Post Graduate School
Indian Agricultural Research Institute, New Delhi

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

Discipline : Plant Physiology

Discipline Code : 19 Roll No. | | | | | | | |

Please Note:

(i) This question paper contains **12** 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. If cell 'A' has an O.P. of -2.5 MPa and T.P. of 1.5 MPa and cell 'B' has O.P. of -3.0 MPa and T.P. of 1.0 MPa; then movement of water will take place from
a) Cell 'B' to cell 'A'
b) Cell 'A' to cell 'B'
c) Cell 'B' to outer atmosphere
d) Cell 'A' to outer atmosphere

32. Molybdenum is a co-factor of
a) Rubisco
b) Nitrogenase
c) Polyamine oxidase
d) GA20 oxidase

33. This nutrient is an important osmolyte in the osmotic adjustment of plant cells
a) Calcium
b) Magnesium
c) Potassium
d) Manganese

34. Photorespiratory CO_2 is evolved from the decarboxylation of
a) RuBP
b) Glycine
c) 2 Phosphoglycolate
d) Serine

35. How many molecules of NADPH and ATP are consumed during Calvin cycle for every molecule of CO_2 fixed into carbohydrate?
a) One and two
b) Two and two
c) Two and three
d) Three and two

36. Rice genome is present in
a) Nucleus, plastid and mitochondria
b) Nucleus only
c) Nucleus and plastids
d) Nucleus and mitochondria

37. Which of the following enzymes is not activated by light in chloroplast?
a) Fructose 1,6-Bisphosphatase
b) RuBP carboxylase
c) NADP-glycereldehyde 3P dehydrogenase
d) 3-phosphoglycerate kinase

38. Species with nitrogen fixing nodules utilizes ureides as transport forms of nitrogen. Name an ureide
a) Glutamic acid
b) Glutamine
c) Citrulline
d) Asparagine

39. Though sulphur is mostly incorporated in biomolecules in reduced form, oxidised form of sulphur is also found in
a) Proteins consisting of cysteine and methionine
b) Sulfoquinovosyldiacyl glycerol
c) Sulpho-carbohydrate complex
d) Phenyl propanoids

40. Nitrogen deficiency symptoms can also be mimicked by
a) Sulphur
b) Phosphorus
c) Molybdenum
d) Zinc

41. Which one of the following is a polypeptide hormone in plants?
a) Lectin
b) Systemin
c) Spermine
d) Strigolactone

42. Which of the following lipid is more abundant in chloroplast membranes than in other cellular membranes?
a) Digalactosyl diacyl glycerol
b) Phosphatityl glycerol
c) Triaceyl glycerol
d) Sterols

43. Cardiolipin biosynthesis takes place in plants in
a) Cytosol
b) Chloroplasts
c) Mitochondria
d) Endoplasmic reticulum

44. Name the naturally occurring auxin transport inhibitor
a) 1-naphthylphthalamic acid (NPA)
b) TIBA (2,3,5-triiodobenzoic acid)
c) Quercetin (Flavonol)
d) 1-NOA (1-naphthoxyacetic acid)

45. Name the unsaturated fatty acid stored in high amount in coconut
a) Lauric acid
b) Oleic acid
c) Erusic acid
d) Stearic acid

46. Glutamine oxoglutarate aminotransferase is also known as
a) Glutamate dehydrogenase
b) Glutamine synthetase
c) Glutamate synthase
d) Glutamate oxoglutarate transminase

47. Canopy temperature depression is useful to calculate
a) Drought susceptibility index
b) Chlorophyll stability index
c) Crop water stress index
d) Membrane stability index

48. Plant hormone which provide protection against insect attack
a) GA
b) Jasmonic acid
c) Cytokinins
d) Ethylene

49. Scintillation counter is used for the measurement of
a) ^{15}N
b) ^{13}C
c) ^{14}C
d) γ-rays

50. In plants, fatty acid elongases are located in
a) Peroxisomes
b) Chloroplasts
c) Endoplasmic reticulum
d) Cytosol

51. Name the fluorescent marker protein that is commonly used for subcellular localization of candidate protein
a) GUS
b) GFP
c) Luciferase
d) FLAG-tag

52. Osmotic adjustment in cells helps plant to _____ and thus increase water uptake.
a) Lower the water potential
b) Increase the water potential
c) Maintain solute concentration
d) Reduce turgor potential

53. Identify the essential element that does not have a role in the structure of organic compound of place cell.
a) Nitrogen
b) Calcium
c) Potassium
d) Hydrogen

