Post Graduate School
Indian Agricultural Research Institute, New Delhi

Examination for Admission to Ph.D. Programme 2013-2014

Discipline : Microbiology

Discipline Code : 14 Roll No. [redacted]

Please Note:

(i) This question paper contains **13** pages. **Please check whether all the pages are printed in this set.** Report discrepancy, if any, **immediately** to the invigilator.

(ii) ***There shall be NEGATIVE marking for WRONG answers in the Multiple Choice type questions (No. 1 to 130) which carry one mark each. For every wrong answer 0.25 mark will be deducted.***

PART – I (General Agriculture)

Multiple choice questions (No. 1 to 30). Choose the correct answer (*a, b, c* or *d*) and enter your choice in the circle (by shading with a pencil) on the OMR - answer sheet as per the instructions given on the answer sheet.

1. Who is the present Chairman of Protection of Plant Varieties and Farmers' Right Authority (PPV&FRA)?
a) Dr. R.R. Hanchinal
b) Dr. P.L. Gautam
c) Dr. S. Nagarajan
d) Dr. Swapan K. Datta

2. Which among the following is another name for vitamin B_{12}?
a) Niacin
b) Pyridoxal phosphate
c) Cobalamin
d) Riboflavin

3. The largest share in India's farm export earning in the year 2011-12 was from
a) Basmati rice
b) Non-basmati rice
c) Sugar
d) Guar gum

4. The National Bureau of Agriculturally Important Insects was established by ICAR in _____, was earlier known as _____.
a) Bangalore; PDBC
b) New Delhi; National Pusa Collection
c) Ranchi; Indian Lac Research Institute
d) New Delhi; NCIPM

5. The most important sucking pests of cotton and rice are respectively
a) *Nilaparvata lugens* and *Aphis gossypii*
b) *Aphis gossypii* and *Thrips oryzae*
c) *Amrasca biguttula biguttula* and *Scirtothrips dorsalis*
d) *Thrips gossypii* and *Orseolia oryzae*

6. Which of the following microorganism causes fatal poisoning in canned fruits and vegetables?
a) *Aspergillus flavus*
b) *Penicillium digitatum*
c) *Clostridium botulinum*
d) *Rhizoctonia solani*

7. The cause of the great Bengal Famine was
a) Blast of rice
b) Brown spot of rice
c) Rust of wheat
d) Karnal bunt of wheat

8. Actinomycetes belong to
a) The fungi
b) Eukaryote
c) *Mycelia sterilia*
d) None of the above

9. A virus-free clone from a virus infected plant can be obtained by
a) Cotyledonary leaf culture
b) Axenic culture
c) Stem culture
d) Meristem tip culture

10. Which of the following is not an objective of the National Food Security Mission?
a) Sustainable increase in production of rice, wheat and pulses
b) Restoring soil fertility and productivity at individual farm level
c) Promoting use of bio-pesticides and organic fertilizers
d) Creation of employment opportunities

11. Agmarknet, a portal for the dissemination of agricultural marketing information, is a joint endeavour of
a) DMI and NIC
b) DMI and Ministry of Agriculture
c) NIC and Ministry of Agriculture
d) DMI and Directorate of Economics and Statistics

12. The share of agriculture and allied activities in India's GDP at constant prices in 2011-12 was
a) 14.1%
b) 14.7%
c) 15.6%
d) 17.0%

13. The average size of land holding in India according to Agricultural Census 2005-06 is
a) 0.38 ha
b) 1.23 ha
c) 1.49 ha
d) 1.70 ha

14. 'Farmers First' concept was proposed by
a) Paul Leagans
b) Neils Rolling
c) Robert Chamber
d) Indira Gandhi

15. In the year 2012, GM crops were cultivated in an area of
a) 150 million hectare in 18 countries
b) 170 million hectare in 28 countries
c) 200 million hectare in 18 countries
d) 1.70 million hectare in 28 countries

16. The broad-spectrum systematic herbicide glyphosate kills the weeds by inhibiting the biosynthesis of
a) Phenylalanine
b) Alanine
c) Glutamine
d) Cysteine

