Roll No. .....

Question Booklet Number

O. M. R. Serial No.

M. Sc. (Microbiology) (Second Semester) EXAMINATION, 2025-26

(New Syllabus Effective from 2023)

BACTERIAL METABOLISM AND PHYSIOLOGY

Paper Code								
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Questions Booklet Series
C

Time : 1:30 Hours] [*Maximum Marks : 75*

Instructions to the Examinee :

1. Do not open the booklet unless you are asked to do so.
2. The booklet contains 100 questions. Examinee is required to answer 75 questions in the OMR Answer-Sheet provided and not in the question booklet. All questions carry equal marks.
3. Examine the Booklet and the OMR Answer-Sheet very carefully before you proceed. Faulty question booklet due to missing or duplicate pages/questions or having any other discrepancy should be got immediately replaced.

परीक्षार्थियों के लिए निर्देश :

1. प्रश्न-पुस्तिका को तब तक न खोलें जब तक आपसे कहा न जाए।
2. प्रश्न-पुस्तिका में 100 प्रश्न हैं। परीक्षार्थी को 75 प्रश्नों को केवल दी गई OMR आन्सर-शीट पर ही हल करना है, प्रश्न-पुस्तिका पर नहीं। सभी प्रश्नों के अंक समान हैं।
3. प्रश्नों के उत्तर अंकित करने से पूर्व प्रश्न-पुस्तिका तथा OMR आन्सर-शीट को सावधानीपूर्वक देख लें। दोषपूर्ण प्रश्न-पुस्तिका जिसमें कुछ भाग छपने से छूट गए हों या प्रश्न एक से अधिक बार छप गए हों या उसमें किसी अन्य प्रकार की कमी हो, तो उसे तुरन्त बदल लें।

(Remaining instructions on the last page) **(शेष निर्देश अन्तिम पृष्ठ पर)**

1. Quorum sensing regulates :

(A) ROS detoxification

(B) ATP synthesis

(C) Virulence, biofilm formation

(D) CO_2 fixation

2. Biofilm matrix is composed of :

(A) Extracellular polymeric substances (EPS)

(B) ATP

(C) RuBisCO

(D) ROS

3. Reducing agents used in anaerobic media include :

(A) Glucose

(B) Thioglycolate

(C) ATP

(D) RuBisCO

4. Heat shock proteins are induced by :

(A) Low ATP

(B) Low oxygen

(C) High CO_2

(D) Elevated temperature

5. Cyanobacteria exhibit multicellular organization via :

(A) Leghemoglobin

(B) Heterocyst differentiation

(C) RuBisCO

(D) Catalase

6. Donnan equilibrium leads to :

(A) Oxygen toxicity

(B) ATP synthesis

(C) Osmotic pressure differences

(D) CO_2 fixation

7. Biofilm formation is an example of :

(A) Multicellular organization

(B) ATP synthesis

(C) ROS detoxification

(D) CO_2 fixation

8. Gram-negative bacteria use quorum sensing autoinducer :

(A) ROS

(B) Peptides

(C) Acyl-homoserine lactones (AHLs)