54. Pyrrole rings are present in
a) β-Carotene
b) Xanthophyll
c) Anthocyanin
d) Chlorophyll

55. In the root nodule of symbiotic nitrogen fixing plant, nodulin (*Nod)* and nodulation (*nod*) genes are coded by the genomes of
a) Host plant
b) Rhizobia
c) Rhizobia and host plant, respectively
d) Host plant and rhizobia, respectively

56. Identify the enzyme that initiates the oxidative pentose pathway in plants.
a) Glucose-6-phosphate dehydrogenase
b) Gluoconate-6-phosphate dehydrogenase
c) Glucose-6-phosphate isomerase
d) Fructose-6-phosphate dehydrogenase

57. Semidwarf high yielding wheat was created through introgression of Rht1 mutant gene. Rht1 codes for
a) GA3 oxidase
b) GA2 oxidase
c) GA receptor
d) DELLA protein

58. Salt Overly Sensitive 1 (*SOS 1*) gene product functions in the plasma membrane as an antiporter for
a) Na^+/K^+
b) Na^+/Ca^{2+}
c) Na^+/H^+
d) Na^+/Cl^-

59. Which one of the following enzymes is coded by chloroplast genome?
a) Carboxyl transferase-β subunit of ACCase
b) Fatty acid synthase
c) Fatty acid desaturase
d) Ribulose-1,5 bisphosphate carboxylase / oxygenase small subunit

60. The PS II yield of dark adapted plants measured by chlorophyll fluorescence meter indicates
a) The amount of variable fluorescence
b) Ratio of variable fluorescence to maximum fluorescence
c) Total fluorescence of intact PS II
d) The ratio of PCq to NPq

61. Rubisco belongs to which class of enzymes?
a) Lyase
b) Oxidoreductase
c) Ligase
d) Isomerase

62. Which of the following amino acid is synthesized by Shikimic acid pathway?
a) Phenylalanine
b) Glutamine
c) Serine
d) Aspartic acid

63. CHLORATE RESISTANCE 1 is a sensor of
a) Silicate
b) Nitrate
c) Phosphate
d) Nitrite

64. To synthesize one molecule of palmitic acid (16:0) in plastids requires
a) 14 ATP and 7 NADPH
b) 16 ATP and 8 NADPH
c) 8 ATP and 16 NADPH
d) 7 ATP and 14 NADPH

65. Root hydrotropism is mainly regulated by
a) Abscisic acid
b) Strigalactone
c) Gibberellic acid
d) Auxin

66. Tritium atom is made up of
a) One proton, one electron, one neutron
b) One proton, one electron, two neutron
c) One proton, one electron, three neutron
d) Three proton, three electron, three neutron

67. In the non-competitive inhibition of enzyme catalysed reaction
a) Km increases whereas no effect on V_{max}
b) Km is unaffected whereas V_{max} decreases
c) Km increases whereas V_{max} decreases
d) Both Km and V_{max} increases

68. One Curie (Ci) is equal to
a) 2.7×10^{10} dps
b) 3.7×10^{10} dps
c) 2.7×10^{7} dpm
d) 3.7×10^{7} dpm

69. Optimum LAI is
a) LAI at which 95% solar radiation is intercepted
b) LAI at which CGR is maximum
c) LAI at which RGR is maximum
d) LAI at which HI is maximum

70. 'Khaira' disease in paddy is caused due to
a) Silicon deficiency
b) Zinc deficiency
c) Calcium deficiency
d) Magnesium deficiency

71. Which of the following compounds is not a product of pentose phosphate pathway?
a) NADPH
b) Glycerate-3-phosphate
c) Carbon dioxide
d) Ribulose-5-phosphate

72. Maximum crop growth rates calculated by Williams and Loomis is
a) 57 $g.m^{-2}$ day^{-1}
b) 77 $g.m^{2}$ day^{-1}
c) 100 mg. CO_2 m^{-2} leaf area $second^{-1}$
d) 85 g. $plant^{-1}$ $week^{-1}$

73. Elongated upper Internode 1 (*eui1*) mutant of rice is impaired in the catabolism of
a) Auxins
b) Cytokinins
c) Gibberellic acid
d) Ethylene

74. Triacylglycerols are stored in
a) Peroxisomes
b) Oleosomes
c) Glyoxysomes
d) Golgi bodies

75. In the development pathway for flowering, the expression of Florigen gene (FT) is induced by
a) CONTANS gene
b) Flowering locus D
c) SOC 1
d) Flowering locus (FLC) gene

