Post Graduate School
Indian Agricultural Research Institute, New Delhi

Examination for Admission to Ph.D. Programme 2011-2012

Discipline : Microbiology

Discipline Code : 13 Roll No

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. Which of the following crops have been approved for commercial cultivation in India?
a) Bt cotton and Bt brinjal
b) Bt cotton and Golden Rice
c) Bt maize and Bt cotton
d) Bt cotton only

2. This year (2010-11) the expected food grain production in India is
a) 212 million tonnes
b) 220 million tonnes
c) 235 million tonnes
d) 250 million tonnes

3. The genome of which of the following crops is still not completely sequenced?
a) Rice
b) Soybean
c) Sorghum
d) Wheat

4. According to the Approach Paper to the 12th Five Year Plan, the basic objective of the 12th Plan is
a) Inclusive growth
b) Sustainable growth
c) Faster, more inclusive and sustainable growth
d) Inclusive and sustainable growth

5. To address the problems of sustainable and holistic development of rainfed areas, including appropriate farming and livelihood system approaches, the Government of India has set up the
a) National Rainfed Area Authority
b) National Watershed Development Project for Rainfed Areas
c) National Mission on Rainfed Areas
d) Command Area Development and Water Management Authority

6. Which of the following sub-schemes are not covered under the Rashtriya Krishi Vikas Yojana?
a) Extending the Green Revolution to eastern India
b) Development of 60,000 pulses and oilseeds villages in identified watersheds
c) National Mission on Saffron
d) National Mission on Bamboo

7. The minimum support price for the common variety of paddy announced by the Government of India for the year 2010-11 was
a) ₹ 1030
b) ₹ 1000
c) ₹ 980
d) ₹ 950

8. According to the Human Development Report 2010 of the United Nations, India's rank in terms of the human development index is
a) 119
b) 134
c) 169
d) 182

9. Which of the following does not apply to SRI method of paddy cultivation?
a) Reduced water application
b) Reduced plant density
c) Increased application of chemical fertilizers
d) Reduced age of seedlings

10. Which organic acid, often used as a preservative, occurs naturally in cranberries, prunes, cinnamon and cloves?
a) Citric acid
b) Benzoic acid
c) Tartaric acid
d) Lactic acid

11. Cotton belongs to the family
a) Cruciferae
b) Anacardiaceae
c) Malvaceae
d) Solanaceae

12. Photoperiodism is
a) Bending of shoot towards source of light
b) Effect of light/dark durations on physiological processes
c) Movement of chloroplast in cell in response to light
d) Effect of light on chlorophyll synthesis

13. Ergot disease is caused by which pathogen on which host?
a) *Claviceps purpurea* on rye
b) *Puccinia recondita* on wheat
c) *Drechlera sorokiniana* on wheat
d) *Albugo candida* on mustard

14. Rocks are the chief sources of parent materials over which soils are developed. Granite, an important rock, is classified as
a) Igneous rock
b) Metamorphic rock
c) Sedimentary rock
d) Hybrid rock

15. Which one of the following is a *Kharif* crop?
a) Pearl millet
b) Lentil
c) Mustard
d) Wheat

16. The coefficient of variation (C.V.) is calculated by the formula
a) (Mean/S.D.) × 100
b) (S.D./Mean) × 100
c) S.D./Mean
d) Mean/S.D.

17. Which of the following is commonly referred to as muriate of potash?
a) Potassium nitrate
b) Potassium chloride
c) Potassium sulphate
d) Potassium silicate

18. Inbred lines that have same genetic constitution but differ only at one locus are called
a) Multi lines
b) Monohybrid
c) Isogenic lines
d) Pure lines

19. For applying 100 kg of nitrogen, how much urea would one use?
a) 45 kg
b) 111 kg
c) 222 kg
d) 333 kg

20. The devastating impact of plant disease on human suffering and survival was first realized by epidemic of
a) Brown spot of rice in Bengal
b) Late blight of potato in USA
c) Late blight of potato in Europe
d) Rust of wheat in India

