ASRB NET Genetics and Plant Breeding Sample Paper

Q1. A hybrid formed between genetically different genotypes of the same species is called
(a) interspecific hybrid
(b) clonal hybrid
(c) intraspecific hybrid
(d) somatic hybrid

Q2. The process of differentiation of root and shoot from somatic embryos in culture medium is called:
(a) Gametogenesis
(b) Sporogenesis
(c) Organogenesis
(d) Embryogenesis

Q3. Beta diversity refers to:
(a) Diversity within a habitat
(b) Total diversity of a landscape
(c) Diversity between two habitats
(d) Genetic variation in a species

Q4. DNA fingerprinting mainly detects:
(a) mRNA types
(b) Protein levels
(c) DNA polymorphism
(d) Hormone changes

Q5. Mating of selected plants in all possible combinations is known as_____?
(a) Inbreeding
(b) Crossbreeding
(c) Diallel cross
(d) Hybrid vigor

Q6. Vectors used for the production of the specified protein in a host cell are called
(a) Cloning vectors
(b) Expression vectors
(c) Insertion vectors
(d) Transformation vectors

Q7. In TMV vector, the transgene is inserted at:
(a) 5' UTR
(b) cp gene site
(c) Promoter region
(d) tRNA gene

Q8. Match the terms related to Horizontal Resistance (Column I) with their correct descriptions (Column II):

Column I (Term)	Column II (Description)
A. General resistance	1. Resistance against all races of a pathogen
B. Polygenic resistance	2. Involves many genes with additive effect
C. Minor gene resistance	3. Resistance controlled by genes with small effects
D. Non-specific resistance	4. Uniform resistance not limited to any one race

Options:

(a) A–1, B–2, C–3, D–4
(b) A–4, B–1, C–2, D–3
(c) A–2, B–3, C–1, D–4
(d) A–1, B–3, C–2, D–4

Q9. The region where crop plants first evolved from wild species is called:

(a) Primary centre of origin
(b) Agro-climatic zone
(c) Germplasm bank
(d) Adaptation centre

Q10. How many different genotypes can be formed if a gene has 5 alleles?

(a) 15
(b) 10
(c) 20
(d) 25

Q11. The gene pool concept was proposed by:

(a) Vavilov
(b) Harland and Dewet
(c) Darwin and Wallace
(d) Linnaeus

Q12. Allocation of treatments to various experimental units by a random process is known as:

(a) Grouping
(b) Replication
(c) Randomization
(d) Blocking

Q13. Hybrid cell involving protoplasts of two different species is called:

(a) Homokaryon
(b) Heterokaryon
(c) Eukaryon
(d) None of these

Q14. Clone-by-clone sequencing begins by:
(a) Randomly cutting DNA
(b) Aligning fragments into contigs
(c) Extracting proteins
(d) Sequencing RNA

Q15. Assertion (A): In pleiotropy, the phenotypic effects of a single gene can span across multiple systems or functions within an organism, sometimes leading to unrelated abnormalities or traits. Reason (R): The red pigment produced in flowers, stems, and leaves by a single gene is an example of pleiotropy because it affects different organs.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Q16. In interspecific hybridization, hybrids can vary from completely fertile to completely sterile, while in intergeneric hybridization, hybrids are
(a) partially sterile
(b) always fertile
(c) always sterile
(d) occasionally sterile

Q17. Any statement about the population parameter is known as:
(a) Variable
(b) Statistic
(c) Hypothesis
(d) Sample

Q18. Match the following types of self-incompatibility (SI) with their correct descriptions:

Type of SI	Description
A. Gametophytic SI	1. SI genes express in the style
B. Trinucleate pollen	2. SI governed by genetic constitution of the pollen gamete
C. Stylar expression	3. Pollen grains have three nuclei
D. Diallelic SI	4. SI governed by two genes

Options:
(a) A–2, B–3, C–1, D–4
(b) A–3, B–1, C–2, D–4
(c) A–4, B–2, C–3, D–1
(d) A–2, B–1, C–4, D–3

Q19. Which test is used to test the independence of two attributes/variables?
(a) t-test
(b) Paired t-test
(c) Chi-square test
(d) Normal test

Q20. Match the information of Group A with that of Group B

Group A	Group B
(A) Partial diallel	4. Incomplete diallel
(B) Triallel	3. Three way cross
(C) Quadriallel	1. Double cross
(D) Diallel cross	2. Vr-Wr-graph

A. A-4, B-3, C-1, D-2
(b) A-3, B-4, C-2, D-1
(c) A-2, B-1, C-3, D-4
(d) A-1, B-2, C-4, D-3

Q21. What is a common consequence when a tag DNA sequence integrates into a gene's coding region?
(a) The gene produces a modified protein
(b) The gene becomes overactive
(c) The gene fails to express its normal phenotype
(d) The tag is automatically removed by the cell

Q22. The major barriers encountered in distant hybridization include
(a) Hybrid inviability
(b) Hybrid sterility
(c) Cross incompatibility
(d) All of the above

Q23. Organisms with four copies of the genome of the same species formed by chromosome doubling are called
(a) allotetraploids
(b) autotetraploids
(c) aneuploids
(d) haploids

Q24. The selection method in which only undesirable off-type plants are removed is called
(a) Positive mass selection
(b) Clonal selection
(c) Negative mass selection
(d) Pure line selection

Q25. The difference between the mean phenotypic value of the individuals selected to be the parents and the whole of the initial generation before selection is defined as_____?
(a) Genetic gain
(b) Selection intensity
(c) Selection differential
(d) Heritability

Q26. Restriction enzymes that recognize the same DNA sequence but differ in cutting methylated DNA are called:
(a) Isoschizomers
(b) Homologous enzymes
(c) Heterodimers
(d) Isoenzymes

Q27. The ability of every individual of one sex to mate with any individual of the opposite sex without restrictions is known as
(a) Selective mating
(b) Random mating
(c) Inbreeding
(d) Crossbreeding

Q28. Oligogenic resistance is governed by:
(a) Cytoplasmic genes
(b) Many minor genes
(c) One or few major genes
(d) Mitochondrial DNA

Q29. The Human Genome Project officially began in:
(a) 2003
(b) 1988
(c) 1990
(d) 2001

Q30. Assertion (A): UPOV provides an effective system for the protection of new plant varieties. Reason (R): The breeder's right under UPOV allows commercial propagation of a protected variety without the breeder's consent.
Options:
(a) Both A and R are true, and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

Q31. Which of the following is the first step in gene cloning or recombinant DNA technology?
(a) Transformation
(b) Selection
(c) Insertion
(d) Production and isolation

Q32. The new world cotton (Gossypium hirsutum) is an example of
(a) autopolyploidy
(b) allopolyploidy
(c) polygenic inheritance
(d) self-pollination

Q33. Disruption of genes by homologous recombination enables:
(a) Gene amplification
(b) Random mutation
(c) Targeted gene knockout
(d) Protein translation

Q34. What is the antisense strand in a gene?
(a) Same as mRNA
(b) Transcribed strand
(c) Contains stop codons
(d) Non-transcribed strand

Q35. The Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, 2001 was enacted to:
(a) Ban all seed patents
(b) Conform with UPOV 1991 rules
(c) Protect both breeders and farmers
(d) Promote only public sector varieties

Q36. Plants that are not true cereals but whose seeds are used like cereals are called
(a) Millets
(b) Legumes
(c) Pseudocereals
(d) Oilseeds

Q37. The evolutionary concept stating that cultivated species originated from multiple ancestral species is called
(a) Monophyletic
(b) Sympatric
(c) Polyphyletic
(d) Allopatric

Q38. In a dihybrid cross, Mendel observed a phenotypic ratio of 9:3:3:1 in F_2 generation. What does this indicate about the genes involved?
(a) The genes are linked and inherited together
(b) One gene is dominant over the other
(c) The two genes assort independently and are unlinked
(d) The genes always produce a uniform phenotype

Q39. Gene tagging is mainly used to:
(a) Remove unwanted DNA segments
(b) Increase gene transcription efficiency
(c) Isolate genes with unknown sequence or function
(d) Insert artificial protein sequences

Q40. The accumulation of desirable alleles in a population through breeding techniques is known as
(a) hybrid seed production
(b) population improvement
(c) mutation breeding
(d) pedigree selection

Q41. The term "Genomics" was coined by
(a) Gregor Mendel
(b) Watson and Crick
(c) Thomas Roderick
(d) Barbara McClintock

Q42. In deficiency heterozygotes, the unpaired segment of the normal chromosome during the pachytene stage of meiosis produces
(a) a chromatid bridge
(b) a characteristic loop in a bivalent
(c) a deletion loop in a chromatid
(d) an inversion loop in a chromosome

Q43. A repeated crossing of a hybrid with one of its original parents is known as
(a) reciprocal cross
(b) backcross method
(c) three-way cross
(d) test cross

Q44. Repetition of treatment under investigation is known as:
(a) Randomization
(b) Replication
(c) Blocking
(d) Sampling

Q45. Which one of the following is NOT a measure of central tendency?
(a) Mean deviation
(b) Geometric mean
(c) Median
(d) Mode

Q46. The phenomenon in which cross-pollinated or asexually reproducing species show reduced vigour and fertility when subjected to selfing or inbreeding is known as _____?
(a) Inbreeding hypothesis
(b) Recessive hypothesis
(c) Dominant hypothesis
(d) Heterosis hypothesis

Q47. The structure of a typical prokaryotic chromosome includes
(a) Circular DNA with histone proteins
(b) Linear DNA with RNA and proteins
(c) Circular DNA without proteins and RNA
(d) Multiple circular chromosomes with chromatin

Q48. Which of the following statements accurately differentiates patent protection from copyright protection?
(a) Copyright applies to inventions; patents apply to artistic works
(b) Copyright requires registration; patents do not
(c) Patents require formal examination; copyright arises automatically
(d) Both are granted without any legal process

Q49. Biparental mating refers to crossing among randomly selected plants in a definite manner to
(a) maintain heterosis in F_1 generation
(b) develop male sterile lines
(c) concentrate favourable genes in a population
(d) induce mutations for variability

Q50. Primary Centre of origin for soybean is:
(a) China Centre
(b) Hindustan Centre
(c) Central Asia
(d) Asia Minor

Q51. The occurrence of two or more alleles in a population such that the frequency of the rare allele is always greater than 1% is called
(a) Genetic drift
(b) Genetic polymorphism
(c) Mutation
(d) Gene flow

Q52. What is the result of sense and antisense RNA pairing?
(a) DNA repair
(b) Faster translation
(c) Gene silencing
(d) mRNA splicing

Q53. Z-test / Student Z-test was developed by:
(a) Karl Pearson
(b) R.A. Fisher
(c) William Sealy Gosset
(d) Ronald Ross

Q54. The degree of freedom of χ^2 test for a 4 × 3 contingency table is:
(a) 12
(b) 7
(c) 6
(d) 11

Q55. A design of biparental cross in which in F2 each selected male is mated to the same group of female plants resulting in m * f crosses per set is referred to as_____?
(a) NCD1
(b) NCD2
(c) Diallel cross
(d) Backcross

Q56. Vertical resistance is also known as:
(a) Polygenic resistance
(b) Uniform resistance
(c) Specific resistance
(d) Durable resistance

Q57. A diagrammatic representation of chromosomes showing morphological details is known as
(a) isochromosome
(b) chromatogram
(c) ideogram
(d) electropherogram

Q58. Which of the following best describes the essence of a patent in modern legal systems?
(a) A government license to use any invention freely
(b) A temporary legal monopoly granted for a disclosed invention
(c) A universal right to use an invention without disclosure
(d) An open invitation for public use of the invention

Q59. The main difference between crossing over and linkage is that crossing over
(a) keeps the genes together
(b) involves individual chromosomes
(c) leads to separation of linked genes
(d) occurs between sister chromatids

Q60. Which of the following statements about disease resistance mechanisms in plants are correct?
A. Resistance can prevent the establishment or growth of a pathogen in host tissue. B. Tolerance refers to the plant's ability to perform well despite pathogen presence. C. Vertical resistance is often associated with hypersensitivity reaction. D. All forms of resistance prevent infection by all pathogen races. E. Morphological traits like hairy and sunken stomata aid in disease resistance.
Options:
(a) A, B, C, and E only
(b) A, C, D, and E only
(c) B, C, D, and E only
(d) A, B, D, and E only

Q61. Hairiness of leaves provides resistance against:
(a) Stem borers
(b) Root nematodes
(c) Leaf miners
(d) Jassids in cotton

Q62. Match the type of radiation with its main property:

Type of Radiation	Main Property
A. Gamma rays	1. Densely ionizing, particulate, positively charged
B. Alpha particles	2. Sparsely ionizing, very penetrating, non-particulate
C. Beta rays	3. Sparsely ionizing, particulate, negatively charged
D. UV rays	4. Non-ionizing, low penetrating

Options:
(a) A–2, B–1, C–3, D–4
(b) A–3, B–2, C–4, D–1
(c) A–4, B–1, C–2, D–3
(d) A–1, B–3, C–2, D–4

Q63. Match the mechanisms promoting autogamy (self-pollination) with their correct descriptions:

Mechanism	Description
A. Bisexuality	1. Maturation of anthers and stigma at the same time
B. Homogamy	2. Presence of male and female reproductive organs in the same flower
C. Cleistogamy	3. Fertilization occurs in unopened flower bud, preventing cross-pollination
D. Chasmogamy	4. Fertilization after opening of flower, also promotes self-pollination

Options:
(a) A–1, B–2, C–3, D–4
(b) A–2, B–1, C–3, D–4
(c) A–2, B–1, C–4, D–3
(d) A–4, B–3, C–2, D–1

Q64. Which feature is true for RFLP but not for RAPD?
(a) Uses random primers
(b) Needs crude DNA
(c) Detects multiple alleles
(d) Requires no enzymes

Q65. FISH replaces radioactive probes with:
(a) Enzymes
(b) Fluorochromes
(c) Hormones
(d) Antibiotics

Q66. The genes that are very closely located on a chromosome and can be separated only by rare crossing over are called:
(a) Multiple alleles
(b) Polygenes
(c) Pseudoalleles
(d) Codominant genes

Q67. In situ hybridization helps in:
(a) Protein folding
(b) Gene sequencing
(c) Locating specific genes
(d) RNA splicing

Q68. The first cytological proof of genetic crossing over was provided by
(a) Thomas Hunt Morgan
(b) Curt Stern
(c) Barbara McClintock
(d) Gregor Mendel

Q69. Qualitative characters are also known as
(a) polygenic traits
(b) Mendelian traits
(c) quantitative traits
(d) continuous traits

Q70. In chromosome walking, a subclone is used to:
(a) Mutate genes
(b) Delete inserts
(c) Act as a probe
(d) Stop DNA synthesis

Q71. Assertion (A): Gene deployment involves the strategic use of major genes in different geographical regions. Reason (R): It is easy to find a large number of genes with similar effectiveness for different races.
Options:
(a) Both A and R are true, and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

Q72. Chromosome walking is mainly used to:
(a) Delete DNA
(b) Induce mutations
(c) Study large DNA regions
(d) Sequence RNA

Q73. Which of the following statements about the Law of Dominance are correct?
(A) The trait expressed in the F_1 generation of a hybrid cross is the dominant one. (B) Recessive genes always produce functional enzymes in heterozygous conditions. (C) Dominant genes code for active polypeptides that form functional enzymes. (D) Heterozygous individuals express the dominant phenotype.
Choose the correct answer from the options below:
(a) A, B, and C only
(b) A, C, and D only
(c) A, B, and D only
(d) A, B, C, and D

Q74. Given below are two statements:
Assertion (A): Genes that are closely located on the same chromosome tend to be inherited together due to strong linkage. Reason (R): The strength of linkage depends on the linear distance between genes; the smaller the distance, the stronger the linkage.
Choose the most appropriate answer from the options given below:
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Q75. Assertion (A): Yield is considered the main criterion for studying salinity resistance in crops. Reason (R): The expression of salinity resistance is influenced by additive and non-additive gene actions.
(a) Both A and R are true, and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

Q76. Zea mexicana, a teosinte species closely related to maize, is primarily found in
(a) Brazil
(b) Mexico
(c) Peru
(d) Argentina

Q77. The process of copying a gene from DNA into RNA is called
(a) Translation
(b) Transcription
(c) Replication
(d) Splicing

Q78. The difference between mean phenotypic values of the progeny of selected plants and original population is referred to as
(a) Genetic advance
(b) Genetic gain
(c) Selection differential
(d) None of the above

Q79. Assertion (A): The Single Seed Descent (SSD) method ensures rapid advancement of segregating generations in self-pollinated crops. Reason (R): In SSD method, multiple seeds from each plant are bulked to preserve maximum variability across generations.
(a) Both A and R are true, and R is the correct explanation of A.
(b) Both A and R are true, but R is not the correct explanation of A.
(c) A is true, but R is false.
(d) A is false, but R is true.

