國立臺灣大學 112 學年度碩士班招生考試試題

複選題 (14 題，每題 4 分)

1. Compare and contrast Mendel's principle of segregation and the principle of independent assortment. Please choose correct descriptions:

   (A). Both principles involve segregation of alleles during meiotic anaphase I.
   (B). Both principles can be demonstrated only if the two parental plants possess different phenotypes encoding a character.
   (C). The principle of segregation can be observed in mitosis.
   (D). The principle of independent assortment involves the random assortment of alleles from different homologs into separate daughter cells.

2. An F2 segregation population showed two distinct phenotypes: 152 pink color and 48 white color. Which of following expected ratios departure from this observation?
   (A). 3:1
   (B). 13:3
   (C). 9:7
   (D). 2:1

3. Please choose correct descriptions below:
   (A). Dominance is the condition in which one allele of a gene pair completely masks or inhibits phenotypic expression of the other allele.
   (B). Co-dominance is the condition in which the complete expression of both alleles of a given gene pair is observed.
   (C). Incomplete dominance is the condition in which one allele only partially inhibits the expression of the other allele in the phenotype.
   (D). Overdominance is the condition in which heterozygotes exhibit phenotypes representing a combination of the two homozygotes.

4. Which of following phenomena can alter expected Mendelian phenotypic ratio in a genetic cross:
   (A). Epitasis
   (B). Linkage
   (C). Chromosome translocation
   (D). Environmental effects

5. Please choose correct descriptions below:
   (A). A single gene can only have two alleles.
   (B). Normal recessive genes typically do not produce functional products.
   (C). A trait exhibiting incomplete penetrance is not expressed at the same degree among all individuals expressing it.
   (D). The occurrences of partial expressivity and incomplete penetrance demonstrate that gene expression can be influenced by non-genetic factors.

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6. Please choose correct descriptions below:
   (A). Meiosis produces gametes.
   (B). Meiosis involves pairing of sister chromatids
   (C). Sister chromatids are segregated in meiosis I
   (D). Crossing over occurs in meiosis I

7. Please choose correct descriptions below:
   (A). It is possible for two different genes located on the same chromosome to assort independently
   (B). Linked genes always exhibit recombination frequencies of less than 50%.
   (C). A genetic map shows the linear order of gene loci present on a chromosome and the relative physical distances between them.
   (D). Haldane's mapping function assumes that no crossover interference between linked loci.

8. In the squirting cucumber *Echballium elaterium*, there are two separate sexes (it is dioecious), determined not by heteromorphic sex chromosomes, but by specific genes. It is known that the genes involved are ***M*** (male fertility), ***m*** (male sterility), ***F*** (female sterility), and ***f*** (female fertility). In populations of this plant, individuals can be male (approximately 50 percent) or female (approximately 50 percent). In addition, a hermaphrodite type is found, but only at a very low frequency. The hermaphrodite has male and female sex organs on the same plant. Which descriptions below are corrected?
   (A). The genotype of the male plant is *MMFF*.
   (B). The genotype of the female plant is m*mff*.
   (C). The genotype of the hermaphrodite plant is *Mmff*
   (D). The very low frequency of the hermaphrodite type is due to tightly genetic linkage between the locus *M* and the locus *F*.

9. Please choose correct descriptions below:
   (A). Allele with no functional activity is always a recessive allele.
   (B). In diploids, single recessive alleles can be expressed in diploids by means of pseudodominance or hemizygosity.
   (C). The neomorph allele is a form of hemizygous.
   (D). Haploinsufficient can be observed in a hemizygous genotype.

10. A corn plant carrying homozygous recessive brachytic (*b*) mutant is cross to a normal plant to produce a heterozygous semi-sterile F1 plant. This F1 plant is then backcrossed to the homozygous brachytic mutant. The progenies obtained show the following phenotypes:

Nonbrachytic, semisterile	334
Nonbrachytic, fertile	36
Brachytic, semisterile	39
Brachytic, fertile	341

If the semi-sterile phenotype results from reciprocal translocation, please choose correct descriptions below:
   (A). The semisterile phenotype resulted from chromosomal translocation.
   (B). The brachytic (*b*) mutant parental plant has chromosomal translocation.
   (C). The chromosome carrying the *b* mutant must be the chromosome involved in the translocation.
   (D). The recombination frequency between the locus *B* and the breakpoint of the reciprocal translocation is 0.1.

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11. Genotypes of leopard frogs from a population in a conservation area were determined for a locus (*M*) that encodes the enzyme malate dehydrogenase. The following numbers of genotypes were observed:

Genotypes	Number
M^1M^1	20
M^1M^2	45
M^2M^2	42
M^1M^3	4
M^2M^3	8
M^3M^3	6
Total	125

From the data shown, which descriptions below are corrected?

(A). The M^1 allele frequency is 0.34.

(B). The M^2 allele frequency is 0.548.

(C). The expected numbers of the M^1M^2 genotype is 49.

(D). This population is in Hardy-Weinberg equilibrium.

