



Post Graduate School
Indian Agricultural Research Institute, New Delhi
Examination for Admission to Ph.D. Programme 2013-2014

Discipline : Genetics

Discipline Code : 12

Roll No.

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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 B₁₂?
 - 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 genes A and B are linked and separated by 14 map units, the percentage of parental progeny produced from test crossing a double heterozygote will be
 a) 7
 b) 14
 c) 46
 d) 86
32. The shortest phase of the cell cycle is
 a) G_2
 b) G_1
 c) M
 d) S
33. When the co-efficient of coincidence is greater than 1, then
 a) Expected double crossovers are less than observed double crossovers
 b) Expected double crossovers are more than observed double crossovers
 c) Interference is 1
 d) Interference is 0
34. Genes that are greater than 50 map units apart cannot be used to predict the frequency of recombinant products, because
 a) Of the absence of recombination
 b) The genes will segregate independently
 c) Of excess of single crossovers
 d) Coefficient of coincidence will be 1

35. A paracentric inversion involves a chromosomal
 a) Region including the centromere
 b) Region excluding the centromere
 c) Exchange between inverted centromeric regions of 2 chromosomes
 d) Exchange between telomeric regions of 2 chromosomes
36. If 'n' denotes the number of alleles of a gene, the number of genotypes in a multiple allelic series is given by
 a) $\frac{n(n-1)}{2}$
 b) $n(n-1)$
 c) $\frac{n(n+1)}{2}$
 d) $n(n+1)$
37. X/A ratio in a male *Drosophila melanogaster* will be
 a) 1.5
 b) 1.0
 c) 0.75
 d) 0.5
38. A+G / T+C ratio in one strand of DNA is 0.8, what will be this ratio in the complementary strand?
 a) 0.20
 b) 0.80
 c) 1.60
 d) 1.25
39. In bread wheat (*T. aestivum* L.), maximum number of multivalents will be observed in _____ stock.
 a) Nulli-5A
 b) Nulli-5B
 c) Nulli-5D
 d) Nulli-3B
40. Which of the following is not a method of population improvement?
 a) Pure line selection
 b) Mass selection
 c) Reciprocal recurrent selection
 d) Diallel selective mating system
41. Gene whose expression is specific to the time and type of cell is called
 a) Modifier gene
 b) Operator gene
 c) Homeotic gene
 d) Temporal gene

42. In *Lac* operon, _____ acts as an inducer.
- Lactose
 - Allolactose
 - Glucose
 - Galactose
43. Number of different types of secondary trisomics possible in maize is
- 10
 - 20
 - 30
 - 40
44. Which of the following can alter the arm ratio of a chromosome without changing its length?
- Deletion
 - Paracentric inversion
 - Pericentric inversion
 - Duplication
45. How many genetically different gametes can be produced by an individual of genotype AaBbccDDEe?
- 5
 - 8
 - 10
 - 32
46. Base pair substitutions involving replacement of a purine for a pyrimidine base and *vice versa* are called
- Transition
 - Frameshift
 - Transcription
 - Transversion
47. The bases in DNA are stacked at a spacing of
- 3.4 \AA
 - 34 \AA
 - 0.34 \AA
 - 0.034 \AA
48. A double tetrasomic is represented by the notation
- $2n+2$
 - $2n+2+2$
 - $2n-2$
 - $2n-1$
49. With 20 inbred lines, the number of possible three way crosses (excluding reciprocals) would be
- 190
 - 400
 - 3420
 - 14535
50. Balanced polymorphism in nature occurs only due to
- Homozygous predominance
 - Heterozygous advantage
 - Elimination of recessives
 - Complete dominance
51. Overlapping genes were first discovered in
- E. coli*
 - Neurospora*
 - Bacteriophage
 - Arabidopsis*
52. SNP refers to
- Sequenced nucleotides polymorphism
 - Super nucleotide polymorphism
 - Single nucleotide polymorphism
 - Saturated nucleotide polymorphism
53. The position of a gene with respect to adjacent region influences its expression. This phenomenon was first demonstrated in
- Maize
 - Pea
 - Fruitfly
 - Bacteriophage
54. Specific genes which expresses either in specialized cells or respond to specific stimuli are described as
- House keeping genes
 - Smart genes
 - Producer genes
 - Integrator genes
55. The proportion of heterozygotes at a single locus in F_4 generation of a cross will be
- $1/2$
 - $1/4$
 - $1/8$
 - $1/16$
56. A single chromatid contains
- A single DNA double helix
 - Two DNA double helices
 - Many DNA double helices
 - Single strand of DNA
57. What will be the proportion of completely homozygous individuals in F_2 of a dihybrid cross?
- $1/2$
 - $1/4$
 - $1/8$
 - $1/16$
58. Which among the following is a 'start' codon in eukaryotes?
- AUU
 - AUC
 - AUA
 - AUG

