

## I. 解釋名詞 (18%) :

- |                       |                          |
|-----------------------|--------------------------|
| (1) Expressivity      | (4) Contig               |
| (2) Hybrid dysgenesis | (5) Chromatin remodeling |
| (3) Genetic load      | (6) Proto-oncogene       |

## II. 單選題 (54%) : ※注意：請於試卷上「選擇題作答區」依序作答。

- Which of the following most accurately restates Mendel's law of segregation?
  - Genes are inherited in discrete units from one generation to the next.
  - Genes can exist in different forms, known as alleles.
  - Homologous chromosomes separate during gamete formation.
  - Genes on different chromosomes are inherited independently.
  - All of the above
- The phenomenon where half the "normal" level of functional protein is not enough to generate a normal phenotype is called "haploinsufficiency". Which of the following situations demonstrates haploinsufficiency?
  - Persons with type AB blood display both A and B antigens on their red blood cells.
  - Heterozygous and homozygous flowers are both purple.
  - "Small eye" in mice is caused by loss of one copy of the *Pax6* gene.
  - A mutation in a protein causes it to become much more active than usual.
  - None of the above
- A semilethal allele is an example of which of the following extensions of Mendelian genetics?
  - Incomplete dominance
  - Incomplete penetrance
  - Variable expressivity
  - Overdominance
  - All of the above
- In a rare blood type referred to as the Bombay phenotype, individuals are unable to attach the A or B antigens to their red blood cells. Individuals that are homozygous recessive for gene "H" have the Bombay phenotype and their blood type is type "O" regardless of their ABO genotype. This is an example of \_\_\_\_\_.
  - Multiple alleles
  - Overdominance
  - Environmental influence
  - Epistasis
  - Pleiotropy
- The recessive mutant allele that causes cystic fibrosis is much more frequent in Caucasians of eastern European descent than in other populations. Some scientists believe heterozygotes must have had a survival advantage during plagues such as cholera that occasionally swept through this population. What concept does this illustrate?
  - Multiple alleles

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- B) Overdominance  
C) Incomplete dominance  
D) Environmental influence  
E) Epistasis
6. A pattern of transmission where all offspring have the same phenotype as their mother is consistent with which type of non-Mendelian inheritance?  
A) Maternal effect  
B) Genomic imprinting  
C) Dosage compensation  
D) Extranuclear inheritance  
E) Epistasis
7. Three mutant strains of plant, Michigan, Kansas, and Oregon have white flowers and are true-breeding. In a complementation test, you cross Michigan  $\times$  Kansas and obtain all white flowers. You cross Oregon with Kansas and obtain all red flowers. Which plants are likely to have a mutation in the same gene?  
A) Oregon and Kansas  
B) Michigan and Kansas  
C) Oregon and Michigan  
D) all have mutations in different genes  
E) all have mutations in the same gene
8. You have calculated the interference value for a given mapping experiment to be 30%. What does this mean?  
A) 30% more double crossovers occurred than expected.  
B) 30% fewer double crossovers occurred than expected.  
C) 70% more double crossovers occurred than expected.  
D) 70% fewer double crossovers occurred than expected.  
E) None of the above
9. When studying eukaryotic enzymes in relation to their prokaryotic counterparts, you discover that some eukaryotic enzymes seem to consist of several regions, each of which performs the function of a separate enzyme in bacteria. Which of the following explanations would you be most likely to accept?  
A) Random mutation has generated these multi-function eukaryotic enzymes.  
B) A polycistronic transcript in bacteria became a polycistronic transcript in eukaryotic cells.  
C) Several genes located near each other in bacteria became transcribed together and the intervening sequences spliced out.  
D) Similar regulatory elements for each of the prokaryotic proteins allowed them to be expressed together.  
E) None of the above
10. Which type(s) of genetic transfer lead to incorporation of new DNA into the bacterial chromosome?  
I. Conjugation mediated by F factor  
II. Hfr mediated conjugation  
III. Transduction  
IV. Transformation

- A) I and II only  
B) III and IV only  
C) II, III, and IV  
D) I, II, III, and IV  
E) None of these.
11. Which of the following forms of DNA repair does NOT require DNA polymerase?  
A) Direct DNA repair.  
B) Base excision repair.  
C) Nucleotide excision repair.  
D) Mismatch repair.  
E) Recombinational repair.
12. Which of these would be an example of a homeotic phenotype?  
A) The wings are shrunken and useless.  
B) The eyes of the fly are brown instead of the normal red.  
C) The first abdominal segment has legs.  
D) All of these.  
E) None of these.
13. Which of the following characteristics would best be used to distinguish eukaryotic chromosomes from prokaryotic chromosomes?  
A) Eukaryotic chromosomes are always linear; bacterial chromosomes are always circular.  
B) Eukaryotes have multiple chromosomes; all bacteria have only one chromosome.  
C) Eukaryotic chromosomes consist of protein and DNA (and associated RNA); bacterial chromosomes consist of DNA (and associated RNA) only.  
D) Histone proteins are a primary component of eukaryotic chromosomal proteins while histones appear to be lacking in bacterial chromosomes.  
E) Eukaryotic chromosomes are housed in a special membrane compartment (the nucleus), while no known bacterial chromosome is surrounded by any membrane other than the plasma membrane.
14. What is the most reasonable explanation for the observation that transposons in the human genome are more often found in nongenic sequences such as the centromere than in genic sequences?  
A) Insertion into nongenic DNA is less likely to have a negative phenotypic effect than insertion into genic DNA.  
B) The AT-rich nature of centromere and other nongenic sequences makes it easier for transposon insertion.  
C) Reverse transcriptase promotes integration into nongenic DNA preferentially.  
D) Genic DNA is protected from transposon insertion by all the transcription factors bound to the region.  
E) None of the above
15. QTL mapping determines the relationship between genes for quantitative traits and which of the following?  
A) The centromere  
B) The telomere  
C) Molecular markers such as RFLPs

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- D) Transposon sites
- E) Structural genes

16. Which statement regarding the human globin genes is likely to be correct?

- A) Myoglobin is probably more similar to  $\alpha$ -globin than is  $\beta$ -globin.
- B)  $\alpha$ -globin and  $\beta$ -globin are probably more similar to each other than they are to myoglobin.
- C) The globin genes in mice are probably more similar to those of humans than are globin genes of chimpanzees.
- D) All of these.
- E) None of these.