Q80. Complementation between two mutations in a trans configuration indicates
(a) both mutations are in the same cistron
(b) both mutations are dominant
(c) the mutations are in different cistrons
(d) one mutation is dominant and the other is recessive

Q81. Shot-gun sequencing involves:
(a) Protein synthesis
(b) Use of contigs
(c) Random sequencing
(d) Only human genomes

Q82. Haploid is a term used to designate individuals or tissues with
(a) two sets of chromosomes
(b) one set of chromosomes
(c) double the diploid chromosome number
(d) a polyploid chromosome number

Q83. Heterosis is confined only to
(a) F_2 generation
(b) parent generation
(c) F_1 generation
(d) backcross generation

Q84. Germplasm accessions of various crops are evaluated based on:
(a) Basic record
(b) Germplasm record
(c) Descriptors
(d) Field note

Q85. Centriole divides and each of the two centrioles starts moving towards opposite poles of the nucleus of the dividing cell. Chromosomes appear as long threads and start coiling during which phase?
(a) Metaphase
(b) Anaphase
(c) Telophase
(d) Early prophase

Q86. Notification of a new variety is essential for:
(a) Inclusion in fertilizer subsidy list
(b) Public seed multiplication and distribution
(c) Export of agricultural produce
(d) GST exemption on inputs

Q87. Which one of the following is meant for long-term conservation?
(a) Base collection
(b) Active collection
(c) Working collection
(d) All the three

Q88. Frequent formation of new insect biotypes affects:
(a) Flowering time
(b) Seed production
(c) Resistance durability
(d) Root development

Q89. Progeny that share both parents in common are referred to as
(a) Half sib
(b) Full sib
(c) Crossbred
(d) Hybrid

Q90. Field inspections during seed production are conducted by _____ from SSCA.
(a) Seed analyst
(b) Extension officer
(c) Seed inspector
(d) Certification officer

Q91. A recombinant DNA molecule is produced by joining together two or more DNA segments usually originating from different organisms
(a) DNA inserted into plasmids, phages, or viruses for cloning
(b) Using a single organism's DNA
(c) Cutting DNA without enzymes
(d) Isolating fragments with no vectors

Q92. Genome sequencing begins with:
(a) Protein tagging
(b) cDNA synthesis
(c) DNA fragmentation
(d) RNA extraction

Q93. Inbreeding depression refers to reduced vigour and fitness due to
(a) increased heterozygosity in a population
(b) crossing between unrelated strains
(c) accumulation of dominant alleles
(d) mating between closely related individuals

Q94. Adaptive Research Trial (ART) is conducted:
(a) At university research farms
(b) In laboratory conditions
(c) At farmers' fields
(d) In seed certification centres

Q95. Gene tagging involves the use of:
(a) Restriction enzymes
(b) RNA probes
(c) T-DNA or transposons
(d) Ribosomes

Q96. According to this hypothesis, at each locus the dominant allele has a favorable effect, while the recessive allele has an unfavorable effect _____?
(a) Inbreeding hypothesis
(b) Recessive hypothesis
(c) Dominant hypothesis
(d) Heterosis hypothesis

Q97. The place of origin of diploid wheat is
(a) Ethiopia
(b) Central Asia
(c) Asia Minor
(d) Indo-Gangetic Plains

Q98. Comparative mapping helps in studying the relationship of genomes across different species and genera by using
(a) DNA sequencing alone
(b) RFLP markers to identify conserved gene orders
(c) phenotypic traits for comparison
(d) protein markers for evolutionary studies

Q99. Semi-conservative DNA replication involves
(a) Both strands remain intact
(b) Only one strand forms new DNA
(c) Each strand forms a new complementary strand
(d) DNA replicates without base pairing

Q100. Which of the following statements is NOT correct regarding Anaphase of mitosis?
(a) Centromeres of all chromosomes divide, and each chromatid becomes a chromosome
(b) Spindle fibres pull the chromosomes toward opposite poles by their centromeres
(c) Cytokinesis begins in anaphase, marked by cleavage furrow or cell plate formation
(d) Chromosomes remain aligned at the equator and do not move to the poles

Q101. The main objective of hybridization in plant breeding is to
(a) eliminate genetic variability
(b) develop uniform landraces
(c) combine desirable traits and create hybrids
(d) produce only sterile varieties

Q102. Which of the following techniques is used for estimation of breeding value
(a) Mean deviation
(b) Regression analysis
(c) Combining ability
(d) All of these

Q103. A double cross hybrid involving one CMS line and two inbreds with dominant restorer genes results in
(a) a sterile double cross hybrid
(b) a heterozygous but sterile hybrid
(c) a male fertile double cross hybrid
(d) a clonal uniform male sterile line

Q104. Gene prediction by comparative analysis involves identifying local similarities between genomes using
(a) protein sequences only
(b) sequence alignment programs
(c) phenotypic traits
(d) gene expression data

Q105. Compared to RFLP, RAPD requires:
(a) More DNA
(b) Radioisotopes
(c) Less time
(d) Specific probes

Q106. Z-test is used when sample size is:
(a) Small (n < 10)
(b) Small (n < 30)
(c) Large (n > 30)
(d) Moderate (n = 25)

Q107. The ratio of genotypic variance to total phenotypic variance is called _____?
(a) Real sense heritability
(b) Broad sense heritability
(c) Additive genetic variance
(d) Phenotypic variance

Q108. Statement I: Eukaryotic cDNAs are free from intron sequences and are smaller than the corresponding genes. Statement II: A cDNA library contains equal amounts of abundant and rare mRNAs.
In light of the above statements, choose the most appropriate answer from the options below:
(a) Both Statement I and Statement II are correct
(b) Both Statement I and Statement II are incorrect
(c) Statement I is correct but Statement II is incorrect
(d) Statement I is incorrect but Statement II is correct

Q109. What is a key assumption in Mather's (1949) Generation Variance Analysis method for estimating genetic components?
(a) The presence of epistasis is essential for calculating dominance variance
(b) Only phenotypic data from F_1 generation is required for analysis
(c) Genes act independently without any interaction (no epistasis)
(d) Only environmental variance is considered while estimating genetic components

Q110. The limits of correlation coefficient are:
(a) –1 to 1
(b) Zero to 1
(c) No limit
(d) Any other

Q111. What is the modified phenotypic ratio observed when a lethal gene is present in homozygous condition?
(a) 1:2:1
(b) 3:1
(c) 2:1
(d) 9:3:3:1

Q112. FlavrSavr tomato was developed to:
(a) Ripen faster
(b) Reduce PG activity
(c) Boost seed number
(d) Improve ethylene use

Q113. Assertion (A): Biparental mating allows the development of full-sib and half-sib progenies from a genetically uniform F_2 population, enabling precise variance estimates. Reason (R): North Carolina Designs I, II, and III were developed to estimate additive and dominance variance in a segregating F_2 population.
(a) Both A and R are true, and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

Q114. Suitable Ex situ method for conservation of crops which do not produce seeds is:
(a) Seed bank
(b) Field bank
(c) Shoot tip bank
(d) DNA bank

Q115. Diploid organisms that have lost a pair of homologous chromosomes are called
(a) monosomics
(b) trisomics
(c) nullisomics
(d) tetrasomics

Q116. Correlation coefficient is independent of:
(a) Change of origin
(b) Change of scale
(c) Change of origin and scale
(d) None of the above

Q117. Breeding value is defined as the genetic worth of an individual which is transmitted to the offspring it is commonly used in
(a) Animal breeding
(b) Plant breeding
(c) Both animal and plant breeding equally
(d) None of the above

Q118. The chromosomes that arise due to repeated replication without cell division are called
(a) lampbrush chromosomes
(b) polytene chromosomes
(c) B-chromosomes
(d) metacentric chromosomes

Q119. The initial step in the bulk breeding method involves
(a) multilocation testing of progenies
(b) selection of only heterozygous plants
(c) bulking generations to eliminate weak genotypes
(d) immediate release of F_1 as a variety

Q120. Raphanobrassica is a classic example of an artificially created
(a) autopolyploid
(b) aneuploid
(c) alloploid
(d) haploid

Q121. Hybrid inviability refers to the inability of a hybrid zygote to grow into
(a) a viable offspring
(b) a normal embryo under normal conditions of development
(c) a hybrid plant with stable traits
(d) a mature organism capable of reproduction

Q122. One major goal of the Human Genome Project was to:
(a) Create protein vaccines
(b) Engineer artificial chromosomes
(c) Sequence the entire human genome
(d) Improve crop yield

Q123. Match the morphological traits (Column I) with their role in drought resistance (Column II):

Column I (Trait)	Column II (Function)
A. Leaf rolling	1. Helps reduce transpiration rate
B. Hairy leaves	2. Lowers leaf temperature
C. Deep roots	3. Enhances water uptake under stress
D. Early maturity	4. Leads to drought escape

A. A–1, B–2, C–3, D–4
(b) A–2, B–1, C–4, D–3
(c) A–4, B–3, C–2, D–1
(d) A–3, B–4, C–1, D–2

Q124. The theory of linear arrangement of genes in chromosomes is confirmed by
(a) DNA sequencing
(b) Cytological maps
(c) Gene expression analysis
(d) Protein profiling

Q125. Somatic hybridization leads to development of:
(a) Symmetrical hybrids
(b) Asymmetrical hybrids
(c) Cybrids
(d) All of these

Q126. Which of the following best defines a double trisomic condition?
(a) (2n – 2)
(b) (2n + 2)
(c) (2n + 1 + 1)
(d) (4n)

Q127. The term ideotype was first proposed by
(a) Norman Borlaug
(b) H.K. Hayes
(c) C.M. Donald
(d) J.H. Bennett

Q128. Which of the following heritability values indicates a high degree of heritability according to Johnson et al. (1955a)?
(a) Less than 30%
(b) 30 - 60%
(c) More than 60%
(d) No categorization

Q129. Read the statements below on the properties of a good vector and choose the most appropriate answer: Statement I: A vector must be able to replicate autonomously to generate multiple copies of the DNA insert. Statement II: A vector should be larger than 10 kb to accommodate large DNA inserts. Statement III: A vector should replicate under strict control to avoid overproduction of DNA. Statement IV: A vector should be small in size to avoid issues during purification and cloning procedures.
(a) Statement I, III, and IV are correct
(b) Statement I, II, and IV are correct
(c) Statement I and IV are correct
(d) Statement II and III are correct

Q130. When an extra chromosome segment is located immediately after the normal segment in the same orientation, it is called
(a) inversion
(b) duplication
(c) translocation
(d) tandem duplication

Q131. Aberrations that remain confined to a single chromosome of a homologous pair are called
(a) inter-chromosomal aberrations
(b) intra-chromosomal aberrations
(c) chromosomal deletions
(d) genetic mutations

Q132. What is the correct description of the term "Dichogamy" in plants?
(a) Anthers and stigma mature at the same time
(b) Male and female flowers on same plant
(c) Anthers and stigma mature at different times
(d) Seed develops without fertilization

Q133. What is the primary requirement before submitting a variety for identification?
(a) Laboratory test results only
(b) Proposal with breeder's name only
(c) Two-year AICRP data across centres
(d) One-year disease data from a single centre

Q134. The objects of comparison in a field experiment used to assess value are called:
(a) Plots
(b) Treatments
(c) Samples
(d) Blocks

Q135. The selection response in a population is calculated using the difference between the mean of offspring from selected parents and the mean of the original population
(a) $\mu_1 - \mu_0$
(b) $\mu_2 - \mu_1$
(c) $\mu_2 - \mu_0$
(d) $\mu_0 - \mu_2$

Q136. Organ culture refers to:
(a) Anther culture
(b) Ovule culture
(c) Embryo culture
(d) All of these

Q137. Paracentric inversions refer to inversions where the inverted segment
(a) includes the centromere
(b) occurs in the centromere
(c) does not include the centromere
(d) involves two different chromosomes

Q138. Somatic hybrid may be:
(a) Interspecific
(b) Intergeneric
(c) Intertribal
(d) All of these

Q139. Assertion (A): Screening of rice against stem borer should be done in the off-season. Reason (R): Off-season shows heavier infestation of stem borer compared to the main season.
(a) Both A and R are true, and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

Q140. The fertile spikelet of Sorghum contains a perfect floret characterized by

(a) One sterile flower and one staminate flower

(b) Two fertile flowers with equal glumes

(c) One sterile flower and one perfect bisexual flower

(d) One fertile flower with five stamens and bicelled ovary

Q141. Gene-for-gene hypothesis was proposed by:

(a) Watson

(b) Mendel

(c) Flor

(d) Borlaug

Q142. Which of the following statements about types of mutations are correct?

A. Macro-mutations involve distinct morphological changes in phenotype. B. Micro-mutations are difficult to detect and affect quantitative traits. C. Macro-mutations are associated with oligogenic inheritance. D. Micro-mutations show clear and visible phenotypic effects. E. Macro-mutations are found in polygenic traits.

Options:

(a) A, B, and C only

(b) A, D, and E only

(c) B, C, and D only

(d) A, C, and E only

Q143. Assertion (A): Triple Test Cross is useful for estimating additive and dominance variance in pureline populations using only two parents. Reason (R): The Triple Test Cross involves crossing selected F_2 individuals with two contrasting parents and their F_1 to detect non-allelic interactions.

(a) Both A and R are true, and R is the correct explanation of A

(b) Both A and R are true, but R is not the correct explanation of A

(c) A is true, but R is false

(d) A is false, but R is true

Q144. The gene pool in which intermating (crossing) is easy and leads to production of fertile hybrids is known as _____?

(a) Secondary gene pool

(b) Tertiary gene pool

(c) Wild gene pool

(d) Primary gene pool

Q145. Which of the following statements about the Pedigree Method are correct?
(A) In the pedigree method, individual plant selection begins from the F_2 generation. (B) Selection is carried out within and between progeny rows during F_3 and F_4 generations. (C) Selection in the F_2 generation is based on complex, polygenic traits only. (D) In the F_5 generation, variation within a progeny row typically disappears.
Choose the correct answer from the options below:
(a) A, B, and D only
(b) A, B, and C only
(c) B, C, and D only
(d) A, B, C, and D

Q146. The contribution of the parents in Griffing's Diallel Mating Design is referred to as_____?
(a) Specific combining ability (SCA)
(b) General combining ability (GCA)
(c) Genetic variability
(d) Gene flow

Q147. The process of dividing experimental material into blocks to ensure greater homogeneity is known as:
(a) Randomization
(b) Replication
(c) Local control
(d) Sampling

Q148. The chemical used to kill microbes on the seed surface is known as:
(a) Seed enhancer
(b) Seed hardener
(c) Seed protectant
(d) Seed primer

Q149. The synaptonemal complex between homologous chromosomes becomes visible in
(a) Leptotene
(b) Zygotene
(c) Pachytene
(d) Diplotene

Q150. One major limitation of pure line varieties is
(a) high genetic variability and wide adaptability
(b) high heritable variation and selection efficiency
(c) poor adaptability and susceptibility to new diseases
(d) better yield stability under diverse environments

Solutions

S1. Ans.(c)
Sol.
✅An intraspecific hybrid (also known as an intervarietal hybrid) is produced by crossing genetically different genotypes of the same species.
These are widely used in cross-pollinated crops like maize, pearl millet, and in some self-pollinated crops like rice.
They are fertile and suitable for commercial cultivation.
Examples include:
Single cross hybrids
Three-way cross hybrids
Double cross hybrids
❌Option (a) refers to hybrids between two different species, not varieties of the same species.
❌Option (b) is not a standard term in hybrid classification.
❌Option (d) refers to hybrids formed via protoplast fusion, which is a biotechnological approach, not conventional breeding.
Intraspecific hybrids play a critical role in improving yield and stability in crop production.

S2. Ans.(c)
Sol.
Organogenesis: ✅Organogenesis refers to the differentiation of somatic embryos into distinct plant organs such as roots and shoots. It is essential for the development of plants from somatic embryos in tissue culture.
❌ Option (a) – Gametogenesis: Gametogenesis is the process of forming gametes (sperm and egg cells), not related to the differentiation of plant organs like roots and shoots.
❌ Option (b) – Sporogenesis: Sporogenesis is the formation of spores, which is a reproductive process in plants but not directly related to root and shoot differentiation from somatic embryos.
❌ Option (d) – Embryogenesis: Embryogenesis is the formation of the embryo, and while it is an essential step in plant development, it does not specifically refer to the formation of roots and shoots from somatic embryos.

S3. Ans.(c)
Sol.
✅ Option (c) is correct – Beta diversity measures the difference in species composition between two habitats or regions. It reflects how much species turnover occurs from one area to another and is considered a measure of species differentiation across ecosystems. It is calculated using the formula:
(Number of species in Habitat 1 – Common species between Habitat 1 and 2) + (Number of species in Habitat 2 – Common species between Habitat 1 and 2)
This allows ecologists to evaluate the variation in species between communities and is essential in biodiversity assessment.
❌ Option (a) refers to alpha diversity, which is local species richness. ❌ Option (b) refers to gamma diversity, the total diversity across a region. ❌ Option (d) refers to genetic diversity, which deals with variation within species.
Conclusion: The correct answer is Option (c) – Diversity between two habitats.

S4. Ans.(c)
Sol.
✅ Option (c) is correct because DNA fingerprinting involves detecting polymorphisms (variations) in DNA sequences. It is done by digesting genomic DNA with restriction enzymes, followed by Southern hybridization using specific probes. These probes bind to highly variable regions, revealing individual-specific patterns. This technique is widely used for varietal identification, germplasm characterization, and even human identification.
RFLP (Restriction Fragment Length Polymorphism) is a common method used, especially in plants like rice and potato. In potato, for example, a two-enzyme system could distinguish more than 100 varieties, showing the power of detecting polymorphism.
❌ Option (a) is incorrect because fingerprinting is based on DNA, not mRNA. ❌ Option (b) is incorrect as it doesn't involve protein analysis. ❌ Option (d) is incorrect since hormone levels are unrelated to this method.
Conclusion: The correct answer is Option (c) – DNA polymorphism.