59. While calculating linkage in a certain 3-point test cross, the interference was 0.963. It implies that _____ of the expected double crossovers _____ .
- 9.63%, were not observed
 - 96.3%, were not observed
 - 9.63%, were observed
 - 96.3%, were observed
60. Breakage of homologous chromatids and non-reciprocal exchange of its part is referred to as
- Recombination
 - Unequal crossing over
 - Gene conversion
 - Translocation
61. The term 'genome' was coined by
- Bateson
 - Stebbins
 - Muller
 - Winkler
62. The first plant disease resistance gene to be cloned and characterized was
- Lr* gene in wheat
 - Hm1* gene in maize
 - Chitinase gene in rice
 - Rps1* gene in Arabidopsis
63. What would be the sequence of bases in the mRNA transcript generated from transcription of this short stretch of DNA:
- $$\begin{array}{l} 5' \text{ ATTC } 3' \\ 3' \text{ TAAG } 5' \end{array}$$
- 5' ATTC 3'
 - 5' TAAG 3'
 - 5' AUUC 3'
 - 5' UAAG 3'
64. Which of the following is not a feature of eukaryotic mRNA processing?
- Alignment of the Shine-Dalgarno sequence
 - Addition of the 5' methylguanosine cap
 - Addition of the 3' poly-A tail
 - Removal of the introns
65. The presence-absence hypothesis to explain mutation was proposed by
- Hugo deVries
 - H.J. Muller
 - W. Bateson
 - C. Correns
66. Proteins are quantified by
- Southern blot
 - Northern blot
 - Western blot
 - Eastern blot
67. In maize, there are 10 pairs of chromosomes in normal sporophyte tissues. Then, 30, 20 and 10 number of chromosomes are expected in which parts of the plant?
- Embryo, root tip, leaf
 - Embryo sac, seed, root tip
 - Endosperm, root tip, pollen tube nucleus
 - Root tip, pollen tube nucleus, leaf
68. Coefficient of variation (%) is computed by the formula:
- $\frac{SE}{\bar{X}} \times 100$
 - $\frac{SD}{\sqrt{\bar{X}}} \times 100$
 - $\frac{SD}{\bar{X}} \times 100$
 - $\frac{V}{\bar{X}} \times 100$
69. In artificial (manual) hybridization program, the performed activities are (given in random order):
- Pollination,
 - Tagging,
 - Bagging,
 - Emasculation
- The correct order of these activities is
- iii, iv, i, ii
 - iv, ii, i, iii
 - iv, iii, i, ii
 - ii, iv, i, iii
70. Synaptonemal complex is formed in
- Zygotene stage
 - Pachytene stage
 - Leptotene stage
 - Diplotene stage
71. Under self-fertilization, homozygosity increases in each generation at the rate of
- 25%
 - 50%
 - 75%
 - 12.5%
72. Selection in favour of both extreme phenotypes is referred to as
- Stabilizing selection
 - Directional selection
 - Disruptive selection
 - Cyclic selection
73. The Protection of Plant Varieties and Farmers' Rights Act was passed by the Indian Parliament in the year
- 1994
 - 1999
 - 2001
 - 2003