21. The species of rice (*Oryza*) other than *O. sativa* that is cultivated is
a) *O. rufipugon*
b) *O. longisteminata*
c) *O. glaberrima*
d) *O. nivara*

22. The enzyme responsible for the fixation of CO_2 in mesophyll cells of C-4 plants is
a) Malic enzyme
b) Phosphoenol pyruvate carboxylase
c) Phosphoenol pyruvate carboxykinase
d) RuBP carboxylase

23. Which one of the following is a 'Vertisol'?
a) Black cotton soil
b) Red sandy loam soil
c) Sandy loam sodic soil
d) Submontane (Tarai) soil

24. What is the most visible physical characteristic of cells in metaphase?
a) Elongated chromosomes
b) Nucleus visible but chromosomes not
c) Fragile double stranded loose chromosomes
d) Condensed paired chromosomes on the cell plate

25. All weather phenomena like rain, fog and mist occur in
a) Troposphere
b) Mesosphere
c) Ionosphere
d) Ozonosphere

26. Which of the following elements is common to all proteins and nucleic acids?
a) Sulphur
b) Magnesium
c) Nitrogen
d) Phosphorous

27. Silt has intermediate characteristics between
a) Sand and loam
b) Clay and loam
c) Loam and gravel
d) Sand and clay

28. Certified seed is produced from
a) Nucleus seed
b) Breeder seed
c) Foundation seed
d) Truthful seed

29. Seedless banana is an
a) Autotriploid
b) Autotetraploid
c) Allotriploid
d) Allotetraploid

30. Which one of the following is used to test the goodness-of-fit of a distribution?
a) Normal test
b) t-test
c) Chi-square test
d) F-test

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. Voges-Proskauer test detects
a) Butanediol fermentation pathway
b) Butanol fermentation pathway
c) Homolactic fermentation pathway
d) Mixed acid fermentation pathway

32. Chemical preservative used to inhibit growth of bacteria, yeast and molds
a) Citric acid
b) Benzoic acid
c) Alcohol
d) Carbon dioxide

33. Strickland reaction occurs during
a) Metabolism of carbohydrates
b) Metabolism of organic acids
c) Metabolism of lipids
d) Metabolism of amino acids

34. Griseofulvin is
a) Fungus
b) Antibiotic
c) Analgesic
d) Disease

35. Cysts are formed in
a) *Azospirillum*
b) *Rhizobium*
c) *Pseudomonas*
d) *Bacillus*

36. When readily metabolizable carbon compounds are added to soil, protozoal population increases because
a) Bacterial population increases
b) Bacterial population decreases
c) Fungal population increases
d) Fungal population decreases

37. *Paramecium* feeds by means of
a) Sucker
b) Pseudopodia
c) Phagocytosis
d) Oral groove

38. Which of these is not in the domain bacteria?
a) Cyanobacteria
b) Proteobacteria
c) Bacteroides
d) Methanobacterium

39. One genus of bacteria that can be found in the bottom, black layer of a Winogradsky column is
a) *Desulfovibrio*
b) *Beggiatoa*
c) Cyanobacteria
d) *Rhodobium*

40. Which of the following has highest alcohol content?
a) Gin
b) White wine
c) Beer
d) Red wine

41. Recombination in prokaryotes occurs in horizontal gene transfer during the process of
a) Meiosis
b) Conjugation
c) Transcription
d) Mitosis

42. What group of organisms is probably the most closely related to the ancient species that gave rise to the bacteria and Archae?
a) Acidophiles
b) Hyperthermophiles
c) Methanogens
d) Barophiles

43. A type of asexual spore found in fungi
a) Ascospores
b) Basidiospores
c) Oospores
d) Blastospores

44. The cell wall of *Mycobacterium* is very rich in
a) Sterols
b) Pseudomurein
c) Lysozyme
d) Mycolic acids

45. The chemical nature of the endotoxin present in the cell wall of gram-negative bacteria is
a) Lipid A
b) Lipopolysaccharide
c) Lipoprotein
d) Glycoprotein