17. At harvest, the above ground straw (leaf, sheath and stem) weight and grain weight of paddy crop are 5.5 and 4.5 tonnes per hectare, respectively. What is the harvest index of paddy?
a) 45%
b) 50%
c) 55%
d) 100%

18. Crossing over between non-sister chromatids of homologous chromosomes takes place during
a) Leptotene
b) Pachytene
c) Diplotene
d) Zygotene

19. The term 'Heterosis' was coined by
a) G.H. Shull
b) W. Bateson
c) T.H. Morgan
d) E.M. East

20. When a transgenic plant is crossed with a non-transgenic, what would be the zygosity status of the F_1 plant?
a) Homozygous
b) Heterozygous
c) Hemizygous
d) Nullizygous

21. The highest per capita consumption of flowers in the world is in
a) The USA
b) India
c) Switzerland
d) The Netherlands

22. Which of the following is a very rich source of betalain pigment?
a) Radish
b) Beet root
c) Carrot
d) Red cabbage

23. Dog ridge is
a) Salt tolerant rootstocks of mango
b) Salt tolerant rootstocks of guava
c) Salt tolerant rootstocks of grape
d) Salt tolerant rootstocks of citrus

24. Which of the following micronutrients are most widely deficient in Indian soils?
a) Zinc and boron
b) Zinc and iron
c) Zinc and manganese
d) Zinc and copper

25. Which of the following fertilizers is not produced in India?
a) DAP
b) Urea
c) Muriate of potash
d) TSP

26. What is the estimated extent of salt affected soils in India?
a) 5.42 mha
b) 7.42 mha
c) 11.42 mha
d) 17.42 mha

27. Which of the following is not a feature of watershed?
a) Hydrological unit
b) Biophysical unit
c) Socio-economic unit
d) Production unit

28. Correlation coefficient 'r' lies between
a) 0 and 1
b) -1 and 1
c) -1 and 0
d) 0 and ∞

29. For the data 1, -2, 4, geometric mean is
a) 2
b) 4
c) $-\frac{7}{3}$
d) -2

30. The relationship between Arithmetic mean (A), Harmonic mean (H) and Geometric mean (G) is
a) $G^2=AH$
b) $G=\sqrt{A+H}$
c) $H^2=GA$
d) $A^2=GH$

PART – II (Subject Paper)

Multiple choice questions (No. 31 to 130). Choose the correct answer (*a, b, c* or *d*) and enter your choice in the circle (by shading with a pencil) on the OMR - answer sheet as per the instructions given on the answer sheet.

31. In a chemostat, growth rate and growth yield are controlled
a) Independently
b) By volume of the vessel
c) Depend on each other
d) None of the above

32. The sequence of stages in the formation of microbial biofilms in nature is
    i) Cell growth and production of polysaccharide
    ii) Reversible attachment of planktonic cells
    iii) Irreversible attachment of the same cells
    iv) Further development to form nearly impenetrable mature biofilm

    The correct sequence is
a) i, ii, iii, iv
b) ii, i, iii, iv
c) i, iii, ii, iv
d) ii, iii, i, iv

33. Each megabase of prokaryotic DNA on an average encodes about
a) 1000 ORFs
b) 100 ORFs
c) 10 ORFs
d) 1 ORF

34. Methanogenic bacteria cannot use the following substrate to produce methane on their own
a) Formate
b) Acetate
c) Glucose
d) Dimethyl sulphide

35. Anderson sampler is
a) An air sampler
b) A fresh water sampler
c) A deep sea water sampler
d) A soil sampler

36. Considering the specificity between the species of legume and rhizobial species in establishing the symbiotic state, soybean is infected by
a) *Azorhizobium*
b) *Bradyrhizobium*
c) *Mesorhizobium*
d) *Sinorhizobium*

37. Chemical structure common to both penicillin and cephalosporin is
a) β-lactam ring
b) Aminoglycosides
c) Lactone ring
d) Naphthacene ring

38. The first antiseptic used by Joseph Lister was
a) Carbolic acid (Phenol)
b) Methyl alcohol (Methanol)
c) Ethyl alcohol (Ethanol)
d) Sulfonamides