S5. Ans.(c)
Sol.
✅Diallel cross: A diallel cross refers to the mating of selected plants in all possible combinations. In a diallel cross, each plant is crossed with every other plant in the set of parents. This method allows for the study of the genetic relationships among different parents and helps in evaluating their ability to combine and produce offspring with desirable traits. It is often used in breeding programs to understand how different parents interact genetically. There are two types of diallel crosses:
Full diallel: Involves all possible crosses between the selected parents.
Half diallel: Involves only a subset of the total possible crosses, often between one parent and all others.
❌ Option (a) - Inbreeding: Inbreeding is the mating of closely related individuals and does not involve the wide variety of crosses typical of diallel crosses. Inbreeding can lead to genetic problems due to reduced genetic diversity.
❌ Option (b) - Crossbreeding: Crossbreeding involves mating individuals from different breeds or species but is not specific to the controlled selection of parents in a diallel cross.
❌ Option (d) - Hybrid vigor: Hybrid vigor refers to the increased strength or vitality observed in hybrid offspring, which is not the same as the mating design of a diallel cross.

S6. Ans.(b)
Sol.
✅ **Option (b) – Expression vectors:** An **expression vector** is specifically designed for **protein expression**, i.e., it allows the production of a protein specified by the DNA insert in a host cell. These vectors contain **regulatory sequences** such as promoters, operators, and ribosomal binding sites, which are necessary for efficient protein production in the host.
❌ **Option (a) – Cloning vectors: Cloning vectors** are used for the **propagation** of DNA inserts in a host but are not designed for the expression of the protein. Cloning vectors only carry DNA for replication.

❌ **Option (c) – Insertion vectors: Insertion vectors** are used to insert DNA fragments into a host organism, but they do not necessarily contain the regulatory elements required for protein expression.
❌ **Option (d) – Transformation vectors: Transformation vectors** are used for introducing foreign DNA into a host cell, but this term is not specific to the production of proteins.
Conclusion: The correct answer is **Option (b)** – **Expression vectors**, as they are specifically designed for producing the protein specified by the inserted DNA.

S7. Ans.(b)
Sol.
✅ Option (b) is correct because in Tobacco Mosaic Virus (TMV), the coat protein (cp) gene is often used as the site of transgene integration. Though the cp gene is essential for systemic spread of infection, it is not required for initiating local infection. Researchers insert the transgene just downstream of the cp gene's initiation codon, allowing its expression under the control of TMV's strong promoter. This makes TMV a useful RNA virus vector for transient gene expression in plants.
❌ Option (a) is incorrect as the 5' UTR is not the typical site for inserting transgenes in TMV. ❌ Option (c) is incorrect because the promoter drives expression but is not the insertion site. ❌ Option (d) is incorrect since tRNA genes are unrelated to TMV-based cloning.
Conclusion: The correct answer is Option (b) – cp gene site.

S8. Ans.(a)
Sol.
✅ A–1: *General resistance* means the host provides resistance to all prevailing races of a pathogen. ✅ B–2: *Polygenic resistance* is governed by multiple genes, each contributing to resistance—also termed quantitative resistance. ✅ C–3: *Minor gene resistance* involves small-effect genes, which are not individually visible but contribute collectively. ✅ D–4: *Non-specific resistance* offers uniform protection, not limited to any specific race—hence also called uniform resistance.
❌ Other options mix up the definitions and do not align with the textbook content.
Conclusion: The correct answer is Option (a) – A–1, B–2, C–3, D–4.

S9. Ans.(a)
Sol.
✅ Option (a) is correct – The primary centre of origin is the geographic region where a crop plant was first domesticated from its wild ancestors and where it exhibits the highest diversity of forms. These regions are rich in genetic variation and were recognized by Nikolai Vavilov, who identified multiple such centres across the world (e.g., Indian subcontinent, China, Central America).
After domestication, crops were spread to other regions due to human activity, and these new areas are sometimes referred to as secondary centres.
❌ Option (b) refers to regions classified based on climate for agricultural planning. ❌ Option (c) is a facility for storing genetic resources, not a region of origin. ❌ Option (d) refers to areas where crops adapt after introduction, not where they originated.
Conclusion: The correct answer is Option (a) – Primary centre of origin.

S10. Ans.(a)
Sol.
✅The formula to calculate the number of possible genotypes for a gene with multiple alleles is:
Number of genotypes=n(n+1)/2
where n = number of alleles.
· Given: n = 5
5(5+1)/2 =5×6/2 =30/2= 15
✅So, 15 genotypes can be formed using 5 different alleles.

S11. Ans.(b)
Sol.
✅ Option (b) is correct – The gene pool concept was introduced by Harland and Dewet in 1971. This concept includes the total collection of genes and alleles in a crop species and its wild relatives that are capable of interbreeding. It forms the basis for plant breeding, as breeders tap into this pool to introduce desirable traits like disease resistance, drought tolerance, or yield improvement.
The gene pool is typically divided into three levels:
· Primary gene pool: Easily crossable, fertile offspring
· Secondary gene pool: Crossable with some difficulty, may produce partial sterility
· Tertiary gene pool: Distantly related, requires advanced techniques like embryo rescue
❌ Option (a) is incorrect – Vavilov proposed the centres of origin of crops. ❌ Option (c) are evolutionary biologists, unrelated to the gene pool model in plant breeding. ❌ Option (d) is the father of taxonomy, not associated with gene pool theory.
Conclusion: The correct answer is Option (b) – Harland and Dewet.

S12. Ans.(c)
Sol.
✅ Option (c) is correct – Randomization refers to the random allocation of treatments to experimental units. It eliminates bias and ensures that the effects observed are due to the treatments and not due to systematic differences among experimental units. It forms the foundation of valid statistical inference.
❌ Option (a) – Grouping is a general term, not a technical statistical design component. ❌ Option (b) – Replication is about repeating the treatments, not assigning them. ❌ Option (d) – Blocking reduces variability by grouping similar experimental units, not by random assignment.
Conclusion: The correct answer is Option (c) – Randomization.

S13. Ans.(b)
Sol.
✅ Heterokaryon: A heterokaryon is a hybrid cell formed by the fusion of protoplasts (cells without a cell wall) from two different species. This hybrid has a combination of genetic material from both species.
❌ Option (a) – Homokaryon: A homokaryon refers to a hybrid cell formed by fusing protoplasts from the same species, not from different species.
❌ Option (c) – Eukaryon: Eukaryon refers to cells that contain a true nucleus, but this term is not specifically used for hybrid protoplasts, so it doesn't apply in this context.
❌ Option (d) – None of these: This is incorrect because heterokaryon (Option b) is the correct term.

S14. Ans.(b)
Sol.
✅ Option (b) is correct because in clone-by-clone sequencing, the genome is first broken into large fragments which are aligned into contigs (overlapping DNA segments). These contigs are then further broken into smaller fragments using BACs (Bacterial Artificial Chromosomes) and cosmids. Each clone in the contig is then individually sequenced. This stepwise approach ensures high accuracy in assembling the full genome. It was used in the Human Genome Project.
❌ Option (a) is incorrect because random cutting is a feature of shot-gun sequencing, not clone-by-clone. ❌ Option (c) is incorrect as this process involves DNA, not protein extraction. ❌ Option (d) is incorrect since the method works on genomic DNA, not RNA.
Conclusion: The correct answer is Option (b) – Aligning fragments into contigs.

S15. Ans.(c)
Sol.
✅ Assertion (A) is true: Pleiotropy involves a single gene influencing multiple, distinct phenotypic traits, often in unrelated biological systems. A classic example is sickle cell anemia, where one gene causes deformation in red blood cells, impacts oxygen transport, and affects spleen and kidney functions.
❌ Reason (R) is false: Although pigment appears in multiple plant organs, this is a result of the gene's same function (pigment production) being expressed in different tissues. This does not qualify as pleiotropy, because the gene does not produce diverse, unrelated effects.
⁉️ True pleiotropy is when one gene causes effects like altered seed coat and fertility, or leaf shape and boll size, as seen in cotton with the lintless gene (lic) — these traits are unrelated in function, yet controlled by the same gene.
✅ Thus, A is true, but R is false → Option (c) is correct.

S16. Ans.(c)
Sol.
✅Interspecific hybridization occurs between two species within the same genus, and the hybrids resulting from this cross can vary in fertility. These hybrids may be completely fertile or completely sterile, depending on the compatibility of the species involved.
Intergeneric hybridization involves crossing species from different genera within the same family. The hybrids produced from these crosses are always sterile, as the genetic differences between genera are typically too great to allow successful meiosis and reproduction.
❌ Option (a): Hybrids in interspecific hybridization can range from fertile to sterile, but the sterility in intergeneric hybrids is not partial; it is always sterile.
❌ Option (b): Intergeneric hybrids are not fertile; they are always sterile.
❌ Option (d): Occasionally sterile does not apply to intergeneric hybridization, where sterility is a consistent trait.
The sterility of intergeneric hybrids is a significant factor in genetic studies and is important for understanding the limitations of hybridization across genera.

S17. Ans.(c)
Sol.
✅ Option (c) is correct – In statistics, a hypothesis is a statement or assumption about a population parameter (like population mean, variance, or proportion). It is tested based on sample data to draw inferences about the population.
There are typically two types:
· Null hypothesis (H_0): Assumes no effect or no difference
· Alternative hypothesis (H_1): Indicates the presence of an effect or difference
❌ Option (a) – A variable refers to a measurable attribute, not a statement. ❌ Option (b) – A statistic is a value calculated from sample data, not a statement about the population. ❌ Option (d) – A sample is a subset of the population, not a statement about it.
Conclusion: The correct answer is Option (c) – Hypothesis.

S18. Ans.(a)
Sol.
✅ A. Gametophytic SI → 2
It is governed by the genetic constitution of the pollen gamete.
✅ B. Trinucleate pollen → 3
Trinucleate pollen grains have three nuclei (one vegetative + two generative nuclei).
✅ C. Stylar expression → 1
SI genes express in the style, hence referred to as stylar SI.
✅ D. Diallelic SI → 4
This form of SI is controlled by two genes.

S19. Ans.(c)
Sol.
✅ Option (c) is correct – The Chi-square test is a non-parametric statistical test used to examine the association or independence between two categorical variables in a contingency table. It helps in determining whether the distribution of sample categorical data matches an expected distribution.
❌ Option (a) – The t-test is used to compare means between two groups, not for independence. ❌ Option (b) – Paired t-test is used when comparing two related samples (e.g., before and after treatment).
❌ Option (d) – Normal test typically refers to tests assuming a normal distribution, not used to check independence of variables.
Conclusion: The correct answer is Option (c) – Chi-square test.

S20. Ans.(a)
Sol.
✅ (a) Partial diallel → 4. Incomplete diallel: A partial diallel involves a subset of all possible crosses among a group of individuals, hence it's called incomplete diallel as not all possible combinations are used.
✅ (b) Triallel → 3. Three way cross: A triallel involves the crossing of three different varieties or species, which corresponds to a three-way cross.
✅ (c) Quadriallel → 1. Double cross: A quadriallel involves four different lines or varieties, similar to a double cross, which is derived from four parent lines.
✅ (d) Diallel cross → 2. Vr-Wr-graph: A diallel cross involves all possible crosses among a set of individuals, and the Vr-Wr-graph is a method used to analyze diallel cross data.

S21. Ans.(c)
Sol.
✅ Option (c) is correct because when a tag DNA sequence integrates into the coding region or regulatory sequence of a gene, it often disrupts the gene's function, resulting in loss or alteration of the normal phenotype. This process, known as insertional mutagenesis, is the basis of gene tagging. By analyzing the phenotypic change and locating the inserted tag, researchers can determine the identity and role of the disrupted gene.
❌ Option (a) is incorrect because the gene usually cannot produce any functional protein, not a modified one. ❌ Option (b) is incorrect as insertion typically disrupts or silences gene function, not enhances it. ❌ Option (d) is incorrect because the tag remains integrated to help trace and study the gene.
Conclusion: The correct answer is Option (c) – The gene fails to express its normal phenotype.

S22. Ans.(d)
Sol.
✅All of the listed options are correct and are major barriers in distant hybridization. These include:
Cross incompatibility – failure of fertilization due to incompatibility between pollen and stigma.
Hybrid inviability – failure of embryo or zygote to develop normally after fertilization.
Hybrid sterility – hybrids formed are unable to produce functional gametes, making them infertile.
These barriers prevent successful gene flow between genetically distant species and are significant challenges in crop improvement programs using wide hybridization.
□□ Overcoming these requires advanced methods such as embryo rescue, chromosome doubling, or bridge crossing.

S23. Ans.(b)
Sol.
✅Autotetraploids are polyploid organisms with four copies of the same genome, arising either spontaneously or through chromosome doubling of a diploid species using chemicals like colchicine.
These individuals are usually stable and fertile because they form diploid gametes (2n), allowing for proper pairing during meiosis.
Autotetraploids are larger, more vigorous, and often used in crop improvement.
Examples include rye, grapes, alfalfa, groundnut, potato, and coffee.
❌Option (a): Allotetraploids involve genomes from different species, not a single species.
❌Option (c): Aneuploids have irregular numbers of chromosomes, not complete sets.
❌Option (d): Haploids have only one set of chromosomes, the opposite of tetraploids.
□□ Autotetraploids are important in plant breeding for traits like larger fruit size, more protein, better recovery, and increased yield.

S24. Ans.(c)
Sol.
✅Negative mass selection involves removing only the undesirable or off-type plants from the field, allowing the rest to grow and reproduce.
It is commonly used in self-pollinated crops for:
Varietal purification
Seed production
Certification programs

This method helps maintain a high level of genetic purity in the seed lot without changing the overall genetic makeup of the variety.

❌Option (a) Positive mass selection: Involves selecting desirable plants and collecting their seeds, unlike negative selection.

❌Option (b) Clonal selection: Applied to vegetatively propagated crops, not relevant here.

❌Option (d) Pure line selection: Involves selection of best homozygous individuals, a different approach from negative mass selection.

S25. Ans.(c)

Sol.

✅Option (c) Selection differential: Selection differential refers to the difference between the mean phenotypic value of the individuals selected as parents and the mean of the entire initial population before selection. It quantifies how much the selected individuals differ from the initial population in terms of a specific trait.

❌ Option (a) Genetic gain: Genetic gain refers to the improvement in a population's genetic make-up due to selection over generations, not the initial difference in mean phenotypic values.

❌ Option (b) Selection intensity: Selection intensity refers to the proportion of individuals selected from the population, not the difference in phenotypic values between selected individuals and the population.

❌ Option (d) Heritability: Heritability refers to the proportion of phenotypic variance due to genetic factors. It doesn't define the difference in phenotypic values between selected parents and the initial population.

S26. Ans.(a)

Sol.

✅Isoschizomers: Isoschizomers are restriction enzymes that recognize the same DNA sequence, but differ in their ability to cut methylated DNA. One enzyme may cut both methylated and non-methylated target sequences, while the other enzyme only recognizes and cuts non-methylated sequences. These enzymes are essentially enzymatic variants of each other.

❌ Option (b) – Homologous enzymes: Homologous enzymes refers to enzymes that share a similar structure or function, but the term does not specifically refer to restriction enzymes that recognize the same target sequence with differences in methylation sensitivity.

❌ Option (c) – Heterodimers: A heterodimer refers to a protein complex made up of two different subunits. This term is unrelated to restriction enzymes recognizing target sequences.

❌ Option (d) – Isoenzymes: Isoenzymes are different forms of the same enzyme that catalyze the same reaction but may differ in their structure or physical properties. While similar, they do not specifically refer to the methylation-sensitive restriction enzymes described in the question.

S27. Ans.(b)

Sol.

✅Random mating refers to the situation in which every individual of one sex has an equal chance to mate with any individual of the opposite sex, with no selective pressure. This is a fundamental assumption in population genetics, ensuring that the genetic material of all individuals is mixed equally. Random mating plays an important role in maintaining genetic diversity within populations, as it prevents genetic isolation and promotes gene flow across generations.

❌ Option (a): Selective mating involves choosing mates based on specific traits or genetic compatibility, which is the opposite of random mating.
❌ Option (c): Inbreeding occurs when individuals within a population mate with close relatives, which can increase the chances of homozygosity for harmful recessive traits, not random mating.
❌ Option (d): Crossbreeding involves mating two different breeds or species, but it doesn't define the lack of restrictions in mating choices within a population.
⁉️ Random mating is key to maintaining genetic equilibrium in populations, as described by Hardy-Weinberg equilibrium.

S28. Ans.(c)
Sol.
✅ Option (c) is correct because oligogenic resistance is a type of disease resistance governed by one or a few major genes. These genes have a large and easily identifiable effect on resistance. The resistance can be controlled by either dominant or recessive alleles, and it typically shows clear differences between resistant and susceptible plants. Oligogenic resistance is also known as race-specific resistance, offering protection against one or a few races of a pathogen and often involves hypersensitive reactions.
❌ Option (a) is incorrect because cytoplasmic inheritance involves organelle DNA, not oligogenic resistance. ❌ Option (b) is incorrect as many minor genes are associated with polygenic resistance, not oligogenic. ❌ Option (d) is incorrect since mitochondrial DNA is not responsible for oligogenic resistance.
Conclusion: The correct answer is Option (c) – One or few major genes.

