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科目： 遺傳學(D)  
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國立臺灣大學 106 學年度碩士班招生考試試題

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I. True or False (2.0 points for each question, 40 points)

1. Diploid cells have two pairs of homologous chromosome.
2. DNA synthesis takes place before the mitosis begins in a cell cycle.
3. The definition of hemizygoty is possession of a single allele at a locus.
4. There are always four different phenotypes in the F2 population of a dihybrid cross.
5. Helen has classic hemophilia, an X-linked recessive disease. Both of her parents are definitely the hemophilia patients.
6. If the phenotype of the heterozygote falls between the phenotypes of the two homozygotes, this type of dominance is named "partial dominance".
7. Pleiotropic characteristics are characteristics encoded by genes at many loci.
8. One map unit equals 1% recombination.
9. A haplotype is defined as a specific set of linked alleles.
10. If two loci are independent assortment, these two loci are located in different linkage groups.
11. George Beadle and Edward Lawrie Tatum were together won the Nobel Prize in Physiology or Medicine 1958 for their hypothesis of one gene-one enzyme.
12. In eukaryote, numerous genes encode more than one polypeptide.
13. In eukaryotic genomes, gene number is in proportion to genome size, indicating larger genomes contain more genes.
14. Site-specific recombination accounts for the tremendous variation in antibody structure.
15. Transcription factors contain leucine zipper motifs which promote dimerization are important to gene regulation.
16. CpG islands are associated with DNA methylation.
17. The program BLAST would be best used for identifying related sequences to a given DNA sequence in the Genbank database.
18. By using positional cloning to isolate gene conferring mutated phenotype and then to study gene function is called reverse genetics.
19. Chemical mutagenesis to create mutant pools and then to isolate and consequently to study gene function is common applied in forward genetics.
20. Chromatin immunoprecipitation (ChIP) assay is used for protein:DNA interaction.

II. Choice (2.0 points for each question, 40 points) ※ 本大題請於試卷內之「選擇題作答區」依序作答。

1. Which of the following statement is incorrect for the homologous chromosomes? (A) Crossing over events only occur between the homologous chromosomes. (B) Alleles at the same locus between the homologous chromosomes can be the same or different. (C) Homologous chromosomes separate at the anaphase I stage in meiosis. (D) More than one possible pairing results occur between homologous chromosomes in an autotetraploid plant species.
2. In which of the following populations derived from the cross of two true-breeding lines with distinct traits, phenotypic segregation cannot be observed? (A) the first backcross population (B) the first filial population (C) the double haploid population (D) the recombinant inbred population.
3. A testcross is always performed between the individual that is heterozygous for the genes to be mapped and an individual who is \_\_\_\_\_. (A) Heterozygous for the genes. (B) Homozygous dominant for the genes. (C) Homozygous recessive for the genes. (D) None of the answers are correct.
4. How many genotypes are possible at a locus with five alleles? (A) 5 (B) 15 (C) 27 (D) 30.
5. In a chi-square test to determine if two genes are linked or assorting independently, what is the default (null) hypothesis that is tested? (A) The genes are linked to one another. (B) The genes are assorting independently. (C) No crossing over occurs. (D) The distance between the genes is very small.
6. For single crossovers, the frequency of recombinant gametes is half the frequency of crossing over because (A) a testcross between a homozygote and heterozygote produces 1/2 heterozygous and 1/2 homozygous progeny. (B) the frequency of recombination is always 50%. (C) each crossover takes place between only two of four chromatids of a homologous pair. (D) crossovers take place in about 50% of meiosis.
7. Please find the incorrect statement. (A) Genetic maps are constructed based on rate of recombination. (B) The Haldane's genetic mapping function assumes the number of crossovers to be in Poisson distribution without interference. (C) Single nucleotide polymorphisms can be mapped in both of the genetic map and the physical map. (D) The repulsion configuration always find in the recombinant progenies of a genetic mapping population.
8. Which of the following terms imply closely the idea of genetic variation? (A) Gene (B) Allele (C) Locus.
9. What is the expected frequency of heterozygotes in a population with allelic frequencies  $x$  and  $y$  that is in Hardy-Weinberg equilibrium? (A)  $(x-y)(x-y)$  (B)  $2xy$  (C)  $xy$  (D)  $x+y$ .
10. A heritability value of 0.997 indicates which of the following? (A) The majority of the phenotypic variation has a genetic basis. (B) The majority of the phenotypic variation has an environmental basis. (C) The trait is polygenic. (D) There is a significant difference between the two strains.