(D) ATP

9. Superoxide dismutase protects cells by converting :

(A) $O_2^- \rightarrow H_2O_2$

(B) $O_2 \rightarrow O_3$

(C) $H_2O_2 \rightarrow O_2$

(D) $OH^- \rightarrow H_2O$

10. Dissimilative nitrate reduction occurs under :

(A) Anaerobic conditions

(B) Aerobic conditions

(C) Nitrogen-limiting conditions

(D) High ATP

11. Bioluminescence requires :

(A) Oxygen and $FMNH_2$

(B) CO_2 and ATP

(C) NADPH only

(D) $FADH_2$ only

12. LuxI/LuxR system is found in :

(A) *E. coli*

(B) *Vibrio fischeri*

(C) *Bacillus subtilis*

(D) *Azotobacter*

13. Donnan equilibrium occurs due to :

(A) Impermeant charged ions inside cells

(B) ATP hydrolysis

(C) Oxygen toxicity

(D) CO_2 diffusion

14. Thermophiles adapt by :

(A) Catalase

(B) Unsaturated fatty acids

(C) RuBisCO

(D) Heat-stable enzymes and saturated fatty acids

15. Aquaporins regulate :

(A) CO_2 transport

(B) Proton transport

(C) Oxygen transport

(D) Water transport

16. Osmoprotectants include :

(A) Trehalose, proline, glycine betaine

(B) ATP, NADH, $FADH_2$

(C) RuBisCO, leghemoglobin

(D) Cytochrome oxidase

17. Peroxidase detoxifies :

(A) CO_2 using NADPH

(B) O_2 using ATP

(C) OH^- using $FADH_2$

(D) H_2O_2 using NADH

18. Acidophiles maintain neutral cytoplasmic pH by :

(A) Producing CO_2

(B) Importing OH^-

(C) Proton pumps expelling H^+

(D) Using Rubisco

19. Obligate anaerobes lack :

(A) Superoxide dismutase and catalase

(B) RuBisCO

(C) ATP synthase

(D) Cytochrome oxidase

20. Assimilative nitrate reduction occurs under :

(A) Oxygen-limiting conditions

(B) Nitrogen-limiting conditions

(C) High ammonia

(D) High ATP

21. The sensor kinase in Pho system is :

(A) NifA

(B) PhoB

(C) PhoR

(D) NifL

22. *Azotobacter* protects nitrogenase by :

(A) High respiratory activity

(B) Heterocyst formation

(C) Leghemoglobin

(D) ATP hydrolysis

23. Route I of ammonia assimilation is effective under :

(A) Anaerobic conditions

(B) Low ammonia concentration

(C) High ammonia concentration

(D) High oxygen

24. ADP-ribosylation of nitrogenase occurs on :

(A) Fe protein (dinitrogenase reductase)

(B) MoFe protein

(C) Leghemoglobin

(D) RuBisCO

25. Pho system regulates :

(A) Genes for nitrogenase

(B) Genes for phosphate uptake

(C) Genes for sulfur assimilation

(D) Genes for glycolysis

26. Sulphur assimilation is essential for :

(A) CO_2 fixation

(B) ATP synthesis

(C) Cysteine and methionine synthesis

(D) Oxygen transport

27. The Pho regulon is activated under :

(A) Nitrogen starvation

(B) Phosphate starvation

(C) Oxygen starvation

(D) ATP excess

28. ATP sulfurylase catalyzes :

(A) $SO_4^{2-} \rightarrow$ APS (adenosine-5′-phosphosulfate)

(B) $SO_3^{2-} \rightarrow SO_4^{2-}$

(C) $H_2S \rightarrow S°$

(D) $S° \rightarrow H_2S$

29. Ammonia assimilation is important for :

(A) Oxygen transport

(B) ATP synthesis

(C) Amino acid biosynthesis

(D) CO_2 fixation

30. Ammonia assimilation occurs via :

(A) Nitrate reductase

(B) Nitrogenase

(C) Glutamine synthetase

(D) ATP synthase

31. The nitrogenase complex consists of :

(A) Fe protein + MoFe protein

(B) Cytochrome + RuBisCO

(C) ATP synthase + NADH dehydrogenase

(D) Ferredoxin + plastocyanin

32. Nitrogenase is repressed by :

(A) Oxygen absence

(B) CO_2

(C) Combined nitrogen sources $\left(NH_4^+, NO_3^-\right)$

(D) High ATP

33. Denitrification is carried out by :

(A) Obligate aerobes

(B) Facultative anaerobes

(C) Obligate anaerobes

(D) Cyanobacteria

34. Nitrification requires :

(A) Oxygen

(B) CO_2

(C) NADPH

(D) Fermentation

35. nifL gene encodes :