S29. Ans.(c)
Sol.
✅ Option (c) is correct because the Human Genome Project (HGP) officially started on October 1, 1990, although planning and discussions began in the mid-1980s, and an Office of Human Genome Project was established in 1988. It was an international collaboration aiming to map and sequence the entire human genome, involving scientists from six countries.
❌ Option (a) is incorrect because 2003 is when the project was completed, not started. ❌ Option (b) is incorrect as 1988 marks the setup of the HGP office, not its official start. ❌ Option (d) is incorrect as it refers to the progress status of sequencing, not the launch year.
Conclusion: The correct answer is Option (c) – 1990.

S30. Ans.(c)
Sol.
✅ Assertion (A) is true – The International Union for the Protection of New Varieties of Plants (UPOV) was established to promote and implement an effective plant variety protection system. It supports innovation by granting intellectual property rights to breeders, thereby encouraging the development of new plant varieties that benefit society.
❌ Reason (R) is false – Under the UPOV Convention, especially after the revisions in 1978 and 1991, a breeder's authorization is mandatory to propagate, sell, or commercially exploit a protected variety. Therefore, commercial use without consent is not permitted under UPOV.
Conclusion: The correct answer is Option (c) – A is true, but R is false.

S31. Ans.(d)

Sol.

✅The first step in gene cloning or recombinant DNA technology is production and isolation of the DNA fragments to be cloned. This is the crucial starting point where the DNA of interest is isolated from the organism. After this, the DNA can be inserted into a vector for further manipulation.

❌Option (a) Transformation: Refers to the introduction of recombinant DNA into the host organism, which occurs later in the process.

❌Option (b) Selection: Involves selecting the transformed cells, which happens after the recombinant DNA is introduced into the host.

❌Option (c) Insertion: Refers to inserting the gene into a vector, which is the second step in the process.

S32. Ans.(b)

Sol.

Allopolyploidy occurs when two different species (in this case, Gossypium herbaceum and Gossypium raimondii) contribute to the formation of a new species with combined chromosome sets from both parents. The F1 hybrid was initially diploid (2n = 26), but by doubling the chromosome number, an allopolyploid was created, resulting in the new world cotton (Gossypium hirsutum), which is fertile and stable.

The hybrid cotton plants were able to produce fertile F1 offspring when crossed with Gossypium hirsutum, confirming the successful allopolyploid formation.

❌ Option (a): Autopolyploidy involves chromosome duplication within a single species, not hybridization between different species.

❌ Option (c): Polygenic inheritance involves the inheritance of traits controlled by multiple genes, not the formation of a new species through chromosome doubling.

❌ Option (d): Self-pollination refers to the pollination process where an individual flower pollinates itself, not related to polyploid formation.

⁉️ The process of allopolyploidy has important implications in plant breeding, especially in crop improvement like cotton.

S33. Ans.(c)

Sol.

✅ Option (c) is correct because homologous recombination allows targeted integration of transgenes into specific sites of the genome. This can be used to abolish or knock out the function of a particular endogenous gene. Such targeted disruption has been successfully applied in the production of transgenic knockout models, particularly in animals like mice, and is being explored in plants as well.

❌ Option (a) is incorrect as amplification refers to increased gene copy number, not disruption. ❌ Option (b) is incorrect because homologous recombination is a targeted, not random, process. ❌ Option (d) is incorrect since gene disruption halts expression and affects transcription, not translation.

Conclusion: The correct answer is Option (c) – Targeted gene knockout.

S34. Ans.(b)
Sol.
✅ Option (b) is correct because the antisense strand of a gene is the DNA strand oriented 3' to 5' and is the one that gets transcribed into mRNA. It is complementary to the mRNA and to the sense strand of DNA. This strand serves as the template for RNA polymerase during transcription.
❌ Option (a) is incorrect because the mRNA sequence is not the same as the antisense strand, but rather complementary to it. ❌ Option (c) is incorrect since the antisense strand's role is not defined by stop codons, but by its use as a template. ❌ Option (d) is incorrect because the sense strand is the non-transcribed one, not the antisense strand.
Conclusion: The correct answer is Option (b) – Transcribed strand.

S35. Ans.(c)
Sol.
✅ Option (c) is correct – The PPV&FR Act, 2001 is a unique Indian legislation that provides a sui generis system for the protection of plant varieties. It ensures intellectual property rights to plant breeders, while also safeguarding the rights of farmers, especially their rights to save, use, exchange, and sell farm-saved seeds. It aligns with the UPOV Convention of 1978, but is tailored to India's agricultural structure, which includes strong public sector breeding and a large base of traditional farming communities.
❌ Option (a) is incorrect – The Act does not ban patents, but provides an alternative system for plant variety protection. ❌ Option (b) is incorrect – The Act follows the UPOV 1978 version, not the stricter UPOV 1991. ❌ Option (d) is incorrect – The Act supports both public and private breeders, and also recognizes farmers' varieties.
Conclusion: The correct answer is Option (c) – Protect both breeders and farmers.

S36. Ans.(c)
Sol.
✅Pseudocereals are plants that do not belong to the Poaceae (grass) family like true cereals but are used similarly for their starchy seeds, often ground into flour or cooked like rice or wheat.
Common examples include:
Buckwheat (Fagopyrum esculentum)
Grain Amaranthus
Quinoa
They are nutrient-rich alternatives and especially important in gluten-free diets.
❌Option (a) Millets: Millets are true cereals from the grass family (e.g., pearl millet, finger millet).
❌Option (b) Legumes: These are plants used mainly for protein-rich seeds (e.g., beans, peas).
❌Option (d) Oilseeds: These are used for oil extraction (e.g., mustard, groundnut).

S37. Ans.(c)
Sol.
✅Polyphyletic origin refers to the theory that a group of organisms (like cultivated rice varieties) originated from more than one ancestral species, evolving independently in different regions.
Example:
Asian rice (*Oryza sativa*) evolved in Asia
African rice (*Oryza glaberrima*) evolved in Africa
Each from different ancestral species, supporting the polyphyletic theory.

❌Option (a) Monophyletic: Means all organisms descended from a single common ancestor — opposite of polyphyletic.

❌Option (b) Sympatric: Refers to speciation without geographic isolation, unrelated to ancestry origin.

❌Option (d) Allopatric: Refers to speciation due to geographic separation, not directly linked to ancestral species diversity.

S38. Ans.(c)

Sol.

✅In Mendel's dihybrid cross, he studied two different traits at the same time — for example, seed shape (round vs. wrinkled) and seed color (yellow vs. green).

He crossed two plants that were heterozygous for both traits (RrYy × RrYy).

The F_2 generation showed a phenotypic ratio of 9:3:3:1:

9 round yellow (both dominant traits)

3 round green

3 wrinkled yellow

1 wrinkled green (both recessive traits)

What this ratio tells us:

Independent Assortment: The genes for seed shape and seed color are inherited independently, meaning the allele a gamete receives for one gene does not influence the allele received for another gene.

This happens when genes are located either on different chromosomes or far apart on the same chromosome, so that crossing over during meiosis separates them.

Therefore, all possible combinations of alleles occur with equal probability, leading to the 9:3:3:1 ratio.

❌ Option (a) is incorrect: Linked genes do not produce a 9:3:3:1 ratio — they show altered ratios due to linkage.

❌ Option (b) misrepresents the concept — it's not about dominance between genes but independence in inheritance.

❌ Option (d) contradicts the basic principle of genetic variation and assortment.

S39. Ans.(c)

Sol.

✅ Option (c) is correct because gene tagging is a technique used to isolate genes responsible for a detectable phenotype, even when their base sequences or protein products are not known. This is achieved by inserting a known DNA sequence (tag) randomly into the genome. When the tag inserts within a coding or regulatory region, it can disrupt the gene's normal function, producing a mutant phenotype. This disruption helps researchers identify the gene of interest by tracking the tag.

❌ Option (a) is incorrect because gene tagging does not involve the removal of DNA but rather the insertion of a tag. ❌ Option (b) is incorrect since gene tagging is not aimed at increasing transcription, but rather identifying gene function. ❌ Option (d) is incorrect because the technique does not insert protein sequences, but DNA tags.

Conclusion: The correct answer is Option (c) – Isolate genes with unknown sequence or function.

S40. Ans.(b)
Sol.
✅Population improvement refers to the genetic enhancement of a breeding population by accumulating favorable alleles for one or more traits through recurrent selection, mass selection, or other breeding methods.
It is widely used in improving open-pollinated varieties and in crops where hybrid development is difficult or not feasible.
The aim is to increase the frequency of desirable genes in the population over time, leading to improved yield, resistance, or other agronomic traits.
❌Option (a): Hybrid seed production involves crossing specific inbred lines, not continuous accumulation of alleles in a population.
❌Option (c): Mutation breeding introduces new variation, not necessarily accumulates existing desirable alleles.
❌Option (d): Pedigree selection is a method for self-pollinated crops, and focuses on selecting individuals, not improving entire populations.
Population improvement is essential in crops like maize, pearl millet, and sorghum to build broad-based, high-performing gene pools.

S41. Ans.(c)
Sol.
✅The term "Genomics" was first coined by Thomas Roderick in 1986. Genomics refers to the study of the entire genome of an organism, including its structure, function, evolution, and mapping.
The field of genomics emerged with the advent of advanced technologies, such as DNA sequencing, which allow for large-scale analysis of genomes.
❌ Option (a): Gregor Mendel is the father of genetics, but he did not coin the term genomics. He is known for his work on inheritance patterns in pea plants.
❌ Option (b): Watson and Crick are famous for discovering the structure of DNA but did not coin the term genomics.
❌ Option (d): Barbara McClintock made groundbreaking contributions to chromosomal structure and genetic transposition but did not coin the term genomics.
Genomics has revolutionized the study of genetics, helping researchers understand complex traits, disease mechanisms, and enabling advancements in personalized medicine.

S42. Ans.(b)
Sol.
✅In deficiency heterozygotes, where one chromosome has a deficiency or deletion, the unpaired segment of the normal chromosome forms a characteristic loop during the pachytene stage of meiosis. This happens in intercalary deletion heterozygotes.
The loop forms because of the unequal pairing between the normal chromosome and the deficient chromosome. The loop compensates for the missing segment, ensuring the bivalent can form during meiosis.
❌ Option (a): A chromatid bridge occurs in structural rearrangements like fusions, not in deficiency heterozygotes.

❌ Option (c): A deletion loop would occur in cases of large deletions, but the description refers to the loop formed in a bivalent.
❌ Option (d): An inversion loop occurs when there is chromosomal inversion, not a simple deletion.
This phenomenon is crucial for understanding how chromosomal deletions are tolerated in heterozygotes and helps us study genetic compensation mechanisms in organisms.

S43. Ans.(b)
Sol.
✅Backcrossing involves crossing an F_1 hybrid (or its subsequent generation) repeatedly with one of its parents, typically the recurrent parent.
The objective is to recover the genetic background of the recurrent parent, while retaining a specific desirable trait from the non-recurrent parent.
This method is especially useful in:
Transferring disease resistance
Improving a specific trait
Developing near-isogenic lines (NILs)
❌Option (a) Reciprocal cross: Refers to switching male and female parents in a cross, not repeated crossing with one parent.
❌Option (c) Three-way cross: Involves three different parent lines, not backcrossing.
❌Option (d) Test cross: Used to determine genotype (e.g., with a recessive parent), not for recovery of parental genotype.
⁉️ Key Concept: The backcross method gradually increases the genetic similarity of progeny to the recurrent parent with each generation.

S44. Ans.(b)
Sol.
✅ Option (b) is correct – Replication refers to the repetition of a treatment across multiple experimental units. It ensures that each treatment is exposed to all possible variations in the field environment, improving the precision and reliability of the results. Replication allows estimation of experimental error and enhances the validity of statistical comparisons.
❌ Option (a) – Randomization involves the assignment of treatments, not their repetition. ❌ Option (c) – Blocking refers to grouping of homogeneous experimental units to reduce variation. ❌ Option (d) – Sampling is the selection of a subset from a population, unrelated to replication.
Conclusion: The correct answer is Option (b) – Replication.

S45. Ans.(a)
Sol.
✅ Option (a) is correct – Mean deviation is a measure of dispersion, not central tendency. It indicates how much data values deviate from the mean, reflecting the spread or variability in a dataset.
❌ Option (b) – Geometric mean is a valid measure of central tendency, especially for data expressed in percentages, ratios, or growth rates. ❌ Option (c) – Median is the middle value that divides the dataset into two equal halves, a classic central tendency measure. ❌ Option (d) – Mode is the value that occurs most frequently in a dataset, also a measure of central tendency.
Conclusion: The correct answer is Option (a) – Mean deviation.

S46. Ans.(c)
Sol.
✅Option (c) - Dominant hypothesis: The dominant hypothesis, first proposed by Davenport in 1908 and later expanded by Bruce, Keeble, and Pellow, suggests that at each locus, the dominant allele has a favorable effect while the recessive allele has an unfavorable effect. According to this hypothesis, when alleles are in a heterozygous state, the negative effects of the recessive allele are masked by the dominant allele. Inbreeding depression occurs because inbreeding causes the recessive alleles to become homozygous, leading to the expression of their harmful effects.
❌ Option (a) - Inbreeding hypothesis: The inbreeding hypothesis is related to the effects of inbreeding but does not specifically describe the relationship between dominant and recessive alleles as explained in the dominant hypothesis.
❌ Option (b) - Recessive hypothesis: The recessive hypothesis would suggest that the recessive alleles are the primary drivers of inbreeding depression, but the dominant hypothesis emphasizes the dominant allele's favorable effect and its role in masking the recessive allele's negative impact.
❌ Option (d) - Heterosis hypothesis: The heterosis hypothesis involves hybrid vigor and does not focus on the dominance-recessive relationship described in the dominant hypothesis.

S47. Ans.(c)
Sol.
✅Option (c) is correct: A typical prokaryotic chromosome is a single circular, double-stranded DNA molecule, located in the nucleoid region of the cell. Unlike eukaryotic chromosomes, it lacks histone proteins and RNA-based packaging structures like chromatin.
❌Option (a) is incorrect: Histone proteins are associated with eukaryotic DNA, not prokaryotic.
❌Option (b) is incorrect: Prokaryotic DNA is not linear (with few exceptions like in *Borrelia*), and it doesn't have RNA or protein packaging like eukaryotes.
❌ Option (d) is incorrect: Prokaryotes generally have a single chromosome, not multiple ones, and do not form chromatin.
Some prokaryotes may have plasmids (small circular DNA), but these are not considered chromosomes.

S48. Ans.(c)
Sol.
✅ Option (c) is correct – The key distinction lies in the nature of protection and legal process:
Copyright protects expressions like books, films, music, and art. In countries that are members of the Berne Convention, copyright protection is automatic upon creation and does not require registration or any other formality.
Patents, on the other hand, protect inventions (products or processes) and are only granted after a formal application and examination by a government authority, such as the Patent Office. The invention must meet criteria like novelty, non-obviousness, and industrial applicability.
❌ Option (a) is incorrect – It reverses the correct application of copyright and patents. ❌ Option (b) is incorrect – It wrongly states the process; in fact, patents require registration, while copyright does not in most countries. ❌ Option (d) is incorrect – Patents are only granted through a legal process; only copyright can arise without one (in most jurisdictions).
Conclusion: The correct answer is Option (c) – Patents require formal examination; copyright arises automatically.

S49. Ans.(c)
Sol.
✅Biparental mating is a breeding technique where randomly selected plants from F_2 or later generations of a cross are intermated in a definite fashion.
The goal is to concentrate desirable alleles or favourable genes across multiple cycles (typically 3–4 cycles) within a breeding population.
It enhances recombination, breaks linkage blocks, and allows selection of superior recombinants, improving the efficiency of selection in segregating populations.
❌Option (a): Heterosis is a feature of F_1 generation but not maintained through biparental mating.
❌Option (b): Male sterile lines are developed using specific cytoplasmic or genetic mechanisms, not biparental crossing.
❌Option (d): Mutation breeding involves using chemicals or radiation, not crossing between plants.
🧑‍🔬 Developed by: Comstock and Robinson (1948, 1952) — the pioneers of this concept.

S50. Ans.(a)
Sol.
✅ Option (a) is correct – The China Centre is recognized as the primary centre of origin for soybean. This region exhibits the highest diversity of wild and cultivated soybean species, indicating that it is the area where soybean was first domesticated. The rich genetic variation found in this centre supports its status as the original homeland of soybean.
❌ Option (b) is incorrect – Hindustan Centre is the primary centre for crops like rice and sugarcane, not soybean. ❌ Option (c) and (d) are incorrect as they are centres for other crop species (e.g., wheat in Central Asia and legumes in Asia Minor).
Conclusion: The correct answer is Option (a) – China Centre.

S51. Ans.(b)
Sol.
✅Genetic polymorphism refers to the presence of two or more alleles in a population, where the frequency of the rare allele is greater than 1%. This condition is essential for genetic diversity within a population and plays a crucial role in evolution and adaptation.
Genetic polymorphism can result from various sources like mutations or environmental factors and typically involves traits that show discontinuous variation, such as blood type in humans or flower color in certain plants.
❌ Option (a): Genetic drift refers to random changes in allele frequencies in a population, particularly in small populations, but does not define the presence of multiple alleles.
❌ Option (c): Mutation is the change in DNA sequence, which can contribute to genetic variation but does not directly describe the occurrence of multiple alleles with a frequency above 1%.
❌ Option (d): Gene flow is the transfer of alleles between populations but does not specifically relate to the frequent occurrence of multiple alleles within a single population.
🧑‍🔬 Genetic polymorphism is crucial in understanding evolutionary processes and the genetic health of populations.