39. The photosynthetic bacteria using inorganic electron donor for reduction of CO_2 are called
a) Photoorganotrophs
b) Chemoorganotrophs
c) Chemolithotrophs
d) Photolithotrophs

40. Wine turns sour
a) On exposure to light
b) Contamination by aerobic *Acetobacter aceti*
c) Contamination by anaerobic *Lactobacillus lactis*
d) On prolonged storage

41. The semilog of per minute growing bacteria is plotted against time. The shape of the graph will be
a) Sigmoid
b) Hyperbolic
c) Ascending straight line
d) Descending straight line

42. The yeast cell wall is made up of
a) Glucans
b) Mannans
c) Cellulose and muramic acid
d) Glucan, mannan and chitin

43. Bacteria are most susceptible to penicillin in
a) Log phase
b) Lag phase
c) Stationary phase
d) Death phase

44. *Staphylococcus aureus* can be differentiated from other staphylococci by
a) Coagulase test
b) Urcase test
c) Catalase test
d) All of the above

45. Prior to staining the slide, one must fix the material to be observed. The purpose of fixation is to
a) Kill the microorganisms
b) Coagulate the protoplasm of the cells
c) Make it to adhere to the slide
d) All of the above

46. The enzyme present in raw milk and is destroyed by adequate pasteurization is
a) Lipase
b) Phosphatase
c) Lyase
d) Peroxidase

47. Both lysozyme and penicillin affect the cell wall of bacteria. The part of cell wall affected is
a) Peptidoglycan
b) Techoic acid
c) Lipopolysaccharide
d) All of the above

48. Alternate name for penicillin binding protein is
a) Aminopeptidase
b) Transpeptidase
c) Transaminase
d) Aminotransferase

49. The lens used in the 'objective' of a compound microscope is
a) Convex lens
b) Concave lens
c) Combination of convex and concave lens
d) Plano-convex lens

50. Resolution in light microscopy depends on wavelength of visible light and numerical aperture (NA) of objective lens. Thus maximum resolution can be obtained with
a) Shortest wavelength and minimum NA
b) Shortest wavelength and maximum NA
c) Longest wavelength and minimum NA
d) Longest wavelength and maximum NA

51. The following organism has 'Peritrichous' arrangement of flagella
a) *Pseudomonas aeruginosa*
b) *Pseudomonas fluorescens*
c) *Salmonella typhi*
d) *Rhodospirillum photometricum*

52. During which phase of bacterial growth, the growth rate is the reciprocal of the generation time?
a) Exponential phase
b) Lag phase
c) Stationary phase
d) Death phase

53. The process of photosynthesis has an important requirement of a chemical reductant. The green and purple bacteria that carry out photosynthesis do not use following as their chemical reductant
a) H_2
b) H_2S
c) H_2O
d) $H_2S_2O_3$

54. The first gene in the sequence of structural genes in *lac* operon codes for
a) β-galactoside permease
b) β-galactosidase
c) Thiogalactoside transacetylase
d) None of the above

55. The species of *Clostridium* most likely to cause spoilage of canned foods is
a) *Clostridium sporogenes*
b) *Clostridium pasteurianum*
c) *Clostridium botulinum*
d) *Clostridium tetani*

56. Decimal reduction time is the time in minutes to reduce the bacterial population by
a) 100 percent
b) 90 percent
c) 10 percent
d) 1 percent

57. The process of nitrification occurs in two steps where each step is performed by different group of bacteria. The oxidation of nitrite to nitrate is exhibited by
a) *Nitrosomonas*
b) *Nitrosovibrio*
c) *Nitrobacter*
d) *Nitrosococcus*

58. Red algae are similar to blue green algae in having
a) Similar reserve food
b) Same type of reproduction
c) Phycobilins
d) Procaryotic nature

59. In a growth experiment beginning with single cell of bacteria having a doubling time of 30 minutes. The population of total number of cells after incubation of 5 hours will be
a) 2^5
b) 2^8
c) 2^{10}
d) 2^{12}

60. Bacteria which can synthesize cellulose
a) *Azotobacter chroococcum*
b) *Clostridium xylinum*
c) *Bacillus subtilis*
d) *Acetobacter xylinum*