(A) ATP synthase subunit

(B) Positive regulator

(C) Structural protein

(D) Negative regulator of nif operon

36. Nitrogenase requires :

(A) NADPH only

(B) ATP and reduced ferredoxin

(C) Oxygen

(D) $FADH_2$

37. Pasteur effect reduces :

(A) Glucose consumption under aerobic conditions

(B) Oxygen consumption under anaerobic conditions

(C) ATP yield under aerobic conditions

(D) NADH yield under anaerobic conditions

38. Nitrate assimilation begins with :

(A) Nitrate reductase

(B) Nitrite reductase

(C) Nitrogenase

(D) Ammonia monooxygenase

39. Nitrogenase reduces :

(A) $NO_3^- \rightarrow NO_2^-$

(B) $N_2 \rightarrow NH_3$

(C) $NH_3 \rightarrow NO_2^-$

(D) $NO_2^- \rightarrow NO_3^-$

40. The enzyme Rubisco is regulated by :

(A) ATP only

(B) Oxygen only

(C) CO_2 and Mg^{2+} concentration

(D) NADH

41. Heterofermentative lactic acid bacteria produce :

(A) Only CO_2

(B) Only lactic acid

(C) Only ethanol

(D) Lactic acid + ethanol + CO_2

42. The glyoxylate cycle is favored when :

(A) NADPH is high

(B) Glucose is abundant

(C) Oxygen is absent

(D) Acetate is the carbon source

43. Phosphofructokinase-1 is inhibited by :

(A) ATP

(B) ADP

(C) AMP

(D) NADH

44. The enzyme that converts pyruvate to acetyl-CoA is :

(A) Lactate dehydrogenase

(B) Pyruvate dehydrogenase

(C) Malate dehydrogenase

(D) Succinate dehydrogenase

45. Substrate-level phosphorylation occurs in :

(A) Glyoxylate cycle

(B) ETS only

(C) PPP only

(D) Glycolysis

46. The enzyme converting pyruvate to lactate is :

(A) Lactate dehydrogenase

(B) Alcohol dehydrogenase

(C) Pyruvate kinase

(D) Malate dehydrogenase

47. The key enzyme unique to glyoxylate cycle is :

(A) Malate dehydrogenase

(B) Citrate synthase

(C) Isocitrate lyase

(D) Succinate dehydrogenase

48. NADH is generated at the step catalyzed by :

(A) Glyceraldehyde-3-phosphate dehydrogenase

(B) Hexokinase

(C) Pyruvate kinase

(D) Enolase

49. Oxidative phosphorylation couples :

(A) PPP with nucleotide synthesis

(B) Glycolysis with fermentation

(C) Electron transport with ATP synthesis

(D) Krebs cycle with CO_2 fixation

50. The Q cycle transfers electrons from :

(A) Ubiquinol to cytochrome c

(B) NADH to oxygen

(C) $FADH_2$ to NAD^+

(D) Succinate to oxygen

51. The β- subunits of F_1 contain :

(A) Catalytic sites for ATP synthesis

(B) Proton channels

(C) Electron carriers

(D) Oxygen evolving complex

52. Rotational catalysis involves rotation of :

(A) β- subunit

(B) α- subunit

(C) γ- subunit of ATP synthase

(D) δ- subunit

53. The key enzyme of PPP is :

(A) Glucose-6-phosphate dehydro-genase

(B) Hexokinase

(C) Pyruvate kinase

(D) Aldolase

54. The chemiosmotic theory explains :

(A) Glycolysis

(B) Oxidative phosphorylation

(C) Fermentation

(D) PPP

55. Methanotrophs use the 'Ribulose Monophosphate' (RuMP) pathway primarily for :

(A) Producing methane

(B) Incorporating formaldehyde into cellular biomass

(C) Splitting water

(D) Transporting iron

56. Complex I of ETS transfers electrons from :

(A) Succinate

(B) $FADH_2$

(C) NADH

(D) Cytochrome c

57. The enzyme producing $FADH_2$ in Krebs cycle is :

(A) Malate dehydrogenase

(B) Succinate dehydrogenase

(C) Isocitrate dehydrogenase

(D) Citrate synthase

58. The rate-limiting enzyme of glycolysis is :

(A) Phosphofructokinase-1

(B) Hexokinase

(C) Pyruvate kinase

(D) Enolase

59. Why do Hydrogen-oxidizing bacteria often have two different Hydrogenase enzymes ?

(A) One for H_2 gas and one for liquid H_2.

(B) One to produce ATP (membrane-bound) and one to produce NADH (cytoplasmic).

(C) One for the day and one for the night.

(D) To compete with methanogens.