74. Essentially Derived Varieties (EDVs) are produced by
- Mutation
 - Backcross breeding
 - Genetic transformation
 - All of the above
75. Inbreeding depression was first observed in maize by
- G.H. Shull
 - K. Mather
 - N.L. Dhawan
 - D. Lewis
76. Maintenance breeding refers to
- Upgrading resistance to disease in crop variety
 - Improving nutritive quality of produce
 - Improving genetic purity of a crop variety
 - Maintain original yield level of a crop variety
77. Which one of the following analysis is appropriate to measure genetic diversity among lines?
- Diallel analysis
 - Line \times Tester analysis
 - D² analysis
 - Metroglyph analysis
78. Inbreeding in a population influences
- Gene and genotype frequencies
 - Genotype frequency only
 - Gene frequency only
 - Neither gene nor genotype frequency
79. Which among the following is genetically heterogeneous but homozygous?
- Hybrid
 - Composite
 - Multiline
 - Synthetic
80. If a plant is heterozygous for four allelic pairs then upon selfing how many types of genotype are possible?
- 9
 - 27
 - 64
 - 81
81. If the blood group of the husband is 'AB' and that of the wife is 'O', which among the following lot of siblings with the indicated blood groups are likely to contain their offsprings?
- A and B
 - B and O
 - AB and O
 - A and AB
82. Which among the following classes of seeds have highest purity?
- Breeder's seed
 - Nucleus seed
 - Certified seed
 - TL seed
83. In which of the following mapping functions, it is presumed that 'interference' is zero?
- Fisher's mapping function
 - Haldane's mapping function
 - Kosambi's mapping function
 - Sturtevant's mapping function
84. First linkage map was constructed by
- T.H. Morgan
 - A.H. Sturtevant
 - S.R. McCouch
 - B. McClintock
85. Heritability of a molecular marker locus is
- 0%
 - 50%
 - 100%
 - 150%
86. Which among the following markers is best suited for testing hybridity of a plant?
- RAPD
 - SSR
 - AFLP
 - ISSR
87. If a plant with the genotype AaBbCc is self-fertilized, what proportion of progeny plants will be of the genotype AabbCc (assume that the genes are assorting independently)?
- 1/2
 - 1/8
 - 1/16
 - 1/32
88. A top cross is a cross between
- Two contrasting inbreds
 - Inbred and an open pollinated variety
 - An F₁ and an open pollinated variety
 - A double cross hybrid and an inbred
89. ZFN stands for
- Zinc finger nitrate
 - Zinc finger nuclease
 - Zebra fish number
 - Zinc finger normal
90. Which among the following is a multiparent mapping population?
- RIL
 - NIL
 - MAGIC
 - F_{2:3}

91. The seeds produced on a F_1 plant represent which generation?
- F_0
 - F_1
 - F_2
 - F_3
92. In a 'cis-trans' test, if two mutations complement each other, then
- Both the mutations are structurally allelic
 - Both the mutations are structurally non-allelic
 - Both the mutations are functionally non-allelic
 - Both b) & c)
93. Who among the following geneticists established for the first time that 'gene is sub-divisible'?
- Seymour Benzer
 - Clarence P. Oliver
 - Edward Lewis
 - Charles Yanofsky
94. Who among the following was not associated in cracking the genetic codes?
- Marshall Nirenberg
 - H.G. Khorana
 - F.C. Crick
 - J.D. Watson
95. A typical bi-parental cross is performed with an aim to
- Decrease deleterious alleles
 - Decrease homozygosity
 - Increase frequency of desirable alleles
 - Increase heterozygosity
96. The blue color tag of a seed packet indicates that it is
- Breeder's seed
 - Nucleus seed
 - Certified seed
 - TL seed
97. The differences in expression of the same gene inherited from the mother and the father is explained by the phenomenon of
- Paramutation
 - Epistasis
 - Gene silencing
 - Imprinting
98. The polytene chromosomes are thick because they are
- Highly condensed
 - Heavily coated with protein
 - Multistranded
 - Rich in heterochromatin
99. The cell deprived of Uracil will show
- No DNA replication
 - No protein synthesis
 - No cell division
 - Mitotic crossing over
100. Cytosine gives rise to Uracil through
- Methylation
 - Demethylation
 - Oxidative deamination
 - None of the above
101. Teminism refers to
- DNA denaturation
 - RNA denaturation
 - Reverse transcription
 - DNA-RNA hybridization
102. Baldness in humans is an example of
- Sex linked trait
 - Sex influenced trait
 - Y-linked trait
 - Sex limited trait
103. If the DNA of a species has the mole fraction of $A+T = 0.44$, the mole fraction of G (Guanine) will be
- 0.22
 - 0.28
 - 0.44
 - 0.56
104. Consider a biallelic locus in a population following Hardy-Weinberg equilibrium. If the genotype frequency of the recessive homozygote is 0.04, what would be the allelic frequency of dominant allele?
- 0.02
 - 0.04
 - 0.2
 - 0.8
105. The bulk method of breeding was first used by
- Nilsson-Ehle
 - Brim
 - Suneson
 - Harlan
106. Which among the following scientists made pioneering contributions to wheat cytogenetics?
- C.R. Burnham
 - B. McClintock
 - Sanjay Rajaram
 - E.R. Sears