61. Lower BOD of sewage water is an indicator of
a) Higher amount of toxic elements
b) Higher acidity
c) Lower organic matter content
d) Higher organic matter content

62. Fusel oil will be more in wine if it is produced from
a) Potato
b) Sugarcane juice
c) Grape juice
d) Pure sucrose solution

63. Passive immunity provides
a) Permanent protection against infection
b) Temporary protection against infection
c) Antibodies for a particular infection
d) No protection is provided

64. An organism is tagged with green fluorescent protein (GFP) and used for seed inoculation in a crop. The researcher used a cross section of root to prove the presence of this organism in the endorhizosphere, which microscope should be used for viewing this root section?
a) Electron microscope
b) Nomarski differential interference microscope
c) Phase contrast microscope
d) Confocal scanning microscope

65. Which one of the following media is not a selective/differential media?
a) Eosin Methylene blue agar
b) Reese minimal media
c) Xylose lysine disoxycholate agar
d) Desoxycholate citrate agar

66. Removal of microorganisms by filtration generally is accomplished by passage through a filter of pore size
a) 0.01-0.1 μm
b) 0.2-0.45 μm
c) More than 0.5 μm
d) Less than 0.1 μm

67. When a microbial cell grows at high temperature, the cytoplasmic membrane has an increased proportion of
a) Phospholipids
b) Unsaturated fatty acids
c) Ether linked lipids
d) Ester linked lipids

68. Lysozyme occurs as part of the following
a) Tears
b) Saliva
c) Egg white
d) All of the above

69. A *Bacillus* culture grown in a medium lacking calcium ion will produce
a) Normal vegetative cells
b) Spores lacking thermotolerance
c) Defective endospores
d) Cells will not multiply

70. Which of the following refers to the addition of microorganisms to the diet in order to provide health benefits beyond basic nutritive value?
a) Antibiotics
b) Adjuvants
c) Synbiotics
d) Probiotics

71. Transmission electron microscopy is best for high magnification viewing of
a) Internal structure of live, motile cell
b) Internal structure of fixed cells
c) Surface structure of fixed cells
d) Surface membrane of live, motile cells

72. All of the following are true about agar except that it
a) Liquefies at 100^oC
b) is a polysaccharide derived from red alga
c) Solidifies at approximately at 40^oC
d) is metabolized by many bacteria

73. If you are designing an experiment involving a chemolithotrophic autotroph, which of the following would be most essential to maintain the growth of the organism?
a) A continual supply of O_2
b) A source of CO_2
c) A nutrient medium containing glucose
d) Keeping the culture at 37^oC

74. The addition of which of the following would change a chemically defined medium into a complex media?
a) Biotin
b) K_2HPO_4
c) Maltose
d) Yeast extract

75. Continuous feed during fermentation is used to maintain
a) Temperature
b) Cell number
c) Substrate concentration
d) Product concentration

76. Mineralization refers to
a) Conversion of inorganic complex compounds into simple inorganic compounds
b) Conversion of complex organic compounds into simple inorganic compounds
c) Conversion of complex organic compounds into simple organic constituents
d) Conversion of inorganic complex materials into elements

77. Roll tube procedure is used to isolate
a) Aerobes
b) Anaerobes
c) Thermopiles
d) Facultative aerobes

78. The repression of lac operon in the presence of glucose or any other readily utilizable substrate is referred as
a) Catabolite repression
b) Feedback inhibition
c) Specific termination
d) Metabolic induction

79. The enzyme produced by gene *lac* A in the *lac* operon
a) β-galactosidase
b) Transacetylase
c) Permease
d) β-glucosidase

80. Introduction of antisense RNA into a cell can
a) Increase or over express the corresponding gene
b) Reduce or prevent the expression of the corresponding gene
c) Shall have no effect on the expression of the gene
d) Will destroy RNA

81. *Rhodotorula* is used to produce
a) Organic acid
b) Enzymes
c) Antibiotics
d) Lipids

82. Streptomycin and neomycin belong to the class of antibiotics called
a) Polypeptides
b) Amino glycosides
c) Macrolides
d) Polyene