46. The bile salt present in the McConkey agar medium serves to inhibit the growth of
a) Gram positive bacteria
b) Gram negative bacteria
c) Actinomycetes
d) Acid-fast bacteria

47. The thiosulphate citrate bilesalt sugar (TCBS) agar is used for the selective isolation of
a) Non-cholera vibrios
b) *Vibrio cholerae*
c) Most Vibrios
d) *Vibrio parahemolyticus*

48. A toxin which has been treated with formalin is called
a) Antitoxin
b) Exotoxin
c) Endotoxin
d) Toxoid

49. Which of the following is used by bacteria to bind iron and/or extract it from proteins?
a) Transferrin
b) Siderophore
c) Lactoferrin
d) Ferritin

50. DNA in spore is present in
a) Condensed B form
b) Z form
c) A form
d) D form

51. A DNA vector which can replicate in both prokaryotic and eukaryotic cells is called
a) Binary vector
b) Shuttle vector
c) Dual vector
d) Cosmid

52. Which statement best describes the F plasmid?
a) F plasmid carry genes for formation of a specialized pilus that helps in bacterial conjugation
b) F plasmid does not have an origin of replication
c) The primary host for F plasmid is *Saccharomyces cerevisiae*
d) F plasmids carry a number of genes for antibiotic resistance

53. Why is SDS used in electrophoresis of proteins?
a) It coats the proteins with uniform negative charge
b) SDS digests the larger proteins in the sample
c) It allows the better staining of proteins by Coommassie blue
d) It adds more molecular weight to proteins so that proteins do not runoff the end of the gel

54. This food-borne pathogen is very well known to grow at refrigeration temperature
a) *Bacillus subtilis*
b) *Listeria monocytogenes*
c) *Vibrio cholerae*
d) *Salmonella typhi*

55. Rhinoviruses are the most common cause of
a) Conjunctivitis
b) Gastroenteritis
c) Foot and mouth disease
d) Common cold

56. The mechanism by which the microorganism present in a biofilm communicate with each other through the production of certain chemicals is called
a) Signal transduction
b) Quorum sensing
c) Chemotaxis
d) Quellung reaction

57. Which of the following is not a DNA virus?
a) Vaccinia virus
b) Hepatitis B virus
c) Foot and mouth disease virus
d) Simian virus 40 (SV_{40})

58. The bacteriophage M13 contains as its genetic material
a) Single stranded RNA
b) Double stranded RNA
c) Single stranded DNA
d) Double stranded DNA

59. Which of the following is not an 'A-B type' of toxin?
a) Diphtheria toxin
b) Cholera toxin
c) Tetanus toxin
d) Pertussis toxin

60. Which of the following is not a cause of food poisoning?
a) *Bacillus cereus*
b) *Clostridium botulinum*
c) *Clostridium perfringens*
d) *Salmonella typhi*

61. This pathogen is transmitted to humans both by insect vectors and by air-borne droplet nuclei
a) *Yersinia pestis*
b) *Vibrio cholerae*
c) *Mycobacterium tuberculosis*
d) *Plasmodium falciparum*

62. Why are 'integrons' important?
a) They spread genes for multiple antibiotic resistance
b) Produce an industrially important enzyme called integrase
c) They are required for over production of proteins
d) They contain non-coding DNA

63. This does not serve as the termination code during the synthesis of polypeptide chain
a) UGA
b) UAA
c) UAG
d) UGG

64. Zymogen is
a) The active form of an enzyme
b) The complex formed between an enzyme and its substrate
c) The inactive form of an enzyme which gets activated by the cleavage
d) The unfolded form of an enzyme