60. The key intermediate of Entner-Doudoroff pathway is :

(A) Acetyl-CoA

(B) Ribose-5-phosphate

(C) Citrate

(D) KDPG (2-keto-3-deoxy-6-phosphogluconate)

61. Cyclic photophosphorylation is favored when :

(A) NADPH levels are high

(B) ATP levels are high

(C) CO_2 levels are low

(D) Oxygen levels are high

62. Ribose-5-phosphate from Pentose Phosphate Pathway (PPP) is used for :

(A) Glycogen synthesis

(B) Protein synthesis

(C) Lipid synthesis

(D) Nucleotide synthesis

63. End product of glycolysis under aerobic conditions is :

(A) Ethanol

(B) Lactate

(C) Pyruvate

(D) Acetyl-CoA

64. Carbon Monoxide (CO) Dehydrogenase is the key enzyme for :

(A) The Calvin Cycle

(B) The Wood-Ljungdahl Pathway

(C) Iron oxidation

(D) Nitrification

65. A bacterium uses H_2S as an electron donor and lives in total darkness at the bottom of the ocean. It is a :

(A) Photoautotroph

(B) Chemoorganotroph

(C) Chemolithoautotroph

(D) Photoheterotroph

66. In nitrifiers, NADH is generated via :

(A) Reverse electron transport

(B) Substrate-level phosphorylation

(C) Fermentation

(D) Glycolysis

67. Which stage of the Calvin Cycle involves the enzyme RuBisCO ?

(A) Reduction phase

(B) Regeneration phase

(C) Carboxylation phase

(D) Photorespiration phase

68. The oxygen-evolving complex (OEC) is located in :

(A) Photosystem II

(B) Photosystem I

(C) Cytochrome b6f

(D) ATP synthase

69. What is the primary role of the 'Antenna' in a Light-Harvesting Complex ?

(A) To act as the final electron acceptor

(B) To expand the surface area and spectral range for photon capture

(C) To pump protons across the membrane

(D) To synthesize ATP directly

70. Phycobiliproteins are light-harvesting pigments characteristic of which group ?

(A) Purple Sulfur Bacteria

(B) Green Sulfur Bacteria

(C) Cyanobacteria

(D) Heliobacteria

71. What is the central coordinating metal ion found in all Chlorophyll and Bacteriochlorophyll molecules ?

(A) Iron

(B) Magnesium

(C) Copper

(D) Zinc

72. Phycobilins are characteristic pigments of :

(A) Sulfur bacteria

(B) Green plants

(C) Purple bacteria

(D) Cyanobacteria

73. The Calvin cycle is also known as :

(A) C_4 pathway

(B) Glyoxylate cycle

(C) Reductive pentose phosphate cycle

(D) Krebs cycle

74. The product of the Calvin cycle that directly enters carbohydrate synthesis is :

(A) 3-phosphoglycerate

(B) Glyceraldehyde-3-phosphate (G3P)

(C) Ribulose-1, 5-bisphosphate

(D) NADPH

75. ATP synthesis in nitrifying bacteria is driven by :

(A) Proton motive force

(B) Substrate-level phosphorylation

(C) Fermentation

(D) Glycolysis

76. Methanogens belong to which domain of life ?

(A) Bacteria

(B) Eukarya

(C) Archaea

(D) Protozoa

77. In cyclic photophosphorylation, electrons are recycled back to :

(A) Photosystem II

(B) Photosystem I reaction center

(C) Cytochrome b6f complex

(D) NADP + reductase

78. The key enzyme in methane oxidation is :

(A) Methane monooxygenase

(B) Alcohol dehydrogenase

(C) Formaldehyde dehydrogenase

(D) Acetyl-CoA carboxylase

79. Sulfur-oxidizing bacteria regulate electron flow through :

(A) Sulfite oxidase

(B) Sulfate permease

(C) Sulfur reductase

(D) ATP sulfurylase

80. Carboxysomes are specialized structures in some autotrophs that contain :

(A) DNA

(B) RuBisCO

(C) ATP synthase

(D) Chlorophyll

81. The oxidation of Ammonia to Nitrite is performed by :

(A) *Nitrobacter*

(B) *Methanogens*

(C) *Pseudomonas*

(D) *Nitrosomonas*

82. Compare the 'Quantum Yield' of Purple Sulfur bacteria (PS I-like) and Cyanobacteria (PS I + PS II). Why is Cyanobacterial photosynthesis considered more 'evolved' ?