83. *Beijerinckia* is predominantly found in
a) Alkaline soil
b) Neutral soil
c) Acidic soil
d) No effect of pH of soil

84. What is the concentration of dissolved oxygen in natural water?
a) 2 mg/l
b) 5 mg/l
c) 10 mg/l
d) 15 mg/l

85. Which property of microorganism is used in bioassay of vitamins?
a) Autotrophy
b) Phototrophy
c) Auxotrophy
d) Chemoheterotrophy

86. Blanching of vegetables prior to preservation is done mainly to denature
a) Enzymes
b) Carbohydrates
c) Nucleic acid
d) Lipids

87. Prions are a type of
a) Viruses
b) Proteinacious particles
c) Yeast-like particles
d) Viroids

88. An example of counter stain and mordant used in Gram's staining reaction are
a) Safranin and alcohol
b) Crystal violet and alcohol
c) Safranin and iodine
d) Crystal violet and iodine

89. Addition of lignocellulosic residues leads to higher population of _____ while incorporation of succulent residues leads to higher _____ population in soil.
a) Fungi; bacteria
b) Fungi; actinobacteria
c) Bacteria; fungi
d) Bacteria; algae

90. *Chlorella* is a
a) Motile unicellular green alga
b) Motile unicellular blue-green alga
c) Non-motile unicellular green-alga
d) Non-motile unicellular protist

91. In Entner-Doudoroff pathway, yield of ATP molecules per molecule of glucose consumed is
a) One
b) Two
c) Four
d) Six

92. The genus *Mycoplasma* is resistant to the effects of
a) Triclosan
b) Sulfonamides
c) Streptomycin
d) Penicillin

93. In general, DNA viruses multiply in the cell _____ and RNA viruses multiply in the cell _____.
a) Vesicles; ribosomes
b) Cytoplasm; nucleus
c) Nucleus; cytoplasm
d) Endoplasmic reticulum; nucleolus

94. Rice cultivated under waterlogged conditions has lower requirement for fertilizer phosphorus then upland crop because
a) Insoluble ferric phosphates are reduced to soluble phosphates
b) There is an increase in acid production by bacteria
c) Anaerobes are better P solubilizers
d) All of the above

95. Dyes that are anionic or have negatively charged groups are called
a) Acid dyes
b) Basic dyes
c) Neutral dyes
d) Differential dyes

96. Nigrosine is used in
a) Acid fast staining
b) Flagella staining
c) Gram staining
d) Negative staining

97. Rickettsias are commonly transmitted through
a) Air
b) Water
c) Soil
d) Arthropod vectors

98. Which one of the following bacteria is a heterotroph?
a) *Erwinia*
b) *Chromatium*
c) *Nitrosomonas*
d) *Nitrobacter*

99. Calcium dipicolinate is present in one of the following layers of the bacterial endospore
a) Exosporium
b) Core
c) Spore coat
d) Cortex

100. A protozoan with two types of nuclei
a) *Plasmodium*
b) *Vorticella*
c) *Euglena*
d) *Amoeba*

101. The 'rust fungi' belongs to
a) Ascomycotina
b) Zygomycotina
c) Basidiomycotina
d) Deuteromycotina

102. An energy yielding process in which inorganic molecules act as terminal e-acceptors
a) Aerobic respiration
b) Anaerobic respiration
c) Fermentation
d) Agglutination

103. Microorganisms indigenous to a particular environment
a) Autochthonous
b) Allochthonous
c) Zymogenous
d) Autogenous

104. Which one of the following fungi produces zygospores?
a) *Penicillium*
b) *Fusarium*
c) *Aspergillus*
d) *Rhizopus*

105. In fermentation one of the following serve as both electron donor and acceptor
a) Organic molecules
b) Inorganic molecules
c) CO_2
d) Oxygen

106. A bacterium that uses one carbon compound as its source of carbon and energy
a) Methylotroph
b) Autotroph
c) Auxotroph
d) Heterotroph