S52. Ans.(c)
Sol.
✅ Option (c) is correct because when antisense RNA is present along with its corresponding sense RNA, the two transcripts are complementary and pair to form double-stranded RNA (dsRNA). This pairing leads to three major outcomes:
1. The mRNA becomes unavailable for translation.
2. The dsRNA is degraded by RNA-specific enzymes.
3. The process may also cause methylation of promoter and coding regions, ultimately leading to silencing of the endogenous gene.
❌ Option (a) is incorrect because this mechanism does not involve DNA repair processes. ❌ Option (b) is incorrect since translation is inhibited, not accelerated. ❌ Option (d) is incorrect because mRNA splicing is unrelated to antisense RNA action.
Conclusion: The correct answer is Option (c) – Gene silencing.

S53. Ans.(b)
Sol.
✅ Option (b) is correct – The Z-test, a type of statistical hypothesis test used when sample size is large ($n > 30$) and population variance is known, was developed by R.A. Fisher. He was a pioneer in the field of modern statistics, particularly in the development of hypothesis testing and design of experiments.
Note: While the t-test was developed by William Sealy Gosset under the pseudonym "Student," the Z-test is linked to Fisher's development of parametric testing techniques for large samples.
Conclusion: The correct answer is Option (b) – R.A. Fisher.

S54. Ans.(c)
Sol.
✅ Option (c) is correct – For a contingency table, the degrees of freedom (df) for a Chi-square (χ^2) test is calculated as:
$df=(r-1)(c-1)$
Where:
· r = number of rows = 4
· c = number of columns = 3
$df=(4-1)(3-1)=3\times2=6$
Hence, the correct degree of freedom is 6.
Conclusion: The correct answer is Option (c) – 6.

S55. Ans.(b)
Sol.
✅ Option (b): NCD2 is a design of biparental cross where in F2 each selected male is mated to the same group of female plants resulting in m * f crosses per set, where "m" and "f" denote the number of male and female plants respectively.
❌ Option (a): NCD1 refers to a different design, often focused on different parameters of crosses, not specifically matching the description of NCD2.
❌ Option (c): A Diallel cross involves crossing all individuals with each other, not specifically the design described in NCD2.

❌ Option (d): Backcross refers to crossing an F1 hybrid with one of the parent species, not the same as NCD2 design.
Conclusion: The correct design matching the given description is NCD2, which follows the male-to-female mating pattern producing m * f crosses.

S56. Ans.(c)
Sol.
✅ Option (c) is correct because vertical resistance refers to the resistance of a host to a specific race of a pathogen, and hence it is also called specific resistance. It is typically controlled by one or few major genes (oligogenic or monogenic), which makes the resistance effective only against a particular pathogen race. This type of resistance is also called qualitative or major gene resistance, and it follows gene-for-gene relationships.
❌ Option (a) is incorrect as polygenic resistance refers to horizontal resistance, not vertical. ❌ Option (b) is incorrect since vertical resistance is non-uniform, affecting only specific races. ❌ Option (d) is incorrect because vertical resistance is generally short-lived or less durable.
Conclusion: The correct answer is Option (c) – Specific resistance.

S57. Ans.(c)
Sol.
✅An ideogram (or sometimes also referred to as an ideotype in cytogenetics) is a schematic diagram that shows the relative sizes and centromere positions of all chromosomes in a karyotype.
It is used to visually represent the structure and characteristics of each chromosome, aiding in cytological studies and comparative genomics.
❌Option (a): Isochromosome is a type of chromosomal abnormality.
❌Option (b): Chromatogram is used in chemical analysis, not chromosome representation.
❌Option (d): Electropherogram is used in DNA sequencing, not chromosome diagrams.

S58. Ans.(b)
Sol.
✅ Option (b) is correct – A patent is a legal monopoly right granted by the government to an inventor for a limited period (typically 20 years). In exchange, the inventor must fully disclose the invention, which must meet specific criteria: it must be novel (new), non-obvious (inventive step), industrially applicable (useful), and patentable under the law. This forms a contract where the public gains access to new knowledge while the inventor is rewarded with exclusive rights.
❌ Option (a) is incorrect – A patent is not a free license to others; it restricts unauthorized use. ❌ Option (c) is incorrect – A patent requires full disclosure, and excludes others from using it without permission. ❌ Option (d) is incorrect – A patent is the opposite of open use; it protects the inventor's rights and prevents unauthorized commercial exploitation.
Conclusion: The correct answer is Option (b) – A temporary legal monopoly granted for a disclosed invention.

S59. Ans.(c)
Sol.
✅Crossing over involves the exchange of segments between non-sister chromatids of homologous chromosomes during meiosis. This process separates linked genes by creating new combinations of alleles, leading to genetic diversity.
Linkage, on the other hand, refers to genes that are located close to each other on the same chromosome, and it keeps the genes together, meaning they are more likely to be inherited together.
❌ Option (a): This describes linkage, not crossing over.
❌ Option (b): Linkage involves the genes on the same chromosome, while crossing over involves exchange between non-sister chromatids.
❌ Option (d): Crossing over occurs between non-sister chromatids, not sister chromatids.
⁉️ Crossing over plays a critical role in genetic recombination, while linkage refers to the physical proximity of genes on the chromosome.

S60. Ans.(a)
Sol.
✅ A is correct – Resistance in plants operates by preventing the establishment, growth, and development of pathogens in host tissues. ✅ B is correct – When a host performs well even after pathogen establishment, this is called tolerance, not true resistance. ✅ C is correct – Vertical resistance is linked to hypersensitive responses, where infected host cells die to limit pathogen spread. ✅ E is correct – Morphological features like sunken, small, and hairy stomata reduce pathogen entry and aid in disease resistance.
❌ D is incorrect – Only horizontal/general resistance provides defense against all races of a pathogen. Vertical resistance is race-specific.
Conclusion: The correct answer is Option (a) – A, B, C, and E only.

S61. Ans.(d)
Sol.
✅ Option (d) is correct because hairiness of leaves is a morphological trait known to confer resistance against various insect pests. Specifically, in cotton, the presence of leaf hairiness has been linked to resistance against jassids. Similarly, aphids in turnip and leaf beetles in cereals are affected by hairiness on the leaves and stems, making it an important natural defense trait in crop plants.
❌ Option (a) is incorrect because hairiness is not directly linked to resistance against stem borers. ❌ Option (b) is incorrect as root nematodes attack underground parts and are not affected by leaf hairiness. ❌ Option (c) is incorrect since leaf miners live inside leaf tissue, and surface hairiness has limited effect on them.
Conclusion: The correct answer is Option (d) – Jassids in cotton.

S62. Ans.(a)
Sol.
✅A. Gamma rays → 2
Gamma rays are sparsely ionizing (S.I.), very penetrating, and non-particulate.
✅B. Alpha particles → 1
Alpha particles are densely ionizing (D.I.), particulate, less penetrating, and positively charged.

✅C. Beta rays → 3
Beta rays are sparsely ionizing, particulate, more penetrating than alpha particles, and negatively charged.
✅D. UV rays → 4
Ultraviolet rays are non-ionizing and have low penetration power.
⁉️ Note:
· D.I. = Densely Ionizing
· S.I. = Sparsely Ionizing
· Particulate = Particle-emitting radiation like alpha, beta, and neutrons
· Non-particulate = Energy waves like gamma and X-rays

S63. Ans.(b)
Sol.
✅A. Bisexuality → 2
Bisexuality refers to the presence of both male and female organs in the same flower, which is essential for self-pollination.
✅B. Homogamy → 1
Homogamy means the simultaneous maturity of anthers and stigma, ensuring successful self-pollination.
✅C. Cleistogamy → 3
In cleistogamy, pollination and fertilization occur in unopened buds, preventing cross-pollination and ensuring complete autogamy.
✅D. Chasmogamy → 4
In chasmogamy, fertilization occurs after the flower opens, but still favors self-pollination in crops like wheat, barley, rice, and oats.
Thus, correct match: A–2, B–1, C–3, D–4 → Option (b) ✅

S64. Ans.(c)
Sol.
✅ Option (c) is correct because RFLP (Restriction Fragment Length Polymorphism) can detect multiple alleles of a marker, thanks to its codominant inheritance pattern. This allows researchers to distinguish between homozygous and heterozygous individuals, making RFLP highly informative for genetic mapping.
❌ Option (a) is incorrect because RAPD, not RFLP, uses random primers. ❌ Option (b) is incorrect since RFLP requires pure DNA, not crude. ❌ Option (d) is incorrect because RFLP does require restriction enzymes, while RAPD does not.
Conclusion: The correct answer is Option (c) – Detects multiple alleles.

S65. Ans.(b)
Sol.
✅ Option (b) is correct because FISH (Fluorescence In Situ Hybridization) uses fluorescent dyes (fluorochromes) instead of radioactive probes to detect DNA or RNA sequences in tissues or chromosomes. This technique is safer, faster, and allows for simultaneous detection of multiple genes using different fluorochromes—a method called McFISH (Multicolour FISH). It also enables a precise analysis of chromosomal rearrangements and gene locations.

❌ Option (a) is incorrect as enzymes are not used in place of radioactive labels. ❌ Option (c) is incorrect because hormones have no role in labeling DNA probes. ❌ Option (d) is incorrect since antibiotics are unrelated to hybridization probes.
Conclusion: The correct answer is Option (b) – Fluorochromes.

S66. Ans.(c)
Sol.
✅ Pseudoalleles are genes that occupy closely linked loci on a chromosome and behave as if they are allelic, meaning they affect the same phenotypic trait, but they are not true alleles in terms of occupying the same locus.
They are separable only by rare crossing over, which means recombination events between them are extremely infrequent due to the minimal distance between their loci.
⁉️ A classic example of pseudoalleles is seen in Drosophila (fruit flies) at the lozenge locus, where multiple genes that control eye development are so close they were once thought to be a single gene.
Why other options are incorrect:
❌ (a) Multiple alleles: These are different forms of the same gene at a single locus, not closely linked but separate loci.
❌ (b) Polygenes: These refer to many genes contributing to a single trait (like height), usually unlinked.
❌ (d) Codominant genes: These are alleles at the same locus that are both expressed (like AB blood group), but this is unrelated to gene proximity or crossing over.

S67. Ans.(c)
Sol.
✅ Option (c) is correct because in situ hybridization is a technique used to locate specific genes or nucleic acid sequences within chromosomes or tissues. It uses a labeled DNA or RNA probe that binds to its complementary sequence in the sample. This method helps identify the exact location of a gene on a chromosome, such as in the salivary gland chromosomes of Drosophila. It is also useful in disease diagnosis to detect viruses in tissues.
❌ Option (a) is incorrect because protein folding is unrelated to hybridization. ❌ Option (b) is incorrect as sequencing determines base order, not location. ❌ Option (d) is incorrect since RNA splicing occurs during post-transcriptional processing, not localization.
Conclusion: The correct answer is Option (c) – Locating specific genes.

S68. Ans.(b)
Sol.
✅Curt Stern provided the first cytological proof of genetic crossing over in 1931 through experiments with Drosophila (fruit flies). He used cytological markers and demonstrated that crossing over occurred between chromosomes, which led to the exchange of genetic material.
He studied a Drosophila female fly in which one X chromosome was broken into two segments, with one segment behaving as a functional X chromosome, helping to confirm the genetic basis of crossing over.
❌ Option (a): Thomas Hunt Morgan contributed significantly to genetics but was not the first to provide cytological evidence of crossing over.
❌ Option (c): Barbara McClintock is known for her work on transposons, not the discovery of crossing over.

❌ Option (d): Gregor Mendel laid the foundation for genetic inheritance, but his work did not involve cytological proof of crossing over.
Curt Stern's experiments were critical in moving genetics from theoretical concepts to physical proof at the chromosomal level.

S69. Ans.(b)
Sol.
✅Qualitative characters are traits that show discontinuous variation and cannot be easily measured. These traits are also known as Mendelian traits because they follow the inheritance patterns described by Mendel's laws. Examples include corolla color (e.g., red, white, or pink) and seed shape (e.g., round or wrinkled), where there are distinct categories, not a continuous range.
These traits usually involve single genes with distinct dominant or recessive alleles, resulting in clear-cut phenotypic outcomes.
❌ Option (a): Polygenic traits involve multiple genes influencing a trait, leading to continuous variation, unlike qualitative characters.
❌ Option (c): Quantitative traits show continuous variation and are influenced by multiple genes, which is opposite to qualitative characters.
❌ Option (d): Continuous traits show a range of variations, not distinct categories like qualitative characters.
Mendelian traits are foundational in genetics and play a key role in classical genetics studies.

S70. Ans.(c)
Sol.
✅ Option (c) is correct because a subclone is a small DNA fragment taken from the end of a previously cloned segment. This subclone is used as a probe to identify the next overlapping DNA clone in a genomic library. It ensures continuity in the chromosome walk by guiding the identification of the next fragment that overlaps with the previous one, gradually advancing toward the gene of interest.
❌ Option (a) is incorrect because subcloning is not used for gene mutation. ❌ Option (b) is incorrect since subclones help find new inserts, not remove them. ❌ Option (d) is incorrect as the process doesn't involve DNA synthesis termination.
Conclusion: The correct answer is Option (c) – Act as a probe.

S71. Ans.(c)
Sol.
✅ Assertion (A) is true – Gene deployment is a strategy used in breeding programs where major resistance genes are used in a planned way across different geographical areas. This helps to manage disease pressure by reducing the chance of a pathogen overcoming a single gene across all regions.
❌ Reason (R) is false – The statement is incorrect because the main drawback of gene deployment is that it is actually difficult (not easy) to find many genes with similar effectiveness against various pathogen races. The limited availability of such genes makes this approach challenging to implement on a large scale.
Conclusion: The correct answer is Option (c) – A is true, but R is false.

S72. Ans.(c)
Sol.
✅ Option (c) is correct because chromosome walking is a molecular technique used to isolate and characterise large regions of chromosomes. It helps researchers move progressively along DNA by using overlapping DNA clones to reach unknown regions near a known marker. Each new probe is based on the end of the previous fragment, allowing step-by-step mapping or gene discovery across extensive DNA segments. It's particularly useful for locating genes close to known sequences.
❌ Option (a) is incorrect as this technique doesn't delete DNA; it isolates it. ❌ Option (b) is incorrect because chromosome walking is not a mutagenesis method. ❌ Option (d) is incorrect as it works with DNA, not RNA.
Conclusion: The correct answer is Option (c) – Study large DNA regions.

S73. Ans.(b)
Sol.
✅ Statement A is correct: According to the law, dominant traits appear in F_1 generation when contrasting characters are crossed.
❌ Statement B is incorrect: Recessive genes are unable to form functional enzymes, especially in heterozygous conditions.
✅ Statement C is correct: Dominant genes synthesize active polypeptides that lead to functional enzymes.
✅ Statement D is correct: In a heterozygous condition, the dominant allele expresses itself, giving the same phenotype as in the homozygous dominant.

S74. Ans.(a)
Sol.
✅Assertion is true: Genes located close together on the same chromosome are often inherited as a block because they are less likely to be separated by crossing over — this is a key feature of linkage.
✅Reason is also true: According to Morgan's Chromosome Theory of Linkage, the physical distance between genes determines the likelihood of recombination. Shorter distances mean stronger linkage.
R correctly explains A: The strength of linkage (A) is directly dependent on the distance between genes (R), making R the correct explanation.

S75. Ans.(b)
Sol.
✅ Option (b) is correct because both the assertion and reason are true, but the reason does not directly explain the assertion.
The Assertion is correct: Since the genetics of salinity resistance is complex and not fully understood, yield performance under saline conditions is often used as a practical measure of resistance.
The Reason is also correct: In fruit crops like grapes and citrus, polygenic inheritance of salt resistance involves both additive and non-additive gene actions, influencing the trait's expression.
However, the reason (R) does not explain why yield is used as the primary criterion in studying salinity resistance—it only explains the genetic basis in certain crops.
❌ Option (a) is incorrect because R does not justify A. ❌ Option (c) and (d) are incorrect because both statements are factually true.
Conclusion: The correct answer is Option (b) – Both A and R are true, but R is not the correct explanation of A.

S76. Ans.(b)
Sol.
✅Zea mexicana (syn. Euchlaena mexicana) is an annual grass species closely related to maize (Zea mays) and is native to Mexico.
It is commonly found as a weed in maize fields and produces multiple basal tillers, unlike cultivated maize.
It readily crosses with maize, and the resulting hybrids are fertile, indicating close genetic similarity.
This species is often used as fodder due to its robust vegetative growth.
❌Option (a) Brazil, (c) Peru, and (d) Argentina are major agricultural regions, but not the native habitat of Zea mexicana.

S77. Ans.(b)
Sol.
✅Transcription is the process where the DNA sequence of a gene is copied into messenger RNA (mRNA).
This takes place in the nucleus of eukaryotic cells and is the first step in protein synthesis.
Transcription allows for the amplification of genetic information, as multiple mRNA copies can be produced from a single DNA sequence.
❌Option (a) Translation: This is the second step, where the mRNA is used to build a protein.
❌Option (c) Replication: Refers to copying DNA to DNA, not DNA to RNA.
❌Option (d) Splicing: A post-transcriptional process where introns are removed from the pre-mRNA.