107. The breakage-fusion-bridge cycle of chromosomes was first elegantly demonstrated by
- T.H. Morgan
 - E.R. Sears
 - C.R. Burnham
 - B. McClintock
108. A *Drosophila* female with genotype AaBBCcddEeff when mated with a male of same genotype, how many different genotypes are expected in the progeny?
- 6
 - 9
 - 12
 - 27
109. Lampbrush chromosomes become distinctively visible at which stage of meiosis in the oocytes?
- Leptotene
 - Zygotene
 - Diplojene
 - Diakinesis
110. The pentose sugar molecule found in the genetic material of ϕ X174 is
- Ribose sugar
 - Deoxyribose sugar
 - Dideoxyribose sugar
 - Both b) and c)
111. In a 3-line hybrid rice production system, which line is used as female parent?
- A line
 - B line
 - R line
 - Mixture of B and R line
112. Which of the following is not associated with prokaryotic genome?
- Exon
 - Intron
 - Promoter
 - TATA box
113. Which one of the following is an exclusive feature of the 'enhancer' elements?
- Enhancing and repressing gene expression
 - Located upstream of the gene to be transcribed
 - Orientation non-specificity
 - Binding site for the DNA-binding proteins
114. Holandric gene is located on
- Autosome
 - X chromosome
 - Y chromosome
 - Mitochondrial genome
115. 'Fairchild's Mule' is an
- Animal
 - Insect
 - Interspecific hybrid plant
 - Invertebrate
116. In the absence of dominance or presence of codominance, which of the following formula can be used to predict the phenotypic classes in F_2 , where 'n' represents number of segregating genes?
- 2^n
 - 3^n
 - 4^n
 - 2^{n+1}
117. In a diploid rice plant, the number of chromosome in the endosperm cell would be
- 12
 - 24
 - 36
 - 48
118. The amino acid having only one genetic code (codon) is
- Phenylalanine (Phe)
 - Proline (Pro)
 - Isoleucine (Ile)
 - Tryptophan (Trp)
119. The DNA extracted from an F_2 population was amplified using a polymorphic SSR marker in a PCR. The amplified products were size separated on an agarose gel through gel electrophoresis and documented. How many different banding patterns can be expected on the gel?
- 1
 - 2
 - 3
 - 4
120. Which among the following has the highest power in identifying QTLs and estimating their effects?
- Single Marker Analysis
 - Simple Interval Mapping
 - Composite Interval Mapping
 - Complex Interval Mapping
121. Which of the following is incorrect?
- SSRs are genetically codominant
 - SSRs are hypervariable
 - SSRs show multilocus profiles
 - SSRs have abundant distribution in the genome

122. Northern blot hybridization is used for analysis of
- DNA
 - RNA
 - Proteins
 - cDNA
123. 'Cry1' proteins are insecticidal to
- Lepidoptera
 - Hymenoptera
 - Diptera
 - All of the above
124. Regarding sex determination in *Drosophila*, which of the following statements is not true?
- Y chromosome is primarily responsible for maleness
 - Males have one X and one Y chromosome
 - Ratio of sex chromosomes to autosomes determines the sex
 - Females have two X chromosomes
125. Which among the following statements regarding a variety developed through MAS is correct? The MAS-derived variety will be
- Completely different from the recurrent parent variety
 - Same as the recurrent parent variety except one or two traits
 - Exactly similar to the donor parent only
 - Intermediate between the recurrent and the donor parents
126. Protogyny is prevalent in
- Rice
 - Wheat
 - Soybean
 - Mungbean
127. Linkage is apparent when recombination frequency (RF) is
- More than 50%
 - Less than 50%
 - Equal to 50%
 - Both a) and b)
128. The unit of coefficient of variation (CV) is
- mm
 - gm
 - μm
 - None of the above
129. The basis of polymorphism detected by SSR marker is the
- Number of restriction sites in a particular sequence
 - Number of repeats of a particular sequence
 - Source (nuclear or mitochondrial) of the genome
 - Size (large or small) of the genome

130. Pea (*Pisum sativum* L.) can have how many primary trisomics?

- 7
- 14
- 21
- 28

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.