(A) It produces more heat.

(B) It can utilize water (H_2O), an almost inexhaustible electron donor, despite its very high reduction potential (+ 0.82V).

(C) It only functions in the presence of H_2S.

(D) It does not require a membrane-bound ATPase.

83. How does anoxygenic photosynthesis differ from oxygenic photosynthesis ?

(A) It does not use light

(B) It does not produce oxygen as a byproduct

(C) It occurs only in eukaryotes

(D) It uses two photosystems (PS I and PS II)

84. Chemolithotrophs obtain their energy from :

(A) Sunlight

(B) Organic compounds

(C) Inorganic compounds

(D) Heat

85. The primary CO_2-fixing enzyme in the Calvin Cycle is :

(A) RuBisCO

(B) ATP citrate lyase

(C) Carbonic anhydrase

(D) Acetyl-CoA carboxylase

86. A researcher inhibits ATP synthesis in a bacteria. Which transport would stop immediately ?

(A) Passive diffusion

(B) ABC transport

(C) Facilitated diffusion

(D) Oxygen uptake

87. Which component of the PTS system is usually sugar-specific ?

(A) Enzyme I

(B) HPr

(C) Enzyme II (specifically IIB and IIC)

(D) ATP-synthase

88. Predict the effect of adding an uncoupler (which dissipates the proton gradient) on proton-gradient driven active transport.

(A) Transport increases

(B) Transport stops

(C) Transport reverses direction

(D) No effect

89. Which transport mechanism is most likely to be used for a highly non-polar gas like O_2 ?

(A) ABC transport

(B) Facilitated diffusion

(C) Passive diffusion

(D) Group translocation

90. A bacteria is in a low-iron environment. To survive, it would likely upregulate the production of :

(A) Porins

(B) Siderophores

(C) Aquaporins

(D) Bacteriorhodopsin

91. If a cell's internal glucose concentration is 10 mM and the external is 2 mM, which mechanism must it use to take up more glucose ?

(A) Simple diffusion

(B) Facilitated diffusion

(C) Active transport

(D) Osmosis

92. Which of the following describes a 'Uniport' system ?

(A) Two molecules moving together

(B) Light-driven movement of electrons

(C) Two molecules moving in opposite directions

(D) One molecule moving in one direction

93. The thermodynamics of transport systems dictates that movement against a gradient requires :

(A) An increase in entropy

(B) Input of free energy ($\Delta G > 0$ for the substrate)

(C) A decrease in temperature

(D) The absence of a membrane

94. Why is group translocation considered 'economical' for a bacterial cell ?

(A) It uses no energy

(B) It uses heat instead of ATP

(C) It modifies the substrate so it cannot diffuse back out

(D) It only works for water molecules

95. What is the primary difference between passive diffusion and facilitated diffusion ?

(A) Passive diffusion requires ATP

(B) Facilitated diffusion uses specific carrier proteins

(C) Passive diffusion moves against the gradient

(D) Facilitated diffusion is faster at very high concentrations

96. What does the acronym ABC in 'ABC transport' stand for ?

(A) Ammonium Binding Complex

(B) Automated Bacterial Carrier

(C) Active Biological Channel

(D) ATP-Binding Cassette

97. Which process moves molecules from an area of high concentration to low concentration without the help of a protein ?

(A) Facilitated diffusion

(B) Passive diffusion

(C) Active transport

(D) Group translocation

98. Bacteriorhodopsin acts as a light-driven pump to move which ion across the membrane ?

(A) Na^+

(B) Cl^-

(C) H^+

(D) K^+

99. ABC transporters utilize the energy from which of the following to move substrates ?

(A) Proton motive force

(B) ATP hydrolysis

(C) Light energy

(D) Sodium gradient

100. Which transport mechanism moves molecules against a concentration gradient by coupling it to the energetically favorable movement of another ion (like H^+ or Na^+) ?