S78. Ans.(b)
Sol.
Genetic gain: Genetic gain refers to the improvement in the phenotypic traits of the progeny when compared to the original population after selection. It is essentially the difference between the average phenotypic values of the progeny (resulting from selected parents) and the original population. This is a direct measure of how much improvement has been achieved through the selection process in breeding programs. Genetic gain is crucial in evaluating the effectiveness of a breeding strategy, as it shows the phenotypic improvement in the next generation.
Genetic gain measures the improvement in the traits of the progeny as compared to the initial population, helping breeders gauge the success of selection. It is typically expressed in terms of increased yield, better quality, or other improved traits in the offspring. Genetic gain is the primary goal of selection as it represents phenotypic improvement across generations in a breeding program.
❌ Option (a): Genetic advance refers to the actual genetic improvement or the response to selection from a particular breeding program, often used synonymously with genetic gain but not precisely the same in this context.
❌ Option (c): Selection differential refers to the difference between the mean phenotype of selected individuals and the mean of the population from which they were selected, but it does not describe the genetic improvement observed in the progeny.
❌ Option (d): This is incorrect because the correct answer is Genetic gain (option b), as it specifically addresses the difference in phenotypic values between the progeny and the original population.

S79. Ans.(c)
Sol.
✅Assertion (A) is true: SSD method involves advancing generations quickly by selecting a single seed from each plant. This technique accelerates inbreeding and homozygosity in self-pollinated crops.
❌Reason (R) is false: SSD does not use multiple seeds per plant. It specifically relies on advancing only one seed per plant to the next generation, which helps reduce the impact of natural selection and keeps the process simple and fast.
✓ Hence, the correct answer is: (c) A is true, but R is false

S80. Ans.(c)
Sol.
✅In the cis-trans test, if complementation occurs (i.e., the wild-type phenotype appears), it means that each mutation is in a different cistron (functional gene unit).
Trans position: Mutations are on different homologous chromosomes.
If no complementation (mutant phenotype appears), the mutations lie in the same cistron.
If complementation occurs (wild-type phenotype), the mutations lie in different cistrons — each functional copy complements the defect of the other.
❌Option (a) is incorrect — if both mutations are in the same cistron, no complementation occurs.
❌Option (b) is unrelated — dominance doesn't determine complementation.
❌Option (d) mixes genetic dominance with the concept of gene function, which is not the focus of the cis-trans test.

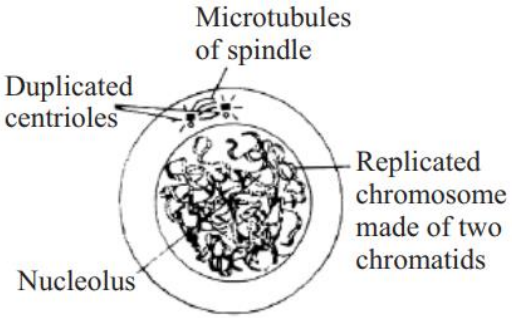
S81. Ans.(c)
Sol.
✅ Option (c) is correct because shot-gun sequencing works by randomly selecting and sequencing clones from a genomic library. These sequences are then assembled using computer software to reconstruct the genome. This method was first used to sequence Haemophilus influenzae and later applied to many eukaryotic genomes, including Drosophila and humans.
❌ Option (a) is incorrect as no protein synthesis is involved. ❌ Option (b) is incorrect because contigs are not pre-aligned like in clone-by-clone sequencing. ❌ Option (d) is incorrect as shot-gun sequencing has been used for both prokaryotic and eukaryotic genomes.
Conclusion: The correct answer is Option (c) – Random sequencing.

S82. Ans.(b)
Sol.
✅Haploid refers to a cell or organism that has a single set of chromosomes, represented by n. This is the gametic chromosome number found in gametes (sperm and egg) and certain organisms or tissues, like some plants or algae, which naturally exist in a haploid state.
Haploid cells are produced through meiosis, reducing the chromosome number by half to ensure that when two gametes fuse during fertilization, the diploid chromosome number is restored.
❌ Option (a): Two sets of chromosomes describe diploid (2n), not haploid.
❌ Option (c): This would describe tetraploidy or a polyploid state, not haploidy.
❌ Option (d): Polyploid organisms have multiple sets of chromosomes, not a single set as in haploid.
⁉️ Haploid cells are essential in sexual reproduction and also used in plant breeding to develop haploid plants that are useful for genetic studies.

S83. Ans.(c)
Sol.
✅Heterosis, also known as hybrid vigour, is the phenomenon where the F_1 hybrid shows superior performance in one or more traits (like yield, growth rate, disease resistance, or adaptability) compared to its parents.
This effect is the result of dominance, overdominance, or epistasis of certain gene combinations that occur only in the F_1 generation. These combinations are temporarily fixed in the F_1 but break apart during segregation in the next generations.
In the F_2 generation and beyond, genetic recombination leads to a breakdown of the favorable gene combinations, resulting in reduced performance compared to F_1.
❌ (a) F_2 generation: Shows segregation and loss of uniformity, thus reducing hybrid vigour.
❌ (b) Parent generation: Is the baseline used to evaluate heterosis — it does not show hybrid vigour itself.
❌ (d) Backcross generation: Used to recover parent traits or introduce specific genes, but does not maintain full heterosis as in F_1.

S84. Ans.(c)
Sol.
✅ Option (c) is correct – Descriptors are the standardized set of traits and parameters used to evaluate and document germplasm accessions. These descriptors are crop-specific and include morphological, agronomic, physiological, and biochemical traits, allowing scientists to uniformly assess and compare germplasm across different regions and institutions.
The use of descriptors ensures that evaluation data is consistent, reproducible, and internationally accepted. Organizations like IBPGR (now Bioversity International) have developed descriptor lists for a wide range of crops.
❌ Option (a) is incorrect as a basic record contains general data, not specific evaluation criteria. ❌ Option (b) refers to records of the germplasm itself, not how it's evaluated. ❌ Option (d) – Field notes are informal and may vary; they are not standardized descriptors.
Conclusion: The correct answer is Option (c) – Descriptors.

S85. Ans.(d)
Sol.
✅Early prophase is the correct answer because:
It is the first stage of mitosis where chromatin begins to condense into visible chromosomes.
Centriole duplication occurs prior to mitosis, and in early prophase, the two centrioles begin migrating towards opposite poles of the nucleus.
Chromosomes appear as thin, long threads and start coiling and shortening, becoming more distinct.



The nuclear membrane is still intact at this stage, and spindle fibers begin to form around centrioles.

S86. Ans.(b)
Sol.
✅ Option (b) is correct – After a variety is identified and released, it must be notified by the Director of High Yielding Varieties (HYV), Ministry of Agriculture, GOI. Notification is a legal step, which permits public sector agencies to carry out seed multiplication and distribution. Without notification, even a released variety cannot be officially marketed or supplied through certified seed programs.
❌ Option (a) is incorrect – Fertilizer subsidies are unrelated to the varietal notification process. ❌ Option (c) is incorrect – Export policies are governed separately and do not depend on varietal release.
❌ Option (d) is incorrect – GST exemptions are not linked to the notification of crop varieties.
Conclusion: The correct answer is Option (b) – Public seed multiplication and distribution.

S87. Ans.(a)
Sol.
✅ Option (a) is correct – Base collections are maintained under long-term storage conditions (typically at –18°C or lower) and are meant to conserve genetic material for 50 years or more without loss of viability. These are stored in gene banks and used primarily for safety backup, not frequent distribution.
❌ Option (b) – Active collections are maintained for medium-term storage and are used frequently for evaluation, multiplication, and distribution. ❌ Option (c) – Working collections are held by breeders for immediate use in breeding programs and are not intended for long-term conservation. ❌ Option (d) is incorrect as only base collections are specifically designed for long-term storage.
Conclusion: The correct answer is Option (a) – Base collection.

S88. Ans.(c)
Sol.
✅ Option (c) is correct because the formation of new biotypes of insects leads to the breakdown of existing resistance in host plants. This directly affects the durability of resistance, making previously resistant varieties susceptible. New insect biotypes can arise due to spontaneous mutations or hybridization. Though their formation rate is generally lower than that of fungal or bacterial races, they still pose a significant challenge in crops, especially in aphids, nematodes, and Hemipterans.
❌ Option (a) is incorrect because biotypes do not directly influence flowering traits. ❌ Option (b) is incorrect as seed production is more affected by overall plant health, not insect biotypes alone. ❌ Option (d) is incorrect since root development is not the primary target of biotype evolution discussed here.
Conclusion: The correct answer is Option (c) – Resistance durability.

S89. Ans.(b)
Sol.
✅Full sib refers to the progeny of the mating of two individuals who have both parents in common. These individuals are considered full siblings because they share both the mother and the father.
In genetics, full sibs have the highest genetic relatedness compared to half sibs, because they share 50% of their genetic material from both parents.
❌ Option (a): Half sibs share only one parent in common. They are related by only one parental side.
❌ Option (c): Crossbred refers to the offspring of two different breeds or species, not the same parent combination.

❌ Option (d): Hybrid generally refers to the offspring from a cross between different species or varieties, which is not related to the concept of sibs.
Full sibs are genetically more related than half sibs because they share both their parents, making them essential for studying inheritance patterns.

S90. Ans.(c)
Sol.
✅ Option (c) is correct – Field inspections are an essential part of seed certification. These inspections ensure that the seed crop conforms to the minimum standards of varietal purity, isolation, off-types, and pest/disease presence. The inspections are conducted by Seed Inspectors appointed by the State Seed Certification Agency (SSCA).
These inspectors are trained to evaluate the crop in different growth stages and recommend whether it qualifies for certification.
❌ Option (a) – Seed analysts work in labs, not in field inspections. ❌ Option (b) – Extension officers provide advisory services, not certification. ❌ Option (d) – While certification officers are involved in the process, seed inspector is the correct technical designation for this role.
Conclusion: The correct answer is Option (c) – Seed inspector.

S91. Ans.(a)
Sol.
✅ DNA inserted into plasmids, phages, or viruses for cloning: Recombinant DNA technology involves joining DNA segments from different organisms by inserting the desired DNA fragment into a vector (like a plasmid, phage, or virus) for cloning in an appropriate host. This is facilitated by specific enzymes for cutting DNA.
❌ Option (b) – Using a single organism's DNA: This is not recombinant DNA technology, as the technique involves the joining of DNA from different organisms.
❌ Option (c) – Cutting DNA without enzymes: Enzymes are essential for cutting and joining DNA in recombinant DNA technology. Cutting DNA without them is not a valid approach.
❌ Option (d) – Isolating fragments with no vectors: Vectors are crucial in recombinant DNA technology to insert and clone foreign DNA. Without vectors, this process would not be feasible.

S92. Ans.(c)
Sol.
✅ Option (c) is correct because genome sequencing starts by breaking the genomic DNA into random fragments. These fragments are usually small (500–600 base pairs) and must overlap with each other. This overlap is crucial to correctly assemble the entire genome sequence. The fragments are then cloned into vectors, forming a genomic library, which is essential for producing multiple copies of each piece for sequencing.
Two major methods—clone-by-clone sequencing and shotgun sequencing—both begin with the creation of a genomic library. Sequencing larger genomes (like humans) requires millions of such small pieces, which are sequenced individually and then assembled computationally.
❌ Option (a) is incorrect because protein tagging is not part of genome sequencing. ❌ Option (b) is incorrect since genome sequencing uses genomic DNA, not cDNA. ❌ Option (d) is incorrect as RNA is not used in sequencing the genome.
Conclusion: The correct answer is Option (c) – DNA fragmentation.

S93. Ans.(c)
Sol.
✅Inbreeding depression is the decline in vigour, fitness, and productivity resulting from mating between closely related individuals, which leads to:
Increased homozygosity
Expression of harmful recessive alleles
Loss of genetic diversity
It is measured by the inbreeding coefficient, and commonly observed in self-pollinated crops or small breeding populations.
❌Option (a) is incorrect: Inbreeding reduces heterozygosity.
❌Option (b) describes the basis of heterosis, not inbreeding depression.
❌Option (c): Dominant alleles are not the cause of inbreeding depression; it's usually the expression of recessive deleterious alleles.
Key Contrast:
Inbreeding Depression = ↓ Heterozygosity → ↓ Vigour
Heterosis = ↑ Heterozygosity → ↑ Vigour

S94. Ans.(c)
Sol.
✅ Option (c) is correct – Adaptive Research Trials (ART) are conducted directly at farmers' fields under real farming conditions. These trials help assess how promising crop varieties or entries perform in actual environments outside research stations. ART is jointly coordinated by TNAU scientists and Agricultural Department staff, and the entries for these trials are finalized during the Scientific Workers Conference (SWC) held annually at TNAU.
Each selected entry must be tested in at least 50 locations across the state. For non-season bound cultures, testing is done in all three seasons (e.g., samba, kuruvai, and navarai), while season-bound cultures require only one or two seasonal trials. The entries performing well in ART may be proposed for varietal release.
❌ Option (a) is incorrect – University farms are used for station trials, not ART. ❌ Option (b) is incorrect – ART is field-based, not conducted under controlled laboratory conditions. ❌ Option (d) is incorrect – Seed certification centres are not involved in conducting ART.
Conclusion: The correct answer is Option (c) – At farmers' fields.

S95. Ans.(c)
Sol.
✅ Option (c) is correct because gene tagging is a method used to identify disrupted genes by inserting T-DNA or transposons into plant genomes. These mobile genetic elements randomly integrate into genes, causing mutations. The resulting phenotypic changes in mutant lines provide clues about the gene's function. Using the known T-DNA or transposon sequence as a probe, the disrupted gene can be isolated and studied from the genomic library.
❌ Option (a) is incorrect as restriction enzymes cut DNA but are not used in gene tagging directly. ❌ Option (b) is incorrect since RNA probes are not used for tagging disruptions. ❌ Option (d) is incorrect because ribosomes are involved in protein synthesis, not gene tagging.
Conclusion: The correct answer is Option (c) – T-DNA or transposons.

S96. Ans.(c)
Sol.
✅Option (c) - Dominant hypothesis: The dominant hypothesis, first proposed by Davenport in 1908 and later expanded by Bruce, Keeble, and Pellow, suggests that at each locus, the dominant allele has a favorable effect while the recessive allele has an unfavorable effect. According to this hypothesis, when alleles are in a heterozygous state, the negative effects of the recessive allele are masked by the dominant allele. Inbreeding depression occurs because inbreeding causes the recessive alleles to become homozygous, leading to the expression of their harmful effects.
❌ Option (a) - Inbreeding hypothesis: The inbreeding hypothesis is related to the effects of inbreeding but does not specifically describe the relationship between dominant and recessive alleles as explained in the dominant hypothesis.
❌ Option (b) - Recessive hypothesis: The recessive hypothesis would suggest that the recessive alleles are the primary drivers of inbreeding depression, but the dominant hypothesis emphasizes the dominant allele's favorable effect and its role in masking the recessive allele's negative impact.
❌ Option (d) - Heterosis hypothesis: The heterosis hypothesis involves hybrid vigor and does not focus on the dominance-recessive relationship described in the dominant hypothesis.

S97. Ans.(c)
Sol.
✅Asia Minor (modern-day Turkey and surrounding regions) is considered the center of origin for diploid wheat species like Triticum monococcum (einkorn wheat).
Diploid wheats have 2 sets of chromosomes (2n = 14) and represent the earliest domesticated forms of wheat.
❌Option (a) Ethiopia: Known as the center of origin for crops like coffee and some tetraploid wheats, but not diploid wheat.
❌Option (b) Central Asia: More associated with barley and legumes, not the primary center for diploid wheat.
❌Option (d) Indo-Gangetic Plains: Major cultivation region, but not the origin of diploid wheat.

S98. Ans.(b)
Sol.
✅Comparative mapping involves studying how genomes relate across species, genera, or families. This is typically done by using RFLP (Restriction Fragment Length Polymorphism) markers, which were among the first markers used to compare linear orders of marker loci between related species.
RFLP markers allow researchers to identify conserved gene arrangements that are shared between species, helping in the understanding of genetic evolution and the conservation of certain genomic regions.
❌ Option (a): While DNA sequencing is important, comparative mapping specifically uses markers like RFLP to identify conserved loci.
❌ Option (c): Phenotypic traits are not used for genomic comparisons in comparative mapping; it's about genomic structure.
❌ Option (d): Protein markers are useful in protein studies, but comparative mapping relies on genomic markers like RFLP.
⁉️ Comparative mapping plays a crucial role in genomic research, crop breeding, and understanding evolutionary biology.

S99. Ans.(c)
Sol.

✅In semi-conservative replication, each of the two parental DNA strands separates and serves as a template to synthesize a new complementary strand.
As a result, each daughter DNA molecule contains one old (parental) strand and one new strand, preserving half of the original molecule — hence the term "semi-conservative."
This mechanism was first proposed by Watson and Crick, and later experimentally confirmed by Meselson and Stahl.
❌Option (a): Incorrect — the two strands do not stay paired during replication.
❌Option (b): Incorrect — both strands act as templates, not just one.
❌Option (d): Incorrect — base pairing is essential for accurate DNA replication.

S100. Ans.(d)
Sol.
✅ (a) Correct statement:
In anaphase, the centromeres divide, allowing sister chromatids to separate and become individual chromosomes.
✅ (b) Correct statement:
Spindle fibres contract, pulling chromosomes toward opposite poles via the centromere, a key feature of anaphase.
✅ (c) Correct statement (with nuance):
Although cytokinesis is technically a separate process, it often begins during late anaphase, especially in animal cells (cleavage furrow) and plant cells (cell plate formation).
(d) Incorrect statement:
In anaphase, chromosomes do not remain at the equator. Instead, they move to opposite poles, which is the defining action of this phase.
Hence, this is the only incorrect statement, making it the correct answer for the question.