76. 0.1% solution of a chemical is
a) 10,000 ppm
b) 1,000 ppm
c) 100 ppm
d) 10 ppm

77. In plants, auxin is synthesized from
a) Glutamine
b) Methionine
c) Arginine
d) Tryptophan

78. Prof. R.D. Asana is known for his work on
a) Flowering
b) Ideotype
c) Ascorbic acid
d) Photoperiodism

79. Oxidation and reduction of plastocyanin function requires
a) Iron
b) Sulphur
c) Copper
d) Molybdenum

80. Major determinant of leaf water potential of wheat is
a) Osmotic potential, gravitational potential
b) Matric potential, osmotic potential
c) Gravitational potential, osmotic potential and turgor potential
d) Osmotic potential, turgor potential

81. Nucleosome consists of
a) DNA alone
b) DNA + Histone 1, 2, 3, 4
c) DNA + Histone 2, 3, 4
d) DNA + Nucleic acid

82. Photosynthate from rice leaves are transported through phloem in the form of
a) Glucose
b) Fructose
c) Sucrose
d) Fructan

83. Oxidative pentose phosphate pathway that supply carbon and energy to fatty acid synthesis takes place in
a) Mitochondria
b) Plastids
c) Cytosol
d) Endoplasmic reticulum

84. Name the protein which is the main target of photoinhibition of photosynthesis by excess light
a) D1
b) D2
c) LHC II
d) Plastocyanin

85. In C_4 and CAM plants, PEP regeneration requires
a) K
b) Na
c) Ca
d) S

86. Sedimentation coefficients of biological particles is represented by letter S, where it stands for
a) Svedberg unit
b) Sandburg unit
c) Swinston unit
d) Simons unit

87. Shikimic acid pathway produced the precursor for
a) Auxin
b) Gibberellins
c) Cytokinins
d) Ethylene

88. The first stable product synthesized during sulphate assimilation is
a) Cysteine
b) Cystine
c) Methionine
d) Glutathione

89. Aquaporins permit movement of water through membranes
a) Against water potential gradient
b) Against chemical potential gradient
c) Against turgor potential gradient
d) Along the water potential gradient

90. No. of water molecules transpired by wheat leaf is 10,000, and No. of CO_2 molecules fixed is 25 per second. What is the transpiration ratio of the leaf?
a) 2,50,000
b) 25,000
c) 400
d) 0.0025

91. Casparian strip is mainly present in root in the
a) Rhizodermis
b) Exodermis
c) Endodermis
d) Stele

92. In anaerobic respiration, there is net gain of only two ATP molecules per glucose molecule oxidized. These ATPs are synthesized by
a) Mitochondrial electron transport
b) ATP synthase
c) Substrate level phosphorylation
d) Oxidative phosphorylation

93. Δ'1 pyrroline-5-carboxylic acid dehydrogenase is involved in the synthesis of
a) Hydroxyproline
b) Carboxylic acid
c) Proline
d) Glutamic acid

94. Diffusivity of water vapour through stomata is equal to _____ times that of CO_2.
a) 1.56
b) 0.64
c) 0.50
d) 0.25

95. Hydrogenase present in N_2 fixing bacteria requires
a) Mo
b) Ni^{2+}
c) K^+
d) Ca^{2+}

96. Ammonia released by photorespiration is re-fixed in
a) Chloroplast
b) Cytoplasm
c) Mitochondria
d) All of the above

97. Carbon isotope discrimination test has been found useful to identify varietal differences in
a) Water use efficiency (WUE)
b) Growth
c) Photosynthetic rate
d) Carbohydrate partitioning

98. The pressure flow theory of phloem transport was given by
a) Broyer T.C.
b) Crafts A.S.
c) Epstein E.
d) Munch E.

99. The number of electrons required for the reduction of NO_3^- to NH_4^+ are
a) 2
b) 4
c) 6
d) 8

100. RUBISCO is activated by Rubisco activase enzyme by
a) Carbamylation
b) Phosphorylation of serine
c) Removal of sugar phosphate
d) Reduction of disulfide bond

101. Oxygen-evolving complex is located in the
a) Lumen
b) Stroma
c) Matrix
d) Between inner and outer membrane of plastids

102. 1-amino-cyclopropane-1-carboxylic acid is a close precursor of
a) Cytokinins
b) Gibberellins
c) Abscisic acid
d) Ethylene

103. The two most important plant measurements required for calculating growth analysis parameters are
a) Dry weight and leaf area
b) Fresh weight and leaf area
c) Turgid weight and leaf area
d) Photosynthesis and fresh weight