65. The catalytic efficiency of an enzyme is given by
a) K_{cat}/K_M
b) K_{cat}
c) K_M
d) Kcat × K_M

66. When viable bacteria are killed by heat or by chemicals, the terminology 'log reduction in counts' is usually used. One log reduction refers to
a) 100% killing of bacteria
b) 90% killing of bacteria
c) 10% killing of bacteria
d) 1% killing of bacteria

67. The capsule produced by *Bacillus anthracis* has unusual chemical nature because
a) It is a polymer of D-glutamic acid residues
b) It is a polymer of complex carbohydrates
c) It is highly slimy in nature
d) It is a polymer of L_7lysine residues

68. Acid-fast staining is used to stain those bacteria which have
a) Highly thick cell walls
b) Cell walls rich in lipids and waxes
c) Volutin granules
d) Cell walls impermeable to other dyes

69. What is common between *Myxobacteria* and *Cytophaga* spp.?
a) Both are parasitic in algae
b) Both are known for their ability to hydrolyse biopolymers of complex carbohydrates
c) Both are sources of antibiotics
d) Both are present in highly polluted environments

70. A lysogenic strain of *E. coli* is resistant to infection by the bacteriophage lambda (λ), because
a) *E. coli* no longer contains receptors on its surface
b) Lysogenic *E. coli* are already dead
c) The presence of repressor protein in the cell
d) One copy of phage is already present inside the *E. coli*

71. A bacterium having doubling time of 10 minutes fills a cylindrical vessel completely in 3 hours. How much time will it take to fill half of the vessel?
a) 80 minutes
b) 90 minutes
c) 150 minutes
d) 170 minutes

72. RNA in the DNA-RNA hybrid is digested by
a) S_1 nucleases
b) RNase A
c) RNase H
d) Endonuclease

73. A bacterial culture had an initial cell density of 10^3 cells/ml. In 6 hours, the cell density reached to 10^6 cells/ml. The number of generations the cells have undergone is
a) 3
b) 10
c) 15
d) 20

74. Which microscope do you think is best suited for study of spirochaetes?
a) Phase contrast microscope
b) Fluorescence microscope
c) Dark-field microscope
d) Transmission electron microscope

75. During which method of food preservation are nitrosamines produced which are considered to be carcinogenic?
a) Preservation using radiation
b) Meat preservation by smoking or curing
c) Preservation using high salt concentration
d) Preservation using high sugar concentration

76. Which of the following is most likely to be found in acidic runoff from a coal mine?
a) *Bacillus*
b) *Sulfolobus*
c) *Lactobacillus*
d) *Streptococcus*

77. An organism that has peroxidase and superoxide dismutase but lacks catalase is most likely an
a) Aerobe
b) Aerotolerant anaerobe
c) Obligate anaerobe
d) None of the above

78. Glycerol is the only known substrate to be transported through cell membrane in bacteria by
a) Passive diffusion
b) Osmosis
c) Facilitated diffusion
d) Active transport

79. Bacteriorhodopsin used in making biochips is obtained from
a) *Halobacterium*
b) *Halococcus*
c) *Natronococcus*
d) *Haloferax*

80. An example of bioluminescent fungus is
a) *Psilocybe*
b) *Calocybe*
c) *Armillarea*
d) *Amanita*

81. Satellite virus was discovered in 1962 by
a) B. Kassanis
b) T.O. Diener
c) A. Temin
d) J.D. Hamilton

82. The largest prokaryotic cell
a) *Methanobacterium*
b) *Epulopiscium*
c) *Thermomonospora*
d) Green sulfur bacteria

83. The bacterial chromosome is a circular DNA macromolecule except in
a) *Escherichia*
b) *Bacillus*
c) *Streptomyces*
d) *Myxobacteria*

84. Which fungi degrade cellulose nut not lignin?
a) Brown rot fungi
b) White rot fungi
c) Soft rot fungi
d) Blue mold fungi

