國立臺灣大學 102 學年度碩士班招生考試試題

I. True or False (2.0 points for each question, 40 points)請於試卷內之「非選擇題作答區」標明題號依序作答。

1. Cells with a single set of chromosomes are called diploid.
2. The principle of independent assortment can be demonstrated using a monohybrid cross.
3. The probability of two or more independent events occurring together is calculated by multiplying their independent probabilities.
4. At a single genetic locus, a diploid individual may have more than two different alleles.
5. An X-linked recessive trait is never seen in females and affects ¼ of all the sons of a female carrier.
6. Phenotypes for a characteristic controlled by genetic maternal effect are determined by the nuclear genotype of the maternal parent.
7. Linked genes always exhibit recombination frequencies of less than 50%.
8. A testcross includes one parent that is homozygous recessive for all gene loci being examined.
9. A QTL is a gene.
10. The heritability of an individual cannot be estimated.
11. Both lytic and lysogenic bacteriophage can allow phage DNA to become incorporated into the bacterial chromosome.
12. HIV's reverse transcriptase is very error prone, giving the virus a high mutation rate and allowing it to evolve rapidly, even within a single host.
13. Cytosine bases are often methylated to form 5-methylcytosine in eukaryotic DNA but prokaryotic DNA.
14. Gene conversion can be distinguished from mutation because gene conversion will be correlated with reciprocal recombination of outside markers about 50% of the time.
15. Retroviruses and retrovirus-like elements share *gag* and *pol*.
16. Group II introns, found in some rRNA genes, are self-splicing.
17. SiRNA but not miRNA molecules combine with proteins to form an RNA-induced silencing complex (RISC) which leads to complementary mRNA to degrade.
18. The consensus sequences TTGACA and TATAAT are commonly found at -10 and -35 of promoter regions of prokaryotic genes.
19. tRNAs, some snRNAs, and some miRNAs are transcribed by RNA polymerase I.
20. The excision repair system of *E. coli* can distinguish template strands verses newly synthesized strands by the methylation of adenine residues of the GATC sequence of the template strand.

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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. How many genotypes are present at a locus with six alleles? **(A)** 3 **(B)** 6 **(C)** 30 **(D)** 36.

2. Sister chromatids separate during **(A)** Meiosis I prophase **(B)** Meiosis I anaphase **(C)** Meiosis II prophase **(D)** Meiosis II anaphase.

3. Genes come in different versions called: **(A)** alleles **(B)** loci **(C)** genotypes **(D)** chromosomes.

4. If a female Drosophila that is heterozygous for a recessive X-linked mutation is crossed to a wild-type male, what proportion of female progeny will have the mutant phenotype? **(A)** 100% **(B)** 0% **(C)** 33% **(D)** 25%.

5. Interactions among the human ABO blood group alleles involve _____ and _____. **(A)** co-dominance; complete dominance **(B)** co-dominance; incomplete dominance **(C)** complete dominance; incomplete dominance.

6. The Huntington's disease is an autosomal dominant traits. A girl learned that her father is a patient of the Huntington's disease but her mother is normal, what is the probability that she will also have the Huntington's disease? **(A)** 1/4 **(B)** 1 **(C)** 1/2 **(D)** 3/4.

7. LOD scores measure: **(A)** the length of genetic distances **(B)** how often double crossovers occur **(C)** the length of a linkage group **(D)** the likelihood of linkage between genes.

8. The estimated broad-sense heritability for milk production in a herd of dairy cattle is high. Which is a valid inference? **(A)** Most of the variation in milk production in the herd is due to additive genetic variance within the herd. **(B)** Most of the variation in milk production in the herd is due to dominant genetic variance. **(C)** Little of the variation in milk production is due to environmental variation within the herd. **(D)** Broad-sense heritability for milk production will be high in most other herds of dairy cattle.

9. If there are two alleles, *A* and *a*, in a population and the population is at Hardy-Weinberg equilibrium, which frequency of *A* would produce the greatest frequency of heterozygotes? **(A)** 0.1 **(B)** 0.25 **(C)** 0.5 **(D)** 1.

10. Which of the following evolutionary forces does NOT normally change allele frequencies? **(A)** nonrandom mating **(B)** mutation **(C)** selection **(D)** migration **(E)** genetic drift.

11. A polyploid with two distinct sets of chromosomes that has each set duplicated is most likely: (1) an allopolyploid. (2) an autopolyploid. (3) a sterile polyploid. (4) a fertile polyploid. **(A)** 1, 3 **(B)** 1, 4 (C) 2, 3 **(D)** 2, 4 **(E)** 1, 2, 3, 4

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12. The condition of semisterility is most closely associated with: **(A)** chromosomal duplications. **(B)** pericentric inversions. **(C)** paracentric inversions. **(D)** translocation heterozygotes. **(E)** translocation homozygotes.