S101. Ans.(c)
Sol.
✅Hybridization is a fundamental plant breeding technique that involves crossing genetically dissimilar plants to:
Combine desirable traits (e.g., disease resistance, yield, drought tolerance) from different parents into a single genotype
Create genetic variability for economic traits
Develop hybrid varieties suitable for commercial cultivation
❌Option (a) is incorrect: Hybridization aims to increase, not eliminate, genetic variability.
❌Option (b) is incorrect: Landraces are traditional varieties, not the direct product of hybridization.
❌Option (d) is incorrect: The goal is to create fertile, productive hybrids, not sterile ones.

S102. Ans.(d)
Sol.
✅All of these: The estimation of breeding value involves several techniques, as each technique offers a different way of assessing the genetic potential of an individual. In this context, all the options listed are valid techniques that can be used to estimate the breeding value in breeding programs:
Mean deviation is used to estimate how far an individual's trait is from the mean of the population, helping in the determination of how much genetic potential that individual may contribute to the offspring.
Regression analysis helps in quantifying the relationship between an individual's genetic value and its observed performance, which is essential for determining the genetic worth or breeding value.
Combining ability assesses the potential of an individual to combine with others in hybrid crosses. This is important when selecting parents with superior breeding value.
❌ Option (a) - Mean deviation: This is just one of the techniques, but it alone does not cover all the aspects of estimating breeding value, which requires a more comprehensive approach.
❌ Option (b) - Regression analysis: While regression analysis is useful in estimating the relationship between traits and genetic value, it is not the only technique used to estimate breeding value.
❌ Option (c) - Combining ability: This technique evaluates the potential of individuals to contribute to the next generation's performance but does not give a complete picture of breeding value estimation on its own.

S103. Ans.(c)
Sol.
✅In hybrid breeding, when one CMS (Cytoplasmic Male Sterile) line is crossed with a male fertile (BMF) inbred, a single cross hybrid (AB MS) is produced.
Then, this hybrid is crossed with a second single cross hybrid formed from two inbreds with dominant restorer genes (MF R) to produce a double cross hybrid.
The presence of dominant restorer genes (R) ensures that the final double cross hybrid is male fertile, which is essential for successful pollination and seed production in the field.
❌Option (a): Incorrect, because the purpose of using restorer genes is to avoid sterility.
❌Option (b): Though heterozygous, the hybrid is fertile due to restorer genes.
❌Option (d): Clonal propagation is unrelated here; hybrids are not clonal and sterility is corrected.
⁉️ This method is commonly used in commercial hybrid seed production, especially in maize and pearl millet.

S104. Ans.(b)
Sol.
✅Gene prediction is the process of identifying genes within a genome sequence using tools such as sequence alignment programs. These programs compare closely or distantly related genomes to detect local similarities in sequences, helping to identify gene locations and structures.
Comparative genomics allows for more accurate predictions by leveraging sequence data from closely related species, such as the mouse genome helping to improve the prediction of human genes.
❌ Option (a): While protein sequences provide useful information, gene prediction primarily relies on DNA sequence alignment, not protein data alone.

❌ Option (c): Phenotypic traits are not directly involved in the process of gene prediction, which is based on sequence similarity.
❌ Option (d): Gene expression data is important in understanding gene function but is not the main tool used for predicting gene locations in a genome.
⁉️ Comparative genomics and sequence alignment are essential in genome annotation and functional genomics.

S105. Ans.(c)
Sol.
✅ Option (c) is correct because RAPD (Random Amplified Polymorphic DNA) takes significantly less time than RFLP. According to the data, RFLP takes about 5 times more time than RAPD due to multiple steps like DNA digestion, probe preparation, hybridization, and detection.
❌ Option (a) is incorrect because RAPD needs much less DNA (>10 ng) compared to RFLP (2–10 µg).
❌ Option (b) is incorrect since RAPD does not use radioisotopes, whereas RFLP does. ❌ Option (d) is incorrect because RAPD uses random base sequences, not specific probes.
Conclusion: The correct answer is Option (c) – Less time.

S106. Ans.(c)
Sol.
✅ Option (c) is correct – The Z-test is appropriate when the sample size is large ($n > 30$), and the population standard deviation (σ) is known. It assumes that the sampling distribution of the mean is approximately normal due to the Central Limit Theorem.
❌ Option (a) and (b) are incorrect – For small samples, the t-test is used instead of the Z-test. ❌ Option (d) is incorrect – $n = 25$ is still considered borderline small and usually evaluated using the t-distribution unless population variance is known and normality is ensured.
Conclusion: The correct answer is Option (c) – Large ($n > 30$).

S107. Ans.(b)
Sol.
✅Option (b) Broad sense heritability: Broad sense heritability (H) is defined as the ratio of genotypic variance to total phenotypic variance, represented as $H = \sigma^2g / \sigma^2p$. This measure includes all types of genetic variance (additive, dominance, and interaction variances).
❌ Option (a) Real sense heritability: Real sense heritability is the ratio of additive genetic variance to total phenotypic variance and does not include other types of genetic variance.
❌ Option (c) Additive genetic variance: This is one component of genetic variance, not the heritability measure.
❌ Option (d) Phenotypic variance: This is the denominator in the formula for both broad sense and real sense heritability, not the type of heritability.

S108. Ans.(c)
Sol.
✅Statement I is correct but Statement II is incorrect:
Statement I is correct because eukaryotic cDNAs are synthesized from mRNA and therefore do not contain introns. They are smaller than the corresponding genes because they only represent the exonic (coding) regions of the gene.

Statement II is incorrect. While cDNA libraries are enriched for abundant mRNAs, they often contain only a few clones representing rare mRNAs. Therefore, they are not equally representative of both abundant and rare mRNAs.

❌ Option (a) – Both Statement I and Statement II are correct: This is incorrect because Statement II is not correct as explained.

❌ Option (b) – Both Statement I and Statement II are incorrect: This is incorrect because Statement I is accurate.

❌ Option (d) – Statement I is incorrect but Statement II is correct: This is incorrect because Statement I is accurate.

S109. Ans.(c)

Sol.

✅ Option (c) – Genes act independently without any interaction (no epistasis) Mather's method assumes no epistatic interaction, meaning different genes do not influence each other's expression. This assumption simplifies the model, allowing the estimation of three key genetic components:

Additive variance (D)

Dominance variance (H)

Environmental variance (E)

❌ Option (a) is incorrect because epistasis is *excluded* in this model to simplify the analysis. ❌ Option (b) is wrong as data from multiple generations (P_1, P_2, F_1, F_2, backcrosses) is required—not just F_1. ❌ Option (d) is incorrect since additive and dominance variances are also central to the analysis, not just environmental variance.

Conclusion: Mather's 1949 model helps partition genetic and environmental contributions to trait variation only under the assumption that there is no epistasis, making Option (c) the correct choice.

S110. Ans.(a)

Sol.

✅ Option (a) is correct – The correlation coefficient (r) measures the strength and direction of a linear relationship between two variables. Its value always lies between –1 and +1:

+1 indicates perfect positive correlation

–1 indicates perfect negative correlation

0 indicates no linear correlation

❌ Options (b), (c), and (d) are incorrect because they either ignore negative values or imply incorrect boundaries.

Conclusion: The correct answer is Option (a) – –1 to 1.

S111. Ans.(c)

Sol.

✅Lethal genes are those that cause the death of the organism when present in the homozygous condition (e.g., AA or aa, depending on whether it's dominant or recessive lethal).

Mendel's classical monohybrid cross gives a 3:1 ratio, assuming all genotypes survive.

However, in the presence of a lethal gene, one genotype (usually homozygous) does not survive, and the expected 3:1 phenotypic ratio is modified.

For example, when two heterozygotes (Aa × Aa) are crossed:

Genotypic ratio: 1 AA : 2 Aa : 1 aa

If AA is lethal and results in death, we observe only 2 Aa : 1 aa in the living offspring.

Hence, the modified phenotypic ratio becomes 2:1, which is a hallmark of lethal gene expression.

S112. Ans.(b)
Sol.
✅ Option (b) is correct because the FlavrSavr tomato was genetically engineered using an antisense gene construct to reduce the expression of the enzyme polygalacturonase (PG). PG degrades pectin, a key component of the fruit cell wall. This degradation causes softening of fruits and leads to reduced shelf life. By suppressing PG activity, FlavrSavr tomatoes show slower softening and longer shelf life (about 2 weeks more than normal tomatoes). This also allows fruits to ripen naturally on plants, improving taste and total soluble solids (TSS).
❌ Option (a) is incorrect because FlavrSavr tomatoes ripen slower, not faster. ❌ Option (c) is incorrect as seed production is not the target trait here. ❌ Option (d) is incorrect since FlavrSavr avoids reliance on ethylene-based artificial ripening used in conventional tomatoes.
Conclusion: The correct answer is Option (b) – Reduce PG activity.

S113. Ans.(d)
Sol.
✅Option (d) – A is false, but R is true
The reason is correct. The North Carolina Designs I, II, and III are widely used for estimating additive genetic variance (σ^2A) and dominance variance (σ^2D) from segregating F_2 populations, which are genetically diverse and derived from crossing two contrasting purelines.
❌ The assertion is incorrect because the F_2 population is not genetically uniform. It is heterogeneous, resulting from segregation of different alleles in the F_1. Hence, while biparental mating does produce full-sib and half-sib families, it does not originate from a genetically uniform F_2 population.

S114. Ans.(c)
Sol.
✅ Option (c) is correct – Shoot tip bank is an Ex situ conservation method used specifically for vegetatively propagated crops or crops that do not produce viable seeds, such as banana, potato, sugarcane, and some tuber crops. In this method, shoot tips or meristematic tissues are preserved under controlled conditions (like slow growth or cryopreservation), allowing for long-term storage and later regeneration.
❌ Option (a) is incorrect – Seed banks are ideal for crops that produce orthodox seeds (which can be dried and stored). ❌ Option (b) – Field banks maintain plants in field conditions but are more vulnerable to pests, diseases, and climate. ❌ Option (d) – DNA banks store genetic material for research, but cannot regenerate whole plants.
Conclusion: The correct answer is Option (c) – Shoot tip bank.

S115. Ans.(c)
Sol.
✅Nullisomics refer to diploid organisms that have lost a pair of homologous chromosomes. The genomic formula for nullisomics is 2n - 2, where n represents the number of chromosomes in a typical diploid organism.
This condition leads to chromosomal imbalance and can result in genetic and developmental abnormalities because the organism is missing critical genetic material from the two missing chromosomes.

❌ Option (a): Monosomics have only one chromosome from a pair instead of two, i.e., 2n - 1.
❌ Option (b): Trisomics have an extra chromosome, i.e., 2n + 1.
❌ Option (d): Tetrasomics have four copies of a chromosome pair, i.e., 2n + 2.
⁉️ Nullisomics are used in genetic studies to understand the roles of individual chromosomes and their contribution to the organism's phenotype.

S116. Ans.(c)
Sol.
✅ Option (c) is correct – The correlation coefficient (r) is a pure number that is not affected by changes in the origin or scale of the variables.
Change of origin means shifting data (e.g., adding/subtracting a constant)
Change of scale means multiplying or dividing data by a constant
Since correlation only measures the relative variation between two variables, these operations do not affect the value of r.
Conclusion: The correct answer is Option (c) – Change of origin and scale.

S117. Ans.(a)
Sol.
✅Animal breeding: Breeding value refers to the genetic quality of an individual that is passed on to its offspring. In animal breeding, breeding value is commonly used to evaluate and select individuals that are expected to pass on desirable traits to their progeny. This is especially significant in livestock breeding, where selecting individuals with high breeding value ensures that beneficial genetic traits, such as higher milk production, better growth rate, or improved disease resistance, are transmitted to the next generation.
Breeding value in animals is often calculated based on the individual's performance in relation to others in the population, and it's a crucial aspect in improving specific traits like milk yield, meat quality, or wool production in animal breeding programs.
❌ Option (b) - Plant breeding: While breeding value is important in plant breeding, it is less commonly used than in animal breeding. In plant breeding, other factors like hybrid vigor, genetic diversity, and trait stability are also considered, and the use of breeding value is less direct when compared to animal breeding.
❌ Option (c) - Both animal and plant breeding equally: While breeding value is used in both animal and plant breeding, it is more commonly utilized in animal breeding because it is easier to evaluate and apply in controlled breeding programs for animals compared to the more complex genetic systems in plants.
❌ Option (d) - None of the above: This is incorrect as breeding value is indeed used in animal breeding, making Option (a) the correct answer.

S118. Ans.(b)
Sol.
✅Polytene chromosomes are large, multi-stranded chromosomes that form as a result of endomitosis or endoreduplication, where the chromosomes replicate repeatedly without separation of chromatids and without cell division.
They were first discovered by E.G. Balbiani in 1882 in the salivary glands of Dipteran insects (e.g., Drosophila) and are also called salivary gland chromosomes.

Polytene chromosomes are useful for cytogenetic studies due to their large size and distinct banding patterns, allowing gene activity and chromosomal rearrangements to be visualized.

❌Option (a): Lampbrush chromosomes are found in amphibian oocytes, not Dipteran glands.

❌Option (c): B-chromosomes are extra chromosomes not essential for normal development.

❌Option (d): Metacentric chromosomes are classified by centromere position, not replication behavior.

The condition of forming polytene chromosomes is called polyteny, and it's crucial for active transcription in certain specialized cells.

S119. Ans.(c)

Sol.

✅In the bulk breeding method, the first step is the bulking period, where F_1 plants are grown, and seeds from F_2 to F_5 generations are harvested in bulk.

During this period, plants are exposed to natural selection pressures (biotic and abiotic), allowing elimination of undesirable genotypes without manual selection.

This helps increase the level of homozygosity and retains naturally selected superior types.

❌Option (a) is incorrect: Multilocation trials are done after superior progeny is identified.

❌Option (b) is incorrect: The process aims for homozygosity, not selection of heterozygotes.

❌Option (d) is incorrect: F_1 is never released directly as a variety; it is too genetically variable.

S120. Ans.(c)

Sol.

✅Raphanobrassica is an artificially synthesized alloploid, meaning it is a hybrid with complete chromosome sets from two different species.

It was developed by Russian geneticist Karpechenko in 1928 by crossing:

Radish (Raphanus sativus, n = 9)

Cabbage (Brassica oleracea, n = 9)

Initially, the hybrid was sterile due to the absence of homologous chromosome pairing, but chromosome doubling restored fertility, forming a stable alloploid.

The goal was to combine useful traits of both species into a fertile, stable hybrid, demonstrating a key method in plant evolutionary genetics and crop improvement.

❌Option (a): Autopolyploid involves duplication of chromosomes from the same species, not different ones.

❌Option (b): Aneuploids have an abnormal number of chromosomes, not full sets from different species.

❌Option (d): Haploids have only one set of chromosomes, unrelated to this context.

Key point: Alloploids are vital in creating new species and improving crops through wide hybridization and polyploidy.

S121. Ans.(b)

Sol.

✅Hybrid inviability refers to the inability of a hybrid zygote to develop into a normal embryo under the typical conditions of development. This occurs when the genetic material from the two parents is incompatible, causing the embryo to fail to grow or develop properly.

Hybrid inviability is one of the barriers to distant hybridization, where the genetic differences between the species or genera involved may cause failure in early development.

❌ Option (a): Hybrid inviability specifically refers to the inability of the hybrid to develop properly into a normal embryo, not simply the absence of viable offspring.
❌ Option (c): Hybrid inviability does not refer to the stability of the hybrid plant but rather to its developmental failure.
❌ Option (d): This option talks about the maturity of the organism but does not accurately define hybrid inviability, which refers to early developmental issues.
Hybrid inviability is a crucial concept in plant breeding and hybridization, helping to explain why some hybrid crosses fail to produce viable or fertile offspring.

S122. Ans.(c)
Sol.
✅ Option (c) is correct because one of the three major goals of the Human Genome Project was to sequence the entire human genome, especially the euchromatic region, which is about 3.2 billion base pairs long. By 2001, 93.5% had been sequenced, though only 32.5% was in finished form. The finished sequence had high accuracy and was repeated 8–9 times to ensure correctness.
❌ Option (a) is incorrect as vaccine development was not part of HGP's main goals. ❌ Option (b) is incorrect because engineering artificial chromosomes wasn't a focus. ❌ Option (d) is incorrect since the project was about the human genome, not crops.
Conclusion: The correct answer is Option (c) – Sequence the entire human genome.

S123. Ans.(a)
Sol.
✅ Option (a) is correct because each morphological character is specifically associated with drought resistance as follows:
A. Leaf rolling → 1: Reduces transpiration by minimizing exposed leaf area; helps conserve water.
B. Hairy leaves → 2: Trap air and reflect light, thereby lowering leaf temperature and reducing water loss.
C. Deep roots → 3: Access water from deeper soil layers, especially important under drought stress.
D. Early maturity → 4: Allows the plant to complete its lifecycle before severe drought, thus escaping drought.
❌ Other options mismatch trait-function pairs based on the content.
Conclusion: The correct answer is Option (a) – A–1, B–2, C–3, D–4.