(A) Passive diffusion

(B) Facilitated diffusion

(C) Secondary active transport

(D) Group translocation

(Only for Rough Work)

4. Four alternative answers are mentioned for each question as—A, B, C & D in the booklet. The candidate has to choose the correct answer and mark the same in the OMR Answer-Sheet as per the direction :

Example :

Question :

Q. 1 (A) ● (C) (D)
Q. 2 (A) (B) ● (D)
Q. 3 (A) ● (C) (D)

Illegible answers with cutting and over-writing or half filled circle will be cancelled.

5. Each question carries equal marks. Marks will be awarded according to the number of correct answers you have.
6. All answers are to be given on OMR Answer Sheet only. Answers given anywhere other than the place specified in the answer sheet will not be considered valid.
7. Before writing anything on the OMR Answer Sheet, all the instructions given in it should be read carefully.
8. After the completion of the examination candidates should leave the examination hall only after providing their OMR Answer Sheet to the invigilator. Candidate can carry their Question Booklet.
9. There will be no negative marking.
10. Rough work, if any, should be done on the blank pages provided for the purpose in the booklet.
11. To bring and use of log-book, calculator, pager and cellular phone in examination hall is prohibited.
12. In case of any difference found in English and Hindi version of the question, the English version of the question will be held authentic.

Impt. : On opening the question booklet, first check that all the pages of the question booklet are printed properly. If there is any discrepancy in the question Booklet, then after showing it to the invigilator, get another question Booklet of the same series.

4. प्रश्न-पुस्तिका में प्रत्येक प्रश्न के चार सम्भावित उत्तर—A, B, C एवं D हैं। परीक्षार्थी को उन चारों विकल्पों में से सही उत्तर छाँटना है। उत्तर को OMR आन्सर-शीट में सम्बन्धित प्रश्न संख्या में निम्न प्रकार भरना है :

उदाहरण :

प्रश्न :

प्रश्न 1 (A) ● (C) (D)
प्रश्न 2 (A) (B) ● (D)
प्रश्न 3 (A) ● (C) (D)

अपठनीय उत्तर या ऐसे उत्तर जिन्हें काटा या बदला गया है, या गोले में आधा भरकर दिया गया, उन्हें निरस्त कर दिया जाएगा।

5. प्रत्येक प्रश्न के अंक समान हैं। आपके जितने उत्तर सही होंगे, उन्हीं के अनुसार अंक प्रदान किये जायेंगे।
6. सभी उत्तर केवल ओ. एम. आर. उत्तर-पत्रक (OMR Answer Sheet) पर ही दिये जाने हैं। उत्तर-पत्रक में निर्धारित स्थान के अलावा अन्यत्र कहीं पर दिया गया उत्तर मान्य नहीं होगा।
7. ओ. एम. आर. उत्तर-पत्रक (OMR Answer Sheet) पर कुछ भी लिखने से पूर्व उसमें दिये गये सभी अनुदेशों को सावधानीपूर्वक पढ़ लिया जाये।
8. परीक्षा समाप्ति के उपरान्त परीक्षार्थी कक्ष निरीक्षक को अपनी OMR Answer Sheet उपलब्ध कराने के बाद ही परीक्षा कक्ष से प्रस्थान करें। परीक्षार्थी अपने साथ प्रश्न-पुस्तिका ले जा सकते हैं।
9. निगेटिव मार्किंग नहीं है।
10. कोई भी रफ कार्य, प्रश्न-पुस्तिका के अन्त में, रफ-कार्य के लिए दिए खाली पेज पर ही किया जाना चाहिए।
11. परीक्षा-कक्ष में लॉग-बुक, कैलकुलेटर, पेजर तथा सेल्युलर फोन ले जाना तथा उसका उपयोग करना वर्जित है।
12. प्रश्न के हिन्दी एवं अंग्रेजी रूपान्तरण में भिन्नता होने की दशा में प्रश्न का अंग्रेजी रूपान्तरण ही मान्य होगा।

महत्वपूर्ण : प्रश्नपुस्तिका खोलने पर प्रथमतः जाँच कर देख लें कि प्रश्न-पुस्तिका के सभी पृष्ठ भलीभाँति छपे हुए हैं। यदि प्रश्नपुस्तिका में कोई कमी हो, तो कक्षनिरीक्षक को दिखाकर उसी सिरीज की दूसरी प्रश्न-पुस्तिका प्राप्त कर लें।