107. An inhibitor of ETC
a) Nitrite
b) Cyanide
c) Tannin
d) Nitrate

108. A food poisoning bacterium normally associated with nostrils of human beings is
a) *Salmonella typhimurium*
b) *Staphylococcus aureus*
c) *Streptococcus faecalis*
d) *Escherichia coli*

109. Synbiotic refers to
a) Probiotic
b) Prebiotic
c) Mixture of probiotic and prebiotic
d) Probiotic, prebiotic and an antibiotic

110. Which one of the following organisms is edible?
a) *Aspergillus awamori*
b) *Agaricus campestris*
c) *Penicillium oxalicum*
d) *Albugo candida*

111. Sodium chloride used in foods as a preservative causes
a) Plasmolysis
b) Hydrolysis
c) Glycolysis
d) Proteolysis

112. The use of γ-rays from cobalt source for control of microorganisms in food
a) Radappertization
b) Radication
c) Radiation
d) Radurization

113. Water bodies that are rich nutritionally and support microbial growth and activities
a) Dystrophic
b) Eutrophic
c) Oligotrophic
d) Holozoic

114. The group of bacteria commonly found in activated sludge
a) Sheathed bacteria
b) Appendaged bacteria
c) Gliding bacteria
d) Budding bacteria

115. A fungus used in the preparation of soya tempeh
a) *Rhizopus nigrificans*
b) *Rhizopus oligosporus*
c) *Aspergillus flavus*
d) *Aspergillus fumigatus*

116. Cedar wood oil is used when using oil immersion lens in microscopy because
a) It has higher refractive index than glass
b) It has the same refractive index as glass
c) It has a lower refractive index than glass
d) It is easily available and easy to use

117. Gelatin is not preferred as a solidifying agent as compared to agar because
a) It can be used as a nutrient source by some microorganisms
b) It has a higher melting point
c) It is complex in nature
d) It is toxic to some microorganisms

118. Addition of salt during saukerant formation leads to
a) Favours growth of lactic acid bacteria and kills other bacteria
b) Improves nutrient availability
c) Buffers the pH
d) Lowers the turgor pressure

119. Lysozyme was discovered by
a) Louis Pasteur
b) Alexander Fleming
c) Robert Koch
d) Arthur Kornberg

120. The initiator t-RNA in protein synthesis of methanogens is
a) Methionine
b) Fomylmethionine
c) Cysteine
d) Formylcysteine

121. In the brewing process, the term used for germinated barley grains heated to stop germination and used as raw material is known as
a) Hops
b) Malt
c) Must
d) Wort

122. The process that converts NH_4^+ to NO_3^- is called
a) Nitrogen fixation
b) Ammonification
c) Denitrification
d) Nitrification

123. *Thermoplasma* grows best in environments characterized by
a) Low pH and high temperature
b) High salt and high temperature
c) High pressure
d) Low nutrients and high temperature

124. The approximate size of 16S rRNA is
a) 0.5 kb
b) 1.0 kb
c) 1.5 kb
d) 2.5 kb

125. Methanogens lack
a) Superoxide dismutase
b) Methyl CoM reductase
c) Hydrogenase
d) Proteinases

126. The source of Pfu DNA polymerase is
a) *Pyrococcus*
b) *Pyrobaculum*
c) *Pyrodictium*
d) *Pseudomonas*

127. The enzyme employed in producing semisynthetic penicillin is
a) Penicillin acylase
b) Penicillinase
c) Penicillin transacetylase
d) Homocitrate synthetase

128. Carbonic anhydrase catalyzes reversible hydration of
a) Carbon dioxide
b) Carbon monoxide
c) Carbon tetrachloride
d) Carbon disulphide

129. In case the generation time of *Saccharomyces cerevisiae* is 2 hours, its specific growth rate will be
a) 0.15 h^{-1}
b) 0.25 h^{-1}
c) 0.35 h^{-1}
d) 0.45 h^{-1}

130. Corn steep liquor stimulates penicillin production because it contains
a) Side chain precursors
b) Precursors of ring structure
c) A high nitrogen content
d) A high carbon content

Matching type questions (No. 131 to 140); all questions carry equal marks. Choose the correct answer (*a, b, c, d* or *e*) for each sub-question (*i, ii, iii, iv* and *v*) and enter your choice in the circle (by shading with a pencil) on the OMR - answer sheet as per the instructions given on the answer sheet.