13. The functions associated with telomeres are to: (1) prevent deoxyribonucleases from degrading the ends of linear DNA molecules. (2) prevent the fusion of chromosomal ends with other DNA molecules. (3) facilitate replication of chromosomes without the loss of termini. (4) ensure the appropriate segregation of chromosomes. (5) provide chromosomal anchorage to spindle-fibers. **(A)** 1,2,3 **(B)** 1,2,4 **(C)** 1,2,5 **(D)** 2,3,4 **(E)** 2,3,5

14. In maize, the *Ac* factor is associated with which of the following? (1) Structural heterogeneity between different *Ac* elements. (2) The activator of chromosomal breakage in regions containing aberrant *Ds*. (3) cis-acting in its ability to transpose *Ds*. (4) Inverted terminal repeats. (5) Direct repeats. **(A)** 1,2,3 **(B)** 1,2,4 **(C)** 1,2,5 **(D)** 2,4,5 **(E)** 2,3,5

15. The double helical structure of DNA can adopt various forms. (1) B-DNA is the conformation under physiological conditions. (2) A-DNA occurs in a partially dehydrated environment. (3) DNA-RNA duplexes exist in an A-form. (4) B and Z are right handed helices, while A is left handed. (5) The Z-form of DNA is sequence-specific and has a defined role *in vivo*. Which of the following statements are ***INCORRECT*** about the form in question? **(A)** 1, 2 **(B)** 2, 3 **(C)** 4, 5 **(D)** 1, 3, 4 **(E)** 2, 4, 5

16. 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

17. Which of the following sequences is true of translation? **(A)** codon recognition→ translocation → peptide bond formation →termination **(B)** peptide bond formation → codon recognition→ translocation → termination **(C)** codon recognition → peptide bond formation → translocation → termination **(D)** codon recognition→ peptide bond formation →termination → translocation **(E)** peptide bond formation → translocation → codon recognition→termination

18. Which one is NOT essential for RNA splicing? **(A)** consequence sequences, GUA/GGU, at 5' splice site **(B)** consequence sequences, CAGG, at 3' splice site **(C)** branch point, which an guanine nucleotide lies on intron **(D)** introns in pre mRNAs beginning with GU and ending with AG **(E)** splicesome

19. Xeroderma pigmentosum, or XP, is an autosomal recessive genetic disorder of DNA repair in which the ability to repair damage caused by ultraviolet (UV) light is deficient. The patient is deficient for what kind of DNA repairmen? **(A)** mismatch repair **(B)** photoreactivation **(C)** base excision repair **(D)** nucleotide excision repair **(E)** translesion synthesis

20. Which of the DNA repair mechanisms can be template independent and requires polymerase activity? **(A)** postreplication repair **(B)** mismatch repair **(C)** light-dependent repair **(D)** error-prone repair **(E)** excision repair

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III. Assay (20 points) 請標明題號依序作答。

1. (10 points) Golden Rice is a well-known GM (Genetic Modified) crop. However, there are still some debates for promoting GM rice in fields and markets. Please answer the following question in detail.
   (a)How to use recombinant DNA technology to create GM crops? (6 points)
   (b)What are some issues of concern about the use of GM crops? (4 points)

2. (10 points) You are working on finding molecular markers that closely linked to a race-specific rust resistance gene in soybean. You find that a wild soybean accession can resist the most prevalent physiological race of the rust pathogen *Phytophthora sojae* in the soybean field. Therefore, you made a backcross population in which the wild soybean accession was used as the donor parent and an elite susceptible soybean was used as the recurrent parent. Before you did inoculation of pathogens to BC1 plants, you already extracted genomic DNA individually from all 1000 BC1 plants. You conducted the Bulk Segregant Analysis (BSA), and eventually developed 3 potential closely linked molecular markers: A, B, and D. In order to verify whether these markers genetically linked to the rust resistant gene, you did genotypes of all three molecular markers on all of 1000 BC1 plants. The genotypes of three molecular markers and the resistant phenotypes were summarized in the table below:

Phenotype	Genotype	Plant number
Resistant	AaBbdd	42
Resistant	Aabbdd	310
Resistant	aaBbDd	6
Resistant	aabbDd	145
Susceptible	AaBbdd	140
Susceptible	Aabbdd	9
Susceptible	aaBbDd	305
Susceptible	aabbDd	43

Please answer questions below:

(1) How many markers link to the resistant gene? Please use Chi-square independence test to validate your conclusion. (5 points)

(2) Please draw the genetic map. On the genetic map, you need to place the order between markers and the resistance gene, and to label genetic distances between molecular markers as well as the genetic distances between markers and the resistant gene. (5 points).

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