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|-----------|------------------------------------|
| i) RFLP | a) Kary Mullis |
| ii) RAPD | b) Michelmore <i>et al.</i> (1991) |
| iii) AFLP | c) Botstein <i>et al.</i> (1980) |
| iv) PCR | d) Vos <i>et al.</i> (1995) |
| v) BSA | e) Williams <i>et al.</i> (1990) |

132.

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|--------------------------|----------------|
| i) Parthenocarpy | a) Pearlmillet |
| ii) Protandry | b) Rapeseed |
| iii) Protogyny | c) Banana |
| iv) Self-incompatibility | d) Oat |
| v) Cleistogamy | e) Maize |

133.

- | | |
|----------------|--------------------|
| i) Gene | a) Waldeyer |
| ii) Mutation | b) Robert Hooke |
| iii) Genetics | c) H.J. Muller |
| iv) Chromosome | d) W. Johannsen |
| v) Cell | e) William Bateson |

134.

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|---|---------------------|
| i) Gene-for-gene hypothesis | a) Charles Yanofsky |
| ii) Colinearity of gene and polypeptide | b) Davenport |
| iii) Chromosomal theory of inheritance | c) Flor |
| iv) Dominance hypothesis of heterosis | d) G.H. Shull |
| v) Single cross hybrid maize | e) Walter S. Sutton |

135.

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|-------------------------------|--------------------------------|
| i) Pure line theory | a) Wr-Vr graph |
| ii) Stability analysis | b) Kempthorne (1957) |
| iii) Diallele analysis | c) Mahalanobis (1936) |
| iv) Path coefficient analysis | d) Johannsen (1903) |
| v) D^2 analysis | e) Eberhart and Russell (1966) |

136.

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|--|-----------------------------|
| i) Sir Archibald Garrod | a) Charles Yanofsky |
| ii) Beadle and Tatum | b) H.G. Khorana |
| iii) Recombination between nucleotide pair | c) Human metabolic diseases |
| iv) Deletion mapping | d) One-gene-one-enzyme |
| v) Deciphering genetic code | e) Seymour Benzer |

137.

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|------------------|--|
| i) Annealing | a) Binding site of the polymerase enzyme |
| ii) Denaturation | b) Changing the genetic message in mRNA through deletion or addition of nucleotide |
| iii) Promoter | c) Binding of the primers to the template DNA |
| iv) RNA splicing | d) Separation of DNA strands |
| v) RNA editing | e) Removal of intron from pre-mRNA |

138.

- | | |
|-----------------------------------|--|
| i) $SE_d \times 't'$ | a) Mean variable / Standard deviation |
| ii) $(\text{Variance})^{1/2}$ | b) Percent Standard deviation of means |
| iii) Coefficient of variance (CV) | c) Standard deviation of sample means |
| iv) Normalization | d) Critical difference (CD) |
| v) Standard error (SE) | e) Standard deviation (SD) |

139.

- | | |
|--------------------------|-------------------|
| i) Rice | a) Hexaploid |
| ii) Soybean | b) Tetraploid |
| iii) Potato | c) Paleopolyploid |
| iv) Bread wheat | d) Triploid |
| v) Watermelon (seedless) | e) Diploid |

140.

- | | |
|------------------|-------------------------------|
| i) Canola | a) Pollen sterility |
| ii) Flavr-Savr | b) Insect resistance |
| iii) Barnase | c) Herbicide tolerant soybean |
| iv) Cry1Ac | d) Long shelf-life tomato |
| v) Roundup-Ready | e) Double-zero (00) rape seed |

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. What do you mean by heterosis? Explain its components and show how the components can be manipulated to maximize heterosis?

142. Differentiate between multilines and pyramided lines, and write their merits and demerits.

143. Describe the role of markers in foreground and background selection in marker-assisted backcross breeding (MABB). List out the advantages of MABB over conventional backcross breeding.

144. What do you mean by 'reverse genetics'? How it differs from 'forward genetics'? Mention a few tools/techniques used in reverse genetics and their applications.

145. The genome of a crop (e.g. rice) has been sequenced. Explain, how the sequence information can be used for genetic improvement of the crop?

146. What is aneuploidy? How does it differ from euploidy? Describe with example, how monosomics can be used in locating a dominant gene to a chromosome?