104. In leaves, the entire process of SO_4^{2-} reduction occurs in
a) Mitochondria
b) Cytosol
c) Chloroplasts
d) Peroxisomes

105. The minimum number of photons required to fix one mole of CO_2 is
a) 2
b) 10
c) 12
d) 20

106. What is the precursor of cytokinin biosynthesis in higher plants?
a) Tryptophan
b) Purine
c) Methionine
d) Tyrosine

107. The name of the scientist who first demonstrated that green plants possess an ability to 'purify' air was
a) Van Niel
b) Govindjee
c) Rabinowitch E.
d) Joseph Priestley

108. Rotenone is an inhibitor of
a) Respiration
b) Photosynthesis
c) Fatty acid synthesis
d) Hydrolytic enzymes

109. "Little leaf" or "rosette" resulting from growth reduction of young leaves and stem internodes is caused by deficiency of
a) Zinc
b) Copper
c) Potassium
d) Boron

110. Growing Degree Days are sum of
a) Mean temperature
b) Maximum temperature
c) Minimum temperature
d) Mean temperature above a base temperature

111. The projected level of CO_2 in the air by 2050 is about
a) 340 ppm
b) 380 ppm
c) 570 ppm
d) 1000 ppm

112. Carbonic anhydrase plays an important role in
a) C_3 pathway
b) C_4 pathway
c) Glycolysis
d) C_2 pathway

113. Teosinte is a progenitor of cultivated
a) Wheat
b) Barley
c) Maize
d) Sugarcane

114. Phytochrome signalling involves activation of the following protein
a) COP1
b) COP9
c) HY5
d) PIF3

115. Fusiccosin, a fungal toxin, induces the
a) V-ATPase
b) P-ATPase
c) Pyrophosphatase
d) Ca^{2+}-ATPase

116. ABC transporters are also known as
a) Actin Binding Cassettee transporters
b) Glutathione Conjugate pumps
c) Active Boron Cation transporters
d) ABA Binding Cassettee proteins

117. What is the NAR of maize crop if LAI=5 and CGR is 250 g m^{-2} day^{-1}?
a) 2500 g m^{-2} day^{-1}
b) 250 g m^{-2} day^{-1}
c) 50 g m^{-2} day^{-1}
d) 0.5 g m^{-2} day^{-1}

118. Glutathione is tripeptide of
a) Cys-Met-Glu
b) Glu-Cys-Gly
c) Asp-Met-Cys
d) Cys-Ser-Cys

119. Name the precursor of polyamines
a) Methionine
b) Tryptophan
c) Glutamine
d) Arginine

120. The vitamin which participates in transamination reaction is
a) Vit-A
b) Vit-B_1
c) Vit-B_6
d) Vit-B_{12}

121. Field equipment for studying evapotranspiration is
a) Radiometer
b) Pressure bomb
c) Lysimeter
d) Tensiometer

122. PIN is the name of
a) Phosphate transporter
b) Sucrose symporter
c) Auxin transporter
d) Potassium antiporter

123. Half-life of ^{14}C is
a) 5.76 years
b) 57.6 years
c) 576.0 years
d) 5760.0 years

124. The low yield in pulse crops is attributed to
a) Indeterminate growth and non-synchronous flowering
b) Determinate growth and non-synchronous flowering
c) Determinate growth and synchronous flowering
d) Determinate growth with monocarpic senescence

125. Salinity level more than 4 dSm^{-1} affects crop growth. This is equivalent to NaCl solution of
a) 40 mM
b) 400 mM
c) 40 μM
d) 4 mM

126. "The Plant Physiology" Journal is now published by
a) Indian Society for Plant Physiology
b) American Society for Plant Biology
c) American Society for Plant Physiology
d) International Society for Plant Physiology

127. To study the interaction of proteins with membrane bound protein, which one of the following is used?
a) Yeast two hybrid system
b) Split ubiquitin system
c) GFP fusion protein system
d) FLAG-tag protein system

128. Which one of this is a stable isotope?
a) ^{32}P
b) ^{35}S
c) ^{13}C
d) ^{33}P

129. Chloroplast movement is controlled by
a) Crytochrome
b) Phytochrome
c) Phototropin
d) Fluorochrome

130. ^{18}O isotope was used to prove that the biosynthesis of the following hormone differs in fungi and higher plants
a) Auxins
b) Cytokinin
c) ABA
d) GA

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.