85. Rec-A protein binds to
a) ssDNA and moves in 5′→3′ direction
b) dsDNA and moves in 5′→3′ direction
c) ssDNA and moves in 3′→5′ direction
d) dsDNA and moves in 3′→5′ direction

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

87. Differential interference contrast microscopy
a) Compares two identical specimens on the same microscope
b) Illuminates the specimen with light of two different phases
c) Illuminates the specimen with both reflected and transmitted light
d) Illuminates the specimen with light of two different colours

88. Which of the following objectives would give the best resolution of small objects?
a) 10x air, N.A. 0.25
b) 40x air, N.A. 0.65
c) 64x oil, N.A. 1.4
d) 100x oil, N.A. 1.25

89. If a canning procedure is not properly followed, which type of microbe is most likely to grow in the canned food?
a) Obligate anaerobe
b) Microaerophile
c) Acidophile
d) Mesophile

90. The role of molecular chaperones is to
a) Facilitate binding of ribosomes to mRNA
b) Aid a newly synthesized polypeptide in folding to its proper shape
c) Degrade newly synthesized polypeptide that contain inaccurate sequences
d) Aid in synthesis of polypeptide

91. To determine fatty acid composition, which of the following tests would be performed?
a) Gas-liquid chromatography
b) DNA probing
c) Ribotyping
d) Immunoassay

92. Who developed the concept of specific toxicity?
a) Jenner
b) Pasteur
c) Ehrlich
d) Watson

93. A pycnidium producing fungus
a) *Septoria*
b) *Aspergillus*
c) *Penicillium*
d) *Rhizopus*

94. A spore resulting from the fragmentation of a hypha
a) Zoopsore
b) Aplanospore
c) Arthrospore
d) Blastospore

95. Which one of the following gases is used for preserving spices?
a) Hydrogen
b) Methane
c) Ammonia
d) Propylene oxide

96. The principal limitation created to stimulate citric acid accumulation by *Aspergillus niger* is
a) Glucose
b) Trace metals
c) Nitrogen
d) Oxygen concentration

97. Cylindrical nodules have
a) Persistent meristem
b) Non-persistent meristem
c) Degenerate meristem
d) No meristem

98. Acridine dyes causes
a) Base pair substitution
b) Frame shift mutation
c) Site specific mutation
d) No mutation

99. Macrostructure of activated sludge floc is made up of
a) Rod shaped *Bacilli*
b) Coccous shaped bacteria
c) Filamentous bacteria
d) None of the above

100. Which of the following is not an example of spore forming bacteria?
a) *Clostridium*
b) *Desulphovibrio*
c) *Desulfotomaculum*
d) *Bacillus*

101. Manganese reduction process is carried out by
a) *Leptothrix, Geobacter*
b) *Leptothrix, Arthrobacter*
c) *Shewanella, Arthrobacter*
d) *Geobacter, Shewanella*

102. Gleying is a phenomenon associated with microbial metabolism of
a) Phosphorus
b) Iron
c) Sulphur
d) Manganese

103. Humus fraction not dispersible by weak alkali or pyrophosphate is termed as
a) Humin
b) Humic acid
c) Fulvic acid
d) Ferulic acid

104. Cyanobacteria lacks a key enzymes of TCA cycle, that is
a) Isocitrate dehydrogenase
b) α-ketoglutarate dehydrogenase
c) Succinate dehydrogenase
d) Malate dehydrogenase

105. Terminal heterocysts followed by akinetes are the distinguishing morphological character found in
a) *Anabaena*
b) *Calothrix*
c) *Tolypothrix*
d) *Cylindrospermum*

106. A thermophile which is a spore forming anaerobe that produces acetic acid, ethanol, CO_2 and H_2
a) *Bacillus stearothermophilus*
b) *Cytophaga johnsonae*
c) *Clostridium thermocellum*
d) *Bacillus subtilis*

107. Alkaline serine protease is industrially produced from
a) *Bacillus licheniformis*
b) *Bacillus amyloliquefaciens*
c) *Bacillus cereus*
d) *Bacillus polymyxa*