見背面

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11. Translocations and inversions may result in (A) no effect (B) semi-sterility (C) position effect (D) anticipation chromosomes (E) genome mutations.
12. A gene is inducible and under negative control. Which of the following pairs will allow expression of this gene? (A) Activator + repressor. (B) Activator + inhibitor (C) Activator + inducer (D) Repressor + co-repressor (E) Repressor + inducer.
13. What basal transcription factor is most often affected by regulatory transcription factors? (A) TFIIA (B) TFIIB (C) TFIID (D) TFIIIE (E) TFIIF
14. DNA replication requires a free 3'-OH to initiate polymerase activity. This accomplished by synthesis (A) a temporary RNA primer, remove by Pol III. (B) a temporary RNA primer, removed by Pol I. (C) a permanent DNA primer, synthesized by pol III. (D) a permanent DNA primer, synthesized by pol I. (E) DNA replication does not require a free 3'-OH
15. Which DNA repair mechanism uses DNA-N-glycolases? (A) Base excision repair (B) Direct repair (C) Mismatch repair (D) Nucleotide excision repair (E) Nonhomologous end joining (NHEJ)
16. Which repair mechanism often leads to deletions in chromosomes? (A) Base excision repair (B) Direct repair (C) Mismatch repair (D) Nucleotide excision repair (E) Nonhomologous end joining (NHEJ)
17. Which DNA repair mechanism is involved when cells are engineered with genome editing? (A) Base excision repair (B) Direct repair (C) Mismatch repair (D) Nucleotide excision repair (E) Nonhomologous end joining (NHEJ)
18. Which of the following best describes the function of the RecA protein in *E. coli* recombination? (A) Promotes strand invasion and formation of the D loop (B) Recognizes double-stranded breaks in the DNA (C) Is involved in the initial formation of the Holliday junctions (D) Resolves Holliday junctions into separate chromosomes (E) none above
19. Which of the following genes was mobile in McClintock's experiments with mutable sites in corn? (A) *Ds* (B) *C* (C) *Sh* (D) *P1* (E) *Wx*
20. Which enzyme is unique to the retro elements? (A) Reverse transcriptase (B) Reverse resolvase (C) Transposase (D) Reverse integrase (E) Integrase

### III. Assay (20 points)

1. (4 points) Parthenocarpy is the phenomena that fruits set in the absence of fertilization. Certain tomato varieties bear ability to induce parthenocarpic fruits through application of auxin analogs, especially when tomato plants grow under heat stress. Six recessive auxin-induced parthenocarpy tomato mutants has been identified. Describe one effective strategy to determine the number of locus that controlling the auxin-induced parthenocarpy.
2. (6 points) Three different true-breeding strains of corn that produce ears with white kernels were crossed to each other. In each of three cases, the F1 plants were all red, while both red and white kernels were observed in the F2 generation in a 9:7 ratio. These results are summarized in the following table.

	F1	F2
White-1 x white-2	Red	9 red: 7 white
White-1 x white-3	Red	9 red: 7 white
White-2 x white-3	Red	9 red: 7 white

Define your symbols and show the genotypes for the true-breeding strains white-1, white-2, white-3. Also, diagram all the three crosses, show the genotypes and phenotypes of the F1 and F2 progenies, and explain the observed 9:7 ratio. Finally, determine the number of loci that are involved in determining kernel color in these three strain.

3. (10 points) To compare a set of genes with significantly differential expression is important to understand how tissue differentiation at spatio-temporal or under different stresses.
  - (a) Describe three different kinds of methods to evaluate gene expression levels. (6 points)
  - (b) How to analyze global gene expression and find a set of genes accounting for differential expression? (4 points)

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