131. Match the type of fermentation with the organism/group of organisms carrying them out

i) Alcoholic	a) *Clostridium acetobutylicum*
ii) Homolactic	b) Yeast
iii) Heterolactic	c) Enteric bacteria
iv) Mixed acid	d) *Lactobacillus*
v) Butanol	e) *Leuconostoc*

132. Match the following shape/characteristic of microorganism with respective organism

i) Kidney or bean shaped	a) *Anabaena*
ii) Swarming	b) *Neisseria* or *Moraxella*
iii) Rods	c) *Vibrio*
iv) Filamentous	d) *Pseudomonas aeruginosa*
v) Comma shaped, curved	e) *Proteus*

133.

i) Optical density	a) Biolog
ii) Serological identification	b) Growth
iii) Physiological characterization	c) PCR
iv) Molecular characterization	d) Microscope
v) Morphological characterization	e) ELISA

134.

i) Green non sulfur bacteria	a) *Chloroflexus*
ii) Radiation resistance	b) *Cytophaga*
iii) Salt tolerant	c) *Chlorobium*
iv) Green sulfur bacteria	d) *Deinococcus*
v) Gliding bacteria	e) *Halobacterium*

135.

i) *Thiobacillus*	a) Nitrifying bacteria
ii) *Desulfovibrio*	b) Iron oxidizing bacteria
iii) *Nitrosomonas*	c) Sulphur oxidizing bacteria
iv) *Gallionella*	d) Sulphate reducing bacteria
v) *Nostoc*	e) Nitrogen-fixing phototrophic bacteria

136.

i) Lister	a) Replica plating
ii) Pruisner	b) TOL plasmids
iii) Chakrabarty	c) Prions
iv) Griffith	d) R and S type of bacteria
v) Joshua-Lederberg	e) Antiseptic

137.

i) Penicillin	a) Cell membrane permeability
ii) Cycloheximide	b) Antifungal
iii) Streptomycin	c) Protein synthesis
iv) Interferon	d) Viral replication
v) Polymyxin	e) Cell wall

138.

i) Krausening	a) O_2 transfer in fermentation
ii) ExFerm process	b) Beer production
iii) Geyser effect	c) Acetic acid
iv) Reynold number	d) Ethanol production
v) Orleans process	e) Turbulent flow in fermenter

139.

i) Nocard and Roux	a) Bacteriophage
ii) Beijerinck	b) Bacterial transformation
iii) D'Herelle and Twort	c) PPLO
iv) Zinder and Lederberg	d) Bacterial transduction
v) Griffith	e) Tobacco mosaic virus

140.

i) *Nostoc*	a) Arbuscule
ii) *Colletotrichum*	b) Pycnium
iii) *Acaulospora*	c) Heterocyst
iv) *Puccinia*	d) Hartig net
v) *Pisolithus*	e) Acervulus

Short questions (No. 141 to 146); each question carries FIVE marks. Write answers, including computation / mathematical calculations if any, in the space provided for each question on the question paper itself.

141. The advent of cyanobacteria is considered a critical step in evolution. Comment.

142. When two strains of *E.coli*, one carrying Ampicillin resistance (Ap^r) gene and other without it were mixed together in a broth, the Ap^r gene could be transferred from one strain to another strain. Further, it was observed that gene transfer did not occur when two strains were kept separated in the broth using a filter membrane (size 0.45 μm pore size). What kind of genetic exchange mechanism is taking place in these organisms? How can you rule out other types of genetic exchange mechanisms?

143. Exposure of contaminated objects to boiling water only disinfects them while steam under pressure for the same duration of time sterilizes them. Why?

144. How would you enrich for anoxygenic photosynthetic bacteria and what is their ecological/biological significance?

145. Discuss the significance of methanogenesis and methane oxidation in global warming, emphasizing the importance of microorganisms and agricultural practices.

146. One of the methods of food preservation is to reduce water activity (A_w). Define this term and how one can reduce the water activity in food/food products to prevent spoilage by microorganisms?