108. Riboflavin is industrially produced by microorganisms belonging to
a) Deutromycetes
b) Ascomycetes
c) Basidiomycetes
d) Phycomycetes

109. Biotin is an essential requirement for the production of
a) Citric acid
b) Aspartic acid
c) Oxalic acid
d) Glutamic acid

110. If *Flavobacterium* secretes cysteine which can be used by *Legionella* in aquatic environment, the interaction can be described as
a) Ammensalism
b) Mutualism
c) Neutralism
d) Commensalism

111. Competence for transformation usually arises at a specific stage of growth of a culture, typically
a) Early log phase
b) Mid log phase
c) Late log phase
d) Stationary phase

112. Bacitracin inhibits
a) Protein biosynthesis
b) Cell wall synthesis
c) DNA replication
d) Membrane biosynthesis

113. Single stranded DNA absorbs ultraviolet light of wavelength 260 nm
a) More strongly than dsDNA
b) Negligible as compared to dsDNA
c) Same as that of dsDNA
d) Only when in solution

114. Fluctuation test was devised by
a) Luria and Bertani
b) Luria and Delbruck
c) Luria and Tatum
d) Luria and Lederberg

115. Soluble inorganic phosphates can be released from inositol hexaphosphate by the action of
a) Inositol dehydrogenase
b) Inositol carboxylase
c) Hydratase
d) Phytase

116. Active cell free preparation of nitrogenase enzyme was first obtained from
a) *Klebsiella pneumoneae*
b) *Azotobacter chroococcum*
c) *Clostridium pasteurianum*
d) *Azotobacter vinelandii*

117. Roll tube culture technique for cultivation of anaerobes was given by
a) Robert Hungate
b) Robert Ludlum
c) Robert Koch
d) Robert Lee

118. Methanogens in general use the following as electron acceptor
a) CH_3
b) CO_2
c) O_2
d) H_2

119. In Ames test, the indicator organism used is a mutant of
a) *Escherichia coli*
b) *Bacillus subtilis*
c) *Streptococcus pneumoniae*
d) *Salmonella typhimurium*

120. The polysaccharide composed of fructose units (2→1) linkage
a) Fructosan
b) Chitin
c) Inulin
d) Xylan

121. If the bacterial culture contains 10^2 cells/ml at time t_0 and 10^9 cells/ml 7 hours later, the specific growth rate of the culture is
a) 0.693 $hour^{-1}$
b) 0.301 $hour^{-1}$
c) 2.303 $hour^{-1}$
d) 16.121 $hour^{-1}$

122. The most common sequence of amino acids in peptidoglycan is
a) D-Ala-D-Glu-L-diamino acid-D-Ala
b) L-Ala-D-Glu-L-diamino acid-D-Ala
c) L-Ala-L-Glu-L-diamino acid-L-Ala
d) L-Ala-D-Glu-D-diamino acid-L-Ala

123. In *Bacillus*, the basal body of flagella consists of
a) 4 rings
b) 3 rings
c) 2 rings
d) 1 ring

124. A stalked bacterium with stalk made up of protein
a) Caulobacter
b) Planctomyces
c) Gallionella
d) Leptothrix

125. Thermophilic, sulphate reducing bacterium with ether linked lipids in membrane is
a) *Thermoplasma*
b) *Staphylothermus*
c) *Sulfolobus*
d) *Thermodesulfobacterium*

126. RNA polymerase core enzyme is aptly described as
a) $\alpha\beta\beta'$
b) $\alpha_2\beta\beta'\sigma$
c) $\alpha_2\beta\beta'$
d) $\sigma_2\beta\beta'$

127. Repression of lytic events in lambda bacteriophage is under the control of
a) CI protein
b) ℓI protein
c) Cro protein
d) RO protein

128. Plasmid pBR322 confers on its host resistance to antibiotic
a) Ampicillin and kanamycin
b) Ampicillin and streptomycin
c) Ampicillin and chloramphenicol
d) Ampicillin and tetracycline