17. A paralog \_\_\_\_\_

- A) is found for every gene in mammals
- B) is only found on the X but not the Y chromosome
- C) can explain the lack of p phenotype for a gene knockout
- D) cannot be mutated
- E) has the same DNA sequence as the original duplicated gene

18. High heritability is best demonstrated in which of the following situations?

- A) Within a wild population of clover plants, there is a very low amount of variation in the number of leaves per stem.
- B) When studying obesity in a human population, there tends to be less variation within families than across the entire population.
- C) In a study of adopted children, the children's height is much more similar to that of their biological parents than their adoptive parents.
- D) The DNR maintains records of deer shot each hunting season. In drought years, the average weight is much lower than in years of sufficient rain.
- E) None of the above

III. 問答題 (28%):

1. The wild-type (W) *Abraxas* moth has large spots on its wings, but the lacticolor (L) form of this species has very small spots. Crosses were made between strains differing in this character, with the following results:

Cross	Parents		Progeny	
	♀	♂	F1	F2
1	L	W	♀ W	♀ 50% L, 50% W
			♂ W	
2	W	L	♀ L	♀ 50% W, 50% L
			♂ W	

Provide a clear genetic explanation of the results in these two crosses, showing the genotypes of all individual moths. (8%)

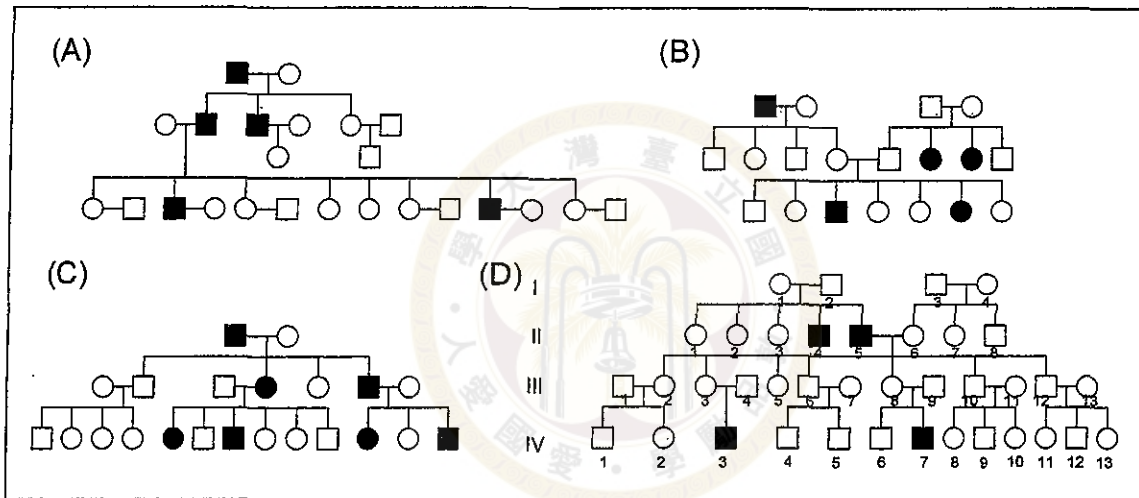
2. You have a white-eyed, male fruit fly with vestigial wings and a wild-type female known to be heterozygous for both traits. You know that vestigial is located on an autosome. What is the probability that a mating between these two flies will generate a female offspring with vestigial wings and white-eyes? (5%)

3. Four patterns of inheritance and four pedigrees are shown below. Assume that individuals marrying into the family are homozygous for the wild-type allele.

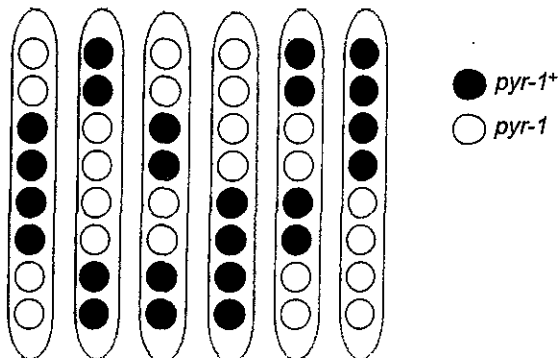
(i) Match each of the inheritance patterns with a pedigree and describe your reasons. (8%)

- a. Autosomal recessive \_\_\_\_\_
- b. Y-linked trait \_\_\_\_\_
- c. X-linked recessive \_\_\_\_\_
- d. Autosomal dominant \_\_\_\_\_

(ii) In pedigree (D), list all individuals that **MUST** be heterozygous and describe your reasons. (2%)



4. On chromosome 4 in *Neurospora*, the allele *pyr-1* results in a pyrimidine requirement for growth. A cross was made between a *pyr-1* and a *pyr-1*<sup>+</sup> (wild-type) strain and the following results were obtained



Total: 22 21 21 451 23 455

What is the distance between the *pyr-1* gene and the centromere? (5%)

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