

Microbiology (XL-S)

Q.1 – Q.5 Multiple Choice Question (MCQ), carry ONE mark each (for each wrong answer: – 1/3).

Q.1	Antonie van Leeuwenhoek observed several microscopic organisms under his hand-made microscope. He described them as
(A)	Bacteria.
(B)	Fungi.
(C)	Animalcules.
(D)	Bacteriophages.

Q.2	Which ONE of the following pathways oxidizes 1 mole of glucose to 2 moles of pyruvic acid along with one mole each of ATP, NADH and NADPH, in <i>Pseudomonas</i> spp., but not in <i>Bacillus</i> spp.?
(A)	Gluconeogenesis
(B)	Embden-Meyerhoff Pathway (EMP)
(C)	Entner-Doudoroff (ED) Pathway
(D)	Pentose Phosphate Pathway (PPP)

Q.3	Water balance in extreme halophiles such as <i>Halobacterium</i> is maintained by cell surface glycoproteins consisting of
(A)	glycine and lysine.
(B)	lysine and histidine.
(C)	glycine.
(D)	aspartate and glutamate.

Q.4	<i>Nocardia</i> spp. are not amenable to the classical method of Gram staining due to the presence of
(A)	N-acetylalosaminuronic acid in the cell wall.
(B)	thick peptidoglycan.
(C)	mycolic acid.
(D)	keto-deoxy-octulosonic acid.

Q.5	Protists belonging to the genus <i>Trichonympha</i> thrive in the gut of termites. They help the termites use wood as a food source. This relationship is an example of
(A)	parasitism.
(B)	competition.
(C)	commensalism.
(D)	mutualism.



Q.6 – Q.9 Multiple Select Question (MSQ), carry ONE mark each (no negative marks).

Q.6	Which of the following is/are used as electron donor/s for CO₂ reduction during photosynthesis in purple sulfur bacteria?
(A)	Hydrogen sulfide
(B)	Thiosulfates
(C)	Methane
(D)	Sulfates

Q.7	Which of the following catalyze(s) substrate-level phosphorylation?
(A)	ATP synthase
(B)	Succinate thiokinase
(C)	Phosphofructokinase
(D)	Pyruvate kinase

Q.8	Which of the following method(s) can be applied to identify a bacterial species?
(A)	Fluorescent in situ hybridization (FISH)
(B)	Polymerase chain reaction (PCR) followed by sequencing of the amplicon
(C)	Gram staining
(D)	Acid-fast staining

Q.9	Which of the following event(s) would contribute to the induction of <i>lac</i> operon in a wild-type strain of <i>E. coli</i>?
(A)	Accumulation of allolactose in the cell
(B)	Direct binding of cAMP to the promoter DNA
(C)	Binding of cAMP to a specific protein leading to its interaction with the promoter
(D)	Elimination of cAMP from the cell



Q.10 Numerical Answer Type (NAT), carry ONE mark each (no negative marks).

Q.10	One mole of a circular bacterial plasmid was digested with a high-fidelity restriction enzyme. The plasmid has five restriction sites for the enzyme used. The number of moles of fragments released upon cleavage at all sites is _____.
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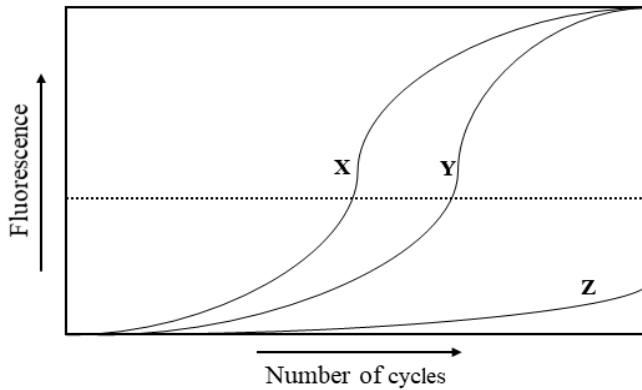
Q.11 – Q.16 Multiple Choice Question (MCQ), carry TWO mark each (for each wrong answer: – 2/3).