129. Wild type lambda is not suitable as a cloning vector because its genome
a) is difficult to isolate and purify
b) is too large in size
c) has region unessential for infectivity
d) has too many restriction enzyme sites

130. Giardiasis disease, a water and food borne disease is caused by
a) Bacteria
b) Protozoa
c) Virus
d) Mold

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.

i) Robert Koch	a) Worked on immunity
ii) Louis Pasteur	b) Method of staining *Mycobacterium tuberculosis*
iii) Twort and d'Herelle	c) Preventive treatment of rabies
iv) Ziehl and Neelsen	d) Pure culture techniques
v) Paul Ehrlich	e) Discovered bacteriophages

132.

i) *Chromatium okenii*	a) Mixotroph
ii) *Rhodospirillum rubrum*	b) Photolithotroph
iii) *Desulfovibrio desulfuricans*	c) Green sulphur bacteria
iv) *Lactobacillus acidophilus*	d) Photoorganotroph
v) *Chlorobium* spp.	e) Heterotroph

133.

i) Whooping cough	a) *Pneumocystis carinii*
ii) Food poisoning	b) Paramyxoviridae
iii) Food infection	c) *Salmonella typhi*
iv) Rubella	d) *Clostridium botulinum*
v) Pneumonia	e) *Bordetella pertussis*

134.

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

135.

i) Niacins	a) *Ochromonas malhamensis*
ii) Biotin	b) *Neurospora crassa*
iii) Vitamin B_{12}	c) *Lactobacillus arabinosus*
iv) Pantothenic acid	d) *Tetrahymene gelei*
v) Folic acid	e) *Saccharomyces carlsbergensis*

136.

i) Endospore	a) *Methylosinus*
ii) Exospore	b) *Sphaerocytophaga*
iii) Cyst	c) *Bacillus*
iv) Heterocyst	d) *Azotobacter*
v) Microcyst	e) *Anabaena*

137.

i) Ray fungi	a) *Leptothrix*
ii) Rickettsia	b) *Gallionella*
iii) Sheathed bacteria	c) *Stemonitis*
iv) Stalked bacteria	d) *Streptomyces*
v) Acellular slime mold	e) *Coxiella*

138.

i) Developed microscopic lenses that corrected aberrations	a) Paul Ehrlich
ii) Supported the theory of spontaneous generation	b) Ernst Abbe
iii) Introduced staining with methylene blue	c) Carl Linnaeus
iv) Microorganisms were comprehensively placed in "Chaos"	d) John Needham
v) Causes of Legionnaire disease in 1976 were established	e) Koch postulates

139.

i) Glucamylase	a) Hydrolyze lignin
ii) α-amylase	b) Laundry detergents
iii) β-amylase	c) Starch to oligosaccharides
iv) Protease	d) Starch to glucose
v) Laccase	e) Starch to maltose and dextrin

140.

i) Riboflavin	a) Immobilising agent
ii) Vitamin B_{12}	b) Chemical preservation
iii) Cellulose	c) Byproduct of acetone butanol fermentation by *Clostridium* sp.
iv) Xenobiotics	d) Byproduct of *Streptomyces* antibiotic fermentation
v) Sorbic acid	e) Polychlorinated biphenyls

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. You have been asked to study the bacterial flora of a soil sample. Briefly explain the culture-dependent and culture-independent approaches to accomplish this task.

142. Why is there a poor correlation between soil microbial numbers and CO_2 evolution?

143. In cyanobacteria, oxygen is evolved during photosynthesis, while *Chloroflexus* and *Rhodopseudomonas* do not evolve oxygen during photosynthesis. Why?

144. A *Rhizobium* mutant shows an altered host range. What could be the reasons for it?

145. Why two different species of bacteria are required for the production of lysine?

146. In a mating between Hfr and F^- cells, the F^- recipient usually remains F^-, why?