correct explanation of A.

(c) A is true, but R is false.

(d) A is false, but R is true.

Section B — Short answer — 8 × 2 = 16 marks

9. How does curd improve the nutritional value of milk?

10. What is each of these microbes used for: (i) Lactobacillus (lactic acid bacteria); (ii) baculoviruses (Nucleopolyhedrovirus)?

11. Sewage with a BOD of 480 mg/L leaves secondary treatment with a BOD of 72 mg/L. What is the percentage reduction? Where in the plant does most of this fall happen, and why?

12. Yeast ferments 1,260 g of glucose. Find the masses of ethanol and carbon dioxide formed ($C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$; $C_6H_{12}O_6 = 180$, $C_2H_5OH = 46$, $CO_2 = 44$). Which gas makes dough rise?

13. A village biogas plant makes 40 m^3 of biogas, 65% of it methane. How much methane is that? Name the microbes that make it and where they normally live.

14. A bacterium divides every 40 minutes. How long does a culture of 10 cells take to reach 10,240 cells?

15. Classify Monascus purpureus and Bacillus thuringiensis (Bt) by their use: industry, medicine, biocontrol, biofertiliser or energy.

16. Which of brandy and whisky is distilled after fermentation? Why are some beverages distilled?

Section C — Word problems — 4 × 4 = 16 marks

17. Describe the treatment of sewage in a sewage treatment plant.

18. Sewage enters a treatment plant with a BOD of 800 mg/L. Primary treatment lowers it by 40% and secondary treatment lowers what is left by 90%. Find the BOD after each step, and describe what happens in each step and to the sludge.

19. Describe the role of yeast in making bread and alcoholic beverages. If 2,700 g of glucose is fully fermented, find the masses of ethanol and CO_2. Is brandy distilled?

20. What are biocontrol agents and biofertilisers? Explain the role of each of these: Rhizobium; Glomus; Bacillus thuringiensis (Bt). Give two advantages of using such microbes.

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Answer key

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Q	Answer	Working
1	**(d) lactic acid bacteria (Lactobacillus)**	—
2	**(a) Trichoderma polysporum**	—
3	**(d) Cyclosporin A, an immunosuppressant for organ transplants**	—
4	**(a) 95%**	(200 − 10) ÷ 200 × 100
5	**(a) 368 g**	4 mol of glucose gives 8 mol of each product
6	**(d) 175 m^3**	250 × 70/100
7	**(b) 32,000**	6 doublings: 500 × 2^6
8	**(c) A is true, but R is false.**	A is true: rum is a distilled beverage. R is false.
9	**Lactic acid bacteria raise the vitamin B_{12} content, and in our stomach they also help check disease-causing microbes.**	—
10	**(i) turning milk into curd, which also raises its vitamin B_{12}; (ii) species-specific control of insect pests**	—
11	**85%; in the aeration tank, where aerobic microbes in flocs consume the organic matter**	(480 − 72) ÷ 480 × 100
12	**ethanol 644 g, CO_2 616 g; CO_2**	7 mol of glucose → 14 mol of ethanol and 14 mol of CO_2
13	**26 m^3; methanogens such as Methanobacterium, found in the rumen of cattle and in anaerobic sludge**	40 × 65/100
14	**10 doublings, so 400 minutes (6 h 40 min)**	10,240 ÷ 10 = 1,024 = 2 multiplied 10 times
15	**Monascus purpureus: medicine; Bacillus thuringiensis (Bt): biocontrol**	—
16	**brandy: distilled; whisky: distilled. Distillation raises the alcohol content**	wine, beer and toddy are not distilled; whisky, brandy and rum are
17	**Primary treatment removes large and small particles: floating debris by sequential filtration and grit by sedimentation; the settled solids form primary sludge. Secondary (biological) treatment: the primary effluent goes to aeration tanks, where air is pumped in and aerobic microbes grow into flocs that consume organic matter, greatly**	—

Q	Answer	Working
	reducing the BOD. In the settling tank the flocs settle as activated sludge; some is returned as inoculum, and the rest is digested anaerobically, producing biogas. The effluent is released into rivers.	
18	**After primary: 480 mg/L; after secondary: 48 mg/L. Primary treatment: floating debris is removed by sequential filtration and grit by sedimentation, leaving primary sludge. The aeration tank: aerobic microbes grow as flocs and consume organic matter, so the BOD falls sharply. The settling tank: the flocs settle as activated sludge; part of it is pumped back to the aeration tank as inoculum. The anaerobic sludge digester: anaerobic bacteria digest the sludge and give biogas (methane, H_2S and CO_2). Release of the effluent: the treated water from secondary treatment goes into rivers and streams**	800 × 0.6 = 480; 480 × 0.1 = 48
19	**Saccharomyces cerevisiae ferments sugars to ethanol and CO_2 ($C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$). In bread the CO_2 makes the dough rise; in beverages the ethanol is kept. Ethanol 1,380 g, CO_2 1,320 g. Brandy is distilled**	15 mol of glucose
20	**Biocontrol agents are organisms used to control pests and diseases; biofertilisers are organisms that enrich the soil with nutrients. Rhizobium, a biofertiliser agent: fixing nitrogen in the root nodules of legumes; Glomus, a biofertiliser agent: mycorrhiza that absorbs phosphorus from the soil for the plant; Bacillus thuringiensis (Bt), a biocontrol agent: controlling butterfly caterpillars. Advantages: less use of harmful chemical pesticides and fertilisers, no pollution of soil and water, and harmless to useful insects and to humans**	—

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