S124. Ans.(b)
Sol.
✅Cytological maps provide visual evidence that genes are arranged in a linear fashion along chromosomes. These maps are created by studying chromosome banding patterns under a microscope and correlate physical landmarks with gene locations, supporting the theory that genes follow a linear arrangement on chromosomes.
Cytological evidence has been crucial in confirming genetic models and understanding how genes are inherited during cell division.
❌ Option (a): While DNA sequencing helps in identifying gene sequences, it doesn't directly confirm the linear arrangement of genes on chromosomes.

❌ Option (c): Gene expression analysis studies the activity of genes, but it does not provide information about their physical arrangement on chromosomes.
❌ Option (d): Protein profiling is used for studying protein expression and not for confirming the linear order of genes on chromosomes.
Cytological maps play a key role in confirming chromosomal structures and genetic theories.

S125. Ans.(d)
Sol.
✅Somatic hybridization can result in various types of hybrids:
Symmetrical hybrids are when both parents contribute equally to the offspring.
Asymmetrical hybrids occur when one parent contributes more significantly than the other.
Cybrids refer to hybrids where the cytoplasm of one parent and the nucleus of another are combined.
Therefore, all of these (Option d) can result from somatic hybridization.

S126. Ans.(c)
Sol.
✅ Double trisomics refers to a condition where an organism possesses two extra chromosomes, but each is different from the other. This is written as 2n + 1 + 1.
For example, if the normal diploid set is ABC, a double trisomic would have ABC, ABC, AB — indicating two different trisomic conditions in one organism.
❌Option (a) describes nullisomy or a type of monosomy, where a pair of chromosomes is lost.
❌Option (b) would imply the addition of the same chromosome twice, leading to tetrasomy, not a double trisomic.
❌Option (d) represents polyploidy (e.g., tetraploidy or 4n), which is not an example of aneuploidy.
Aneuploidy refers to the gain or loss of one or a few chromosomes, not whole sets.

S127. Ans.(c)
Sol.
✅The term "ideotype" was first proposed by C.M. Donald in 1968 while working on wheat.
A crop ideotype refers to an ideal plant type or model expected to perform optimally in a specific environment. It is biologically designed to produce higher yield of grain, fibre, oil, or any other useful economic product.
Ideotype breeding involves genetic manipulation of individual traits of a plant to achieve this ideal model, thus enhancing genetic yield potential.
❌Option (a): Norman Borlaug is known for his work in semi-dwarf wheat and the Green Revolution, but not for coining the term ideotype.
❌Option (b) and (d): These scientists contributed to breeding genetics but did not define or propose the ideotype concept.
This concept forms the basis for modern breeding programs aiming at trait-specific crop improvement tailored to defined agro-climatic conditions.

S128. Ans.(c)
Sol.
✅Option (c) More than 60%: According to Johnson et al. (1955a), a high heritability value is categorized as more than 60%. This means that the genetic factors contribute more significantly to the trait compared to environmental factors.
❌ Option (a) Less than 30%: This value is categorized as low heritability, meaning environmental factors have more influence on the trait than genetic factors.
❌ Option (b) 30 - 60%: This value is considered moderate heritability, indicating a balanced influence of genetic and environmental factors.
❌ Option (d) No categorization: This option is incorrect since heritability values are categorized based on percentages.

S129. Ans.(c)
Sol.
✅Statement I and IV are correct:
Statement I is correct because a vector must replicate autonomously in the host cell to produce multiple copies of the DNA insert.
Statement IV is also correct because a vector should ideally be smaller than 10 kb to avoid complications during purification and DNA manipulation, which large vectors can cause.
❌ Option (a) – Statement I, III, and IV are correct: Statement III is incorrect because the vector replication should not be under strict control; it needs to be relaxed to allow replication and copying of the insert in the host.
❌ Option (b) – Statement I, II, and IV are correct: Statement II is incorrect because vectors should be smaller than 10 kb to avoid complications in purification and cloning procedures.
❌ Option (d) – Statement II and III are correct: Both Statement II and Statement III are incorrect based on the reasons provided above.
Conclusion: The correct answer is Option (c) – Statement I and IV are correct.

S130. Ans.(d)
Sol.
✅Tandem duplication occurs when an extra chromosome segment is located immediately after the normal segment and is oriented in the same direction. This results in repeated genetic material within the chromosome, which can affect gene expression and chromosomal behavior during meiosis.
Tandem duplications lead to the formation of repeated gene sequences and are important in evolution as they can increase genetic variation.
❌ Option (a): Inversion involves a segment of a chromosome being flipped in orientation, not repeated in the same direction.
❌ Option (b): Duplication generally refers to the presence of extra genetic material, but tandem duplication specifies the immediate sequential placement of the repeated segment.
❌ Option (c): Translocation involves the movement of a chromosome segment from one chromosome to another, not the replication of a segment.
Tandem duplications can lead to gene redundancy or dosage effects, impacting the phenotype and evolution of the species.

S131. Ans.(b)
Sol.
✅Intra-chromosomal aberrations refer to genetic changes that occur within a single chromosome of a homologous pair. These can include deletions, duplications, or inversions that affect the structure of a chromosome but do not involve multiple chromosomes.
Inter-chromosomal aberrations, on the other hand, affect multiple chromosomes or the interaction between different chromosomes, leading to rearrangements such as translocations.
❌ Option (a): Inter-chromosomal aberrations involve changes between different chromosomes.
❌ Option (c): Chromosomal deletions are a specific type of aberration but don't necessarily imply intra-chromosomal changes.
❌ Option (d): Genetic mutations can be broader changes, including point mutations or other genetic variations, but intra-chromosomal aberrations are more specific to structural changes within a single chromosome.
⁉️ Intra-chromosomal aberrations are important in studying chromosomal disorders and the structural evolution of chromosomes.

S132. Ans.(c)
Sol.
Option (c) is correct: Dichogamy is a mechanism that promotes cross-pollination by ensuring that the anthers and stigma mature at different times in the same flower. This prevents self-pollination, even in hermaphrodite flowers.
It is of two types:
Protogyny: Pistil matures before anthers (e.g., pearl millet)
Protandry: Anthers mature before pistil (e.g., maize, sugar beet)
Option (a) refers to homogamy, not dichogamy.
Option (b) describes monoecious plants.
Option (d) defines apomixis, not dichogamy.

S133. Ans.(c)
Sol.
✅ Option (c) is correct – To submit a culture for identification as a variety, the breeder must prepare a proposal containing multi-location data from at least two years of AICRP (All India Coordinated Research Project) trials. The proposal must also include data on pest and disease resistance, agronomic performance, and quality traits. This comprehensive evaluation ensures that only stable and superior cultures are considered by the Identification Committee.
❌ Option (a) is incorrect – Laboratory results alone are not sufficient; field data is essential. ❌ Option (b) is incorrect – A proposal must contain much more than just the breeder's name. ❌ Option (d) is incorrect – Single-year, single-centre data is insufficient for national-level identification.
Conclusion: The correct answer is Option (c) – Two-year AICRP data across centres.

S134. Ans.(b)
Sol.
✅ Option (b) is correct – In field experiments, treatments are the different inputs, techniques, or materials (such as different seed varieties, fertilizer doses, irrigation schedules, etc.) applied to the experimental units for comparison. The purpose is to assess the effect of each treatment on the outcome variable (e.g., yield, height, disease resistance).

❌ Option (a) – Plots are physical units in the experiment, not the object of comparison. ❌ Option (c) – Samples may be drawn from the plots, but the comparison is made between treatments. ❌ Option (d) – Blocks help control variability but are not the focus of comparison.
Conclusion: The correct answer is Option (b) – Treatments.

S135. Ans.(c)
Sol.
✅The selection response (R) represents the effect of selection on a population, measured by how much the population mean shifts due to selection. According to the definition provided:
μ_0 = Mean of the initial population
μ_1 = Mean of individuals selected as parents
μ_2 = Mean of offspring from selected parents
Hence, the selection response (R) is given by:
$R=\mu 2-\mu 0$
This formula captures the genetic improvement passed on to the next generation as a result of selecting certain parents based on desirable traits.
❌ Option (a) is incorrect because $\mu_1 - \mu_0$ refers to selection differential, not response. ❌ Option (b) does not represent any standard metric in selection theory. ❌ Option (d) is the negative of the actual response value.
✅ Therefore, option (c) is the correct choice for defining selection response.

S136. Ans.(c)
Sol.
✅Embryo culture: Organ culture refers to the cultivation of whole organs or tissues from a plant, such as embryos, outside the plant under controlled conditions.
Embryo culture fits this description as it involves the culture of plant embryos.
❌ Option (a) – Anther culture: Anther culture involves the culture of anthers (male reproductive organs) but is a specific type of culture, not a general term for organ culture.
❌ Option (b) – Ovule culture: Ovule culture involves the culture of ovules (female reproductive organs), which is also a specific technique and not the general term for organ culture.
❌ Option (d) – All of these: This is incorrect because only embryo culture fits the description of organ culture.

S137. Ans.(c)
Sol.
✅Paracentric inversions are a type of chromosomal inversion where the inverted segment does not include the centromere. The inversion only affects one arm of the chromosome, either the p-arm (short arm) or the q-arm (long arm), but not the centromere.
These inversions can affect chromosomal structure and lead to problems in chromosome pairing during meiosis, resulting in genetic imbalances or reduced fertility.
❌ Option (a): This would describe pericentric inversions, which include the centromere in the inversion.
❌ Option (b): This option is incorrect because the centromere is not involved in paracentric inversions.
❌ Option (d): Paracentric inversions occur within one chromosome and do not involve two chromosomes.
⁉️ Paracentric inversions are important in understanding chromosome structure and genetic disorders that result from abnormal recombination events.

S138. Ans.(d)
Sol.
✅Somatic hybrids can be formed across various levels of classification:
Interspecific hybrids occur between different species.
Intergeneric hybrids involve the fusion of protoplasts from different genera.
Intertribal hybrids occur between different tribes of plants. Therefore, the correct answer is All of these (Option d).

S139. Ans.(a)
Sol.
✅ Option (a) is correct because both the assertion and reason are true, and the reason correctly explains the assertion. In rice, stem borer infestation is higher in the off-season compared to the main crop season. Therefore, to effectively evaluate and screen genotypes for resistance against stem borer, it is ideal to conduct the screening during the off-season to ensure uniform and heavy pest pressure. This helps in more accurate identification of resistant and susceptible genotypes.
❌ Option (b) is incorrect because R does explain A correctly. ❌ Option (c) is incorrect as both A and R are true. ❌ Option (d) is incorrect since A is true and based on R being valid.
Conclusion: The correct answer is Option (a) – Both A and R are true, and R is the correct explanation of A.

S140. Ans.(c)
Sol.
✅In Sorghum bicolor, the fertile or sessile spikelet contains two florets:
The lower floret is sterile, having an empty lemma (L1) and no palea (P1).
The upper floret is a perfect bisexual flower, with a membranous lemma (L2) and a small, delicate palea (P2).
It includes:
Two lodicules
Three versatile stamens
A single-celled ovary with two long styles ending in feathery stigmas
❌Option (a): The second flower is bisexual, not just staminate.
❌Option (b): Only one flower is fertile, the other is sterile.
❌Option (d): The ovary is unicellular, and the floret has three stamens, not five.
This detailed floral arrangement is important for understanding reproductive biology and hybridization techniques in sorghum breeding.

S141. Ans.(c)
Sol.
✅ Option (c) is correct because the gene-for-gene hypothesis was proposed by Harold Flor in 1956, based on his work on flax (linseed) and its interaction with rust disease. The hypothesis explains that for every resistance gene in the host plant, there is a corresponding gene in the pathogen that determines its virulence. This model is fundamental in understanding host-pathogen interactions, particularly in plant disease resistance studies.

❌ Option (a) is incorrect as Watson is known for DNA double-helix discovery, not plant pathology. ❌ Option (b) is incorrect; Mendel worked on inheritance laws, not gene-for-gene interaction. ❌ Option (d) is incorrect; Borlaug is known for the Green Revolution, not this hypothesis.
Conclusion: The correct answer is Option (c) – Flor.

S142. Ans.(a)
Sol.
✅ Statement A is correct – Macro-mutations cause distinct morphological changes that are easily observable. ✅ Statement B is correct – Micro-mutations affect quantitative characters, are usually polygenic, and are hard to identify. ✅ Statement C is correct – Since macro-mutations affect qualitative characters, they are governed by oligogenic (few gene) control.
❌ Statement D is incorrect – Micro-mutations cause invisible phenotypic changes, not visible ones. ❌ Statement E is incorrect – Macro-mutations are not found in polygenic traits; those are associated with micro-mutations.
Conclusion: The correct answer is Option (a) – A, B, and C only.

S143. Ans.(d)
Sol.
✅ Option (d) – A is false, but R is true
The reason is correct. In the Triple Test Cross method (developed by Kearsey and Jinks, 1968), each selected F_2 plant is crossed with P_1, P_2, and their F_1 hybrid. This design helps in detecting epistasis (non-allelic interaction) and provides more information than standard biparental mating.
❌ The assertion is incorrect because Triple Test Cross does not involve only two parents. It involves three testers: P_1, P_2, and F_1, not just two parents. Its main purpose is to analyze epistasis, not solely additive and dominance variance.

S144. Ans.(d)
Sol.
✅Primary gene pool (GP1) is the correct answer because:
It includes plants of the same species or closely related species.
When these plants are intercrossed, they produce completely fertile offspring.
Crossing is simple and natural, requiring no special breeding techniques or treatments.
Gene exchange can occur easily through normal hybridization.
It is considered the most important group for plant breeding due to high genetic compatibility.
This pool provides breeders with a reliable source of desirable traits like yield, disease resistance, etc.

S145. Ans.(a)
Sol.
✅A is correct: Selection in the Pedigree Method begins from the F_2 generation, where plants are space-planted to facilitate individual selection.
✅B is correct: During F_3 and F_4, selection is done both within and between progeny rows.
❌C is incorrect: In the F_2 generation, selection is based primarily on simply inherited traits, not complex ones.
✅D is correct: By the F_5 generation, variation within rows reduces, and breeders focus on selection between progeny rows.

S146. Ans.(b)
Sol.
✅Option (b) - General combining ability (GCA): In Griffing's Diallel Mating Design, the General combining ability (GCA) refers to the overall contribution of the parents to the cross. It represents the additive genetic effects of the parents and indicates their ability to contribute beneficial traits to the offspring in a consistent manner.
GCA is a crucial part of the factorial design that evaluates the average performance of parents in contributing favorable genes to the hybrid offspring.
❌Option (a) - Specific combining ability (SCA): Specific combining ability (SCA) refers to the interaction between two particular parents beyond the average performance measured by GCA. It is the excess effect over GCA that comes from the specific genetic interaction between the two parents.
❌ Option (c) - Genetic variability: Genetic variability refers to the diversity in genetic makeup within a population. It is not related to the specific parental contribution in a mating design.
❌ Option (d) - Gene flow: Gene flow refers to the movement of alleles between different populations. It does not refer to the contribution of individual parents in a cross, which is what GCA measures.

S147. Ans.(c)
Sol.
✅ Option (c) is correct – Local control (also known as error control) involves dividing the experimental field into blocks, each block containing relatively homogeneous experimental units. This helps to minimize variability due to uncontrolled external factors and increases the precision of comparisons between treatments. The process is also referred to as blocking.
❌ Option (a) – Randomization deals with assigning treatments randomly, not creating blocks. ❌ Option (b) – Replication is about repeating treatments, not grouping them. ❌ Option (d) – Sampling refers to selecting representative subsets and is unrelated to block design.
Conclusion: The correct answer is Option (c) – Local control.

S148. Ans.(c)
Sol.
✅ Option (c) is correct – A seed protectant is a chemical substance used to disinfect or sterilize the surface of seeds. It protects seeds from pathogenic fungi, bacteria, and viruses present either on the seed surface or in the soil, thereby improving germination, seedling vigor, and early crop establishment. Common seed protectants include fungicides (like Thiram, Captan) and bactericides.
❌ Option (a) – Seed enhancers improve seed performance but don't kill microbes. ❌ Option (b) – Seed hardeners help in improving drought tolerance, not microbial control. ❌ Option (d) – Seed primers promote early germination but are not disinfectants.
Conclusion: The correct answer is Option (c) – Seed protectant.

S149. Ans.(b)
Sol.
✅Zygotene is the stage of prophase I of meiosis where homologous chromosomes begin to pair in a process called synapsis.
During this stage, the synaptonemal complex — a protein structure that forms between homologs — becomes visible under an electron microscope.

This complex holds the homologs tightly together, enabling genetic recombination in the next stage.

❌Leptotene: Chromosomes begin to condense, but no pairing yet.

❌Pachytene: Crossing over occurs, but the synaptonemal complex is already established.

❌Diplotene: Synaptonemal complex starts to disassemble; chiasmata become visible.

So, the first appearance of the synaptonemal complex is a defining feature of the zygotene stage.

S150. Ans.(c)

Sol.

✅Pure line varieties are derived from self-pollinated crops and consist of genetically identical individuals. Due to this, they have:

Homogeneity and high uniformity

Very narrow genetic base

No heritable variation, making selection ineffective

Limited adaptability to varying environmental conditions

Higher vulnerability to new diseases, as they lack genetic diversity for resistance

❌Option (a) is incorrect: Pure lines are genetically uniform, not variable.

❌Option (b) is incorrect: They lack heritable variation, so selection is ineffective.

❌Option (d) is incorrect: Pure lines do not show stable yield across diverse environments due to narrow adaptation.