Hormone	Signalling/sensing Components
i) ABA	a) Slender 1
ii) Cytokinin	b) Pyrabactin resistance 1
iii) Ethylene	c) Transport inhibitor response 1
iv) Auxin	d) Constitutive triple response 1
v) GA	e) Response Regulator 1

132.

Unit	Growth Parameter
i) g m^{-2} leaf area	a) CGR
ii) g m^{-2} land area. day^{-1}	b) SLW
iii) g m^{-2} leaf area. day^{-1}	c) RGR
iv) mg g^{-1} day^{-1}	d) NAR
v) m^2 kg^{-1} leaf wt	e) SLA

133. Match the elements and activator of enzymes

i) Zinc	a) Oxygen Evolving Complex
ii) Manganese	b) Co-enzyme A
iii) Sulphur	c) Aconitase
iv) Iron	d) Xanthine oxidase
v) Molybdenum	e) Carbonic anhydrase

134.

Scientist	Discovery
i) Andrew Benson	a) Co-enzyme A
ii) Fritz A. Lipman	b) Aquaporin
iii) Peter Agre	c) RNA interference
iv) Andrew Fire and Craig C. Mellow	d) Photosynthetic reaction centre
v) J. Deisenhofer, R. Huber and H. Michel	e) Calvin cycle

135.

Mitochondrial ETC	Enzymes
i) Complex I	a) Succinate dehydrogenase
ii) Complex II	b) NADH dehydrogenase
iii) Complex III	c) Cytochrome C oxidase
iv) Complex IV	d) Cytochrome bC1 complex
v) Complex V	e) ATP synthase

136.

Scientist	Discovery/contribution
i) Warburg O.	a) Osmotic potential
ii) Vant Hoff J.H.	b) Leaf Area Index
iii) Liebig J.V.	c) Law of minimum
iv) Blackman F.	d) O_2 inhibition of photosynthesis
v) Watson D.J.	e) Law of limiting factors

137.

Crop	Transpiration ratio
i) Maize (*Zea mays*)	a) 682
ii) Millet (*Seteria italica*)	b) 557
iii) Barley (*Hordium vulgare*)	c) 350
iv) Rice (*Oryza sativa*)	d) 285
v) Wheat (*Triticum aestivum*)	e) 518

138.

Crop	Biomass production value (g/g glucose)
i) Peas	a) 0.75
ii) Mustard	b) 0.71
iii) Rice	c) 0.43
iv) Wheat	d) 0.50
v) Soybean	e) 0.65

139.

i) Beer Lambert law	a) Water potential
ii) Vapour pressure equilibration	b) Unpaired electron
iii) Electron spin resonance	c) Concentration of solution
iv) Patch-Clamp	d) CO_2 estimation
v) IRGA	e) Ion transport

140.

Genes used in breeding/genetic engineering	Physiological function
i) sd1	a) Starch metabolism
ii) SUBIA	b) Amino acid biosynthesis
iii) Ppd-1	c) Gibberellin biosynthesis
iv) EPSPS	d) Inhibition of stem elongation under flooding
v) WAXY	e) Vernalization

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. Calculate the wheat yield in t/ha and HI using the following yield components:
(i) Number of spikelet per ear = 25
(ii) Number of fertile florets (with grain) per spikelet = 2
(iii) Number of tillers or shoots/m^2 = 500
(iv) Productive tillers = 80%
(v) 1000 grain weight = 40 g
(vi) Biomass = 1600 g/m^2

142. Calculate the volume of commercial HCl required for preparation 1000 ml of 0.1 M HCl solution. The purity and specific gravity of commercial HCl are 40% and 1.2 g/mL, respectively (Mol. mass of HCl=36.5). Also calculate the pH of this 0.1 M HCl solution.

143. A plant cell at insipient plasmolysis state has water potential of -0.732 MPa. This cell was placed in one litre of 0.1M sucrose solution till equilibrium. Calculate the water potential, osmotic potential and turgor potential of the cell after equilibrium. If the equilibrated cell is then pressurized to remove half of the water from the cell, what will be the water potential, osmotic potential and turgor potential? ($R=8.32\ J.mol^{-1}.K^{-1}$; Temperature = $20^{o}C$)

144. Explain ABC model of flowering. Give the phenotypes of four whorls of flowers of *Arabidopsis* mutants for loss of function of A, B and C, respectively.

145. Briefly describe the sucrose synthesis in leaves and its regulation by protein phosphorylation.

146. What is retrograde signalling? Briefly discuss plastid retrograde signalling.