12. A study was conducted to investigate the 1000 grains weight and heading date of rice from a population of F8 progenies made by single seed decent method at several different experimental farms. The variances (*V*) were calculated and are shown below:

Variance	1000 grain weight	heading date
V_P	321.2	95.8
V_E	119.7	45.3
V_A	107.4	40.2
V_D	94.1	10.3

Which descriptions below are corrected?

(A). The narrow-sense heritability for 1000 grain weight is 0.334

(B). The broad-sense heritability for 1000 grain weight is 0.373

(C). The broad-sense heritability for heading date is 0.527

(D). Artificial selection will more likely alter 1000 grain weight than heading date.

Critical values of the χ^2 distribution					
df	1	2	3	4	5
P=0.05	3.841	5.991	7.815	9.488	11.07

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13. Which of the following statements are true about double-stranded DNA? (4 points. 需全部答對才給分. Receive full points only if you select all the correct answers and none of the incorrect answers)

a. A + C = T + G
b. A + G = C + T
c. A + T = G + C
d. A/G = C/T
e. A/G = T/C
f. (C +A) / (G + T) = 1

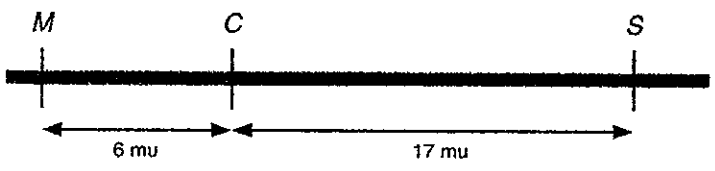
14. From "a" to "f" sequences, select possible open reading frames (frames without stop codons) exist that extend through the following sequence. (4 points. 需全部答對才給分. Receive full points only if you select all the correct answers and none of the incorrect answers)

5' ... CTTACAGTTTATTGATACGGAGAAGG ...3'
3' ... GAATGTCAAATAACTATGCCTCTTCC ...5'

a. 5' ... CTT ACA GTT TAT TGA TAC GGA GAA GG ...3'
b. 5' ... C TTA CAG TTT ATT GAT ACG GAG AAG G ...3'
c. 5' ... CT TAC AGT TTA TTG ATA CGG AGA AGG ...3'
d. 3' ... GA ATG TCA AAT AAC TAT GCC TCT TCC ...5'
e. 3' ... GAA TGT CAA ATA ACT ATG CCT CTT CC ...5'
f. 3' ... G AAT GTC AAA TAA CTA TGC CTC TTC C ...5'

問答題

15. A true-breeding strain of Virginia tobacco has dominant alleles determining leaf morphology (*M*), leaf color (*C*), and leaf size (*S*). A Carolina strain is homozygous for the recessive alleles of these three genes. These genes are found on the chromosome as follows:



An F1 hybrid between the two strains is now backcrossed to the Carolina strain. Assuming no interference:

15.1 What proportion of the backcross progeny will resemble the Virginia strain for all three traits? (4 points)
15.2 What proportion of the backcross progeny will resemble the Carolina strain for all three traits? (4 points)
15.3 What proportion of the backcross progeny will have the leaf morphology and leaf size of the Virginia strain but the leaf color of the Carolina strain? (5 points)
15.4 What proportion of the backcross progeny will have the leaf morphology and leaf color of the Virginia strain but the leaf size of the Carolina strain? (5 points)

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16. You found five T4 *rII*− mutants that will not grow on *E. coli* K(λ). You mixed together all possible combinations of two mutants (as indicated in the following chart), added the mixtures to *E. coli* K(λ), and scored plaques (indicated as a + in the chart).

	1	2	3	4	5
1	-	+	+	-	+
2		-	-	+	-
3			-	+	-
4				-	+
5					-

16.1 How many genes were identified by this analysis? (4 points)

16.2 Which mutants belong to the same complementation groups? (4 points)

17. The DNA sequence of one strand of a gene from three independently isolated mutants is given here (5' ends are at left). Using this information, please write the DNA sequence of wild-type gene on answer sheet. (2 points)

Mutant 1 ACCGTAATCGACTGGTAAACTTTGCGCG
Mutant 2 ACCGTAGTCGACCGGTAAACTTTGCGCG
Mutant 3 ACCGTAGTCGACTGGTTAACTTTGCGCG
Wild-type ?

18. Two true-breeding and white flower plant strains are crossed to make F_1 plants, all of F_1 were purple flower. The F_1 plants are then self-fertilized to produce F_2 progeny, the ratio of flower color in F_2 progeny is 9 purple: 7 white. According to these results, please answer the following questions:

18.1 How many genes are involved in determining flower color? (2 points)

18.2 Define the genotypes of the two parents, F_1 and F_2, and must indicate the flower color next to each genotype. (6 points)

18.3 Write possible biochemical pathway(s) that could explain the formation of flower color. Indicate the step(s) where genes are involved. (4 points)

18.4 If all relevant genes (answer in question "a") were tightly linked, what ratio of flower color could be expected in F_2 progeny? (4 points)

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