Q. 11	Under anaerobic fermentative growth conditions, one mole of glucose yields 22 grams of <i>Streptococcus faecalis</i> or 8.6 grams of <i>Zymomonas mobilis</i>. The molar growth yield (Y_{ATP}) for (i) <i>S. faecalis</i> and (ii) <i>Z. mobilis</i> will be
(A)	(i) 11 and (ii) 4.3
(B)	(i) 22 and (ii) 4.3
(C)	(i) 22 and (ii) 8.6
(D)	(i) 11 and (ii) 8.6

Q. 12	The order of abundance of quinones (ubiquinone [UQ], menaquinone [MQ] and demethylmenaquinone [DMQ]) in <i>E. coli</i> growing anaerobically on fumarate is
(A)	UQ > DMQ > MQ
(B)	MQ > DMQ > UQ
(C)	MQ = DMQ > UQ
(D)	MQ > UQ > DMQ

Q. 13	What is the number of ATPs generated per molecule of NADH during oxidative phosphorylation in <i>E. coli</i> via (i) NDH-1 and cytochrome bo complex or (ii) the NDH-2 and cytochrome bd complex? (Assume $H^+/ATP = 3$)
(A)	(i) 2.00 and (ii) 3.67
(B)	(i) 3.00 and (ii) 2.67
(C)	(i) 2.70 and (ii) 0.67
(D)	(i) 2.50 and (ii) 0.50

Q. 14	Match the Immunoglobulin classes with their function												
	<table> <tr> <th>Immunoglobulin</th><th>Function</th></tr> <tr> <td>(i) IgE</td><td>(p) protects the fetus</td></tr> <tr> <td>(ii) IgG</td><td>(q) first antibody to be produced in response to infection</td></tr> <tr> <td>(iii) IgM</td><td>(r) provides localized protection of mucosal surfaces</td></tr> <tr> <td>(iv) IgA</td><td>(s) mediates allergic reaction</td></tr> <tr> <td></td><td>(t) directly lyses the target cells</td></tr> </table>	Immunoglobulin	Function	(i) IgE	(p) protects the fetus	(ii) IgG	(q) first antibody to be produced in response to infection	(iii) IgM	(r) provides localized protection of mucosal surfaces	(iv) IgA	(s) mediates allergic reaction		(t) directly lyses the target cells
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(A)	(i)- (s), (ii)-(p), (iii)-(q), (iv)-(r)												
(B)	(i)- (p), (ii)-(t), (iii)-(q), (iv)-(r)												
(C)	(i)- (q), (ii)-(p), (iii)-(t), (iv)-(r)												
(D)	(i)- (r), (ii)-(p), (iii)-(t), (iv)-(s)												

Q. 15	The figure shows the profiles of quantitative real-time PCR (qRT-PCR) tests for SARS-CoV-2 conducted on the throat swab samples of three individuals (X, Y and Z). Tests were carried out under identical conditions. Dotted line represents the threshold fluorescent value. Identify the correct statement on the status of the COVID-19 tests of the individuals based on their qRT-PCR profiles. 
(A)	X and Y are negative; Z is positive
(B)	X and Y are positive; There is no apparent difference in their viral load
(C)	X and Y are positive; X has the highest viral load
(D)	X and Y are positive; Y has the highest viral load

Q.16	The rate of appearance of recombinant <i>E. coli</i> strains containing different genes after a mating between Hfr and F⁻ strains is shown in the graph (left). The approximate location of different genes (<i>p</i>, <i>q</i>, <i>r</i>, <i>s</i>, <i>t</i>, <i>x</i>, and <i>y</i>) along the Hfr chromosome is also shown (right). Based on this information, identify the recombinants X, Y and Z.
(A)	X is x^+ , Y is r^+ and Z is p^+
(B)	X is p^+ , Y is r^+ and Z is x^+
(C)	X is x^+ , Y is p^+ and Z is r^+
(D)	X is p^+ , Y is x^+ and Z is r^+

Q.17 – Q.20 Numerical Answer Type (NAT), carry TWO mark each (no negative marks).

Q.17	The genome of a bacterium encodes for 10 different surface antigens, whose expression can be turned 'ON' or 'OFF' randomly and independently. The number of possible antigenic combinations is_____.
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Q.18	Suppose the mRNAs in a newly discovered bacteria are composed of only two distinct nucleotides (as opposed to four found in all known organisms). Considering that the organism has no nucleotide modification systems, the number of nucleotides required per codon to encode at least 20 distinct amino acids will be_____.
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Q. 19	The decimal reduction time (D) for reducing 10^{12} spores of <i>Clostridium botulinum</i> to 1 spore at 111°C will be_____ min (in integer). The D value is 0.2 min at 121°C . The increase in temperature required to change D to $1/10^{\text{th}}$ of its initial value (Z value) is 10°C .
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Q. 20	The generation time of <i>E. coli</i> is 30 minutes. For an exponentially growing culture, the initial number of bacteria required to reach a number of 10^9 in 2 hours is_____ $\times 10^7$ (round off to two decimal places).
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END OF THE QUESTION PAPER