

I. 單選題 (80%; 1-20 題各 3 分, 21-24 題各 5 分): ※注意：請於試卷上「選擇題作答區」依序作答。

1. In four-o'clock plants, red flower color is dominant to white flower color. However, heterozygous plants have a pink color. If a pink flowered plant is crossed with a white flowered plant, what will be the phenotypic ratios of their offspring?
  - A) 1/4 red, 1/2 pink, 1/4 white
  - B) all pink
  - C) all white
  - D) 1/2 pink, 1/2 white
  - E) 1/2 red, 1/2 pink
2. Besides mental impairment, humans with the disorder PKU develop light colored hair. What kind of genetic effect is this?
  - A) epistatic
  - B) pleiotropic
  - C) phenotypic
  - D) variable expressivity
  - E) incomplete penetrance
3. A ( $w^+$ ) red-eyed *Drosophila* female is crossed with a white-eyed male. Assuming the trait for eye color is sex-linked, what are the possible phenotypes of the progeny?
  - A) all red-eyed individuals
  - B) red- and white-eyed females and red- and white-eyed males
  - C) only red-eyed females and white-eyed males
  - D) both red- and white-eyed males and only white-eyed females.
  - E) none of the above
4. A P1 with blue-flowered, short-stalked plants and white-flowered, long-stalked plants is crossed as is the resulting F1. You find:
  - 400 blue, short.
  - 400 white, long.
  - 100 blue, long.
  - 100 white, short.What is the recombination frequency?
  - A) 0.25
  - B) 0.20
  - C) 0.08
  - D) 0.10
  - E) 0.05
5. You are analyzing a human pedigree for a new disease and discover that the disease occurs with the same frequency in both sexes and that 25% of the children from two unaffected heterozygous parents have the

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disease. This disease is displaying \_\_\_\_ inheritance.

- A) autosomal recessive
- B) autosomal dominant
- C) sex-linked recessive
- D) sex-linked dominant
- E) cannot be determined

6. Epigenetic inheritance may occur at which of the following stages?

- A) oogenesis
- B) spermatogenesis
- C) embryogenesis
- D) all of the above
- E) none of the above

7. You cross two yeast strains with two different mutations on the same chromosome. You detect a single crossover event. What type of asci is most likely?

- A) parental ditype
- B) nonparental ditype
- C) tetatype
- D) You need more information about the results of the cross.
- E) both parental and nonparental ditypes

8. In a complementation test, which of the following would indicate that two mutants are allelic?

- A) The *trans*-heterozygote has the mutant phenotype.
- B) The *trans*-heterozygote has the wild-type phenotype.
- C) The *cis*-heterozygote has the wild-type phenotype.
- D) The *cis*-heterozygote has the mutant phenotype.
- E) None of the above

9. Polycistronic messages in prokaryotes are often:

- A) Spliced to form the mature mRNA's
- B) The result of frame-shift mutations
- C) Grouped as polycistronic messages because they encode proteins in the same biochemical pathway
- D) Degraded as soon as they are synthesized, since monocistronic messages are the norm in prokaryotes
- E) Transcribed individually and then ligated to form the polycistronic message

10. Which of the following is strong evidence that a putative gene identified by sequence analysis of the genome functions as a *bona fide* gene *in vivo*?

- A) Presence of introns and exons in the genomic sequence
- B) Presence of a "start" and "stop" codon in the genomic sequence flanking relatively long ORFs interrupted by intron sequences

- C) Presence of mRNA in the cell with an ORF that corresponds precisely with the predicted exons in the putative gene
- D) All of the above
- E) None of the above
11. The polytene chromosomes of *Drosophila* are an example of \_\_\_\_\_.
- A) aneuploidy
- B) polyploidy
- C) translocations
- D) inversion loops
- E) none of the answers are correct
12. Which of the following provides for a higher level of stability in the mRNA?
- A) alternative splicing
- B) RNA editing
- C) 5' capping
- D) 3' polyA tailing
- E) trimming
13. Which of the following may account for the process of gene conversion?
- A) DNA mismatch repair
- B) DNA gap repair
- C) photolyase activity
- D) nucleotide excision repair
- E) more than one of the above
14. Bacteriophage  $\lambda$  inserts into a bacterial chromosome using which of the following?
- A) nucleotide excision repair
- B) endonuclease activity
- C) site-specific recombination
- D) DNA gap repair
- E) none of the answers are correct
15. In a given population of *Drosophila*, curly wings (*c*) is recessive to the wild-type condition of straight wings (*c*<sup>+</sup>). You isolate a population of 35 curly winged flies, 70 flies that are heterozygous for straight wings and 45 that are homozygous for straight wings. What is the total number alleles in the gene pool?
- A) 2
- B) 150
- C) 230
- D) 300
- E) none of the above

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16. The prevalence of the allele for sickle cell anemia in some populations is an example of?
- A) Heterogeneous environments
  - B) Balancing selection
  - C) Inverted selection
  - D) Non-Darwinian selection
  - E) Nonrandom mating
17. Some mariner elements show a high degree of similarity between organisms that are separated by millions of years of evolutionary time. What is the current explanation for this?
- A) Mariner is highly conserved.
  - B) Mariner was horizontally transferred by bacterium.
  - C) Mariner was horizontally transferred by virus.
  - D) Mariner elements in divergent species have arisen through inter-species breeding events.
  - E) All of the above
18. RNA interference:
- A) refers to antisense silencing of target mRNA translation.
  - B) occurs when post-transcriptional processing of the target mRNA is occurring in the nucleus.
  - C) occurs when double-stranded RNA is cleaved to siRNAs which in turn induce either the target mRNA degradation or interfere with its translation.
  - D) acts as a ribonucleoprotein complex always bound to the double-stranded RNA.
  - E) none of the above.
19. If a geneticist describes a trait as being 70% penetrant, what would they mean?
- A) The expression of the trait varies by individual.
  - B) The degree of expression of the trait is at least 70%.
  - C) It is lethal in 30% of the individuals who have the trait.
  - D) Only 70% of the individuals who carry the trait express the trait.
  - E) The trait is present in 70% of the population.
20. Proteins evolve at different rates because:
- A) introns are not under selection.
  - B) some base substitutions do not cause an amino acid substitution.
  - C) some amino acid substitutions occur in non-functional parts of a protein.
  - D) some mutations are more likely than others.
  - E) some proteins are more functionally constrained than others.
21. In rice, plants homozygous for the recessive allele *sd1* are relatively short in stature. Plants homozygous for a dominant allele, *Xa4*, corresponding to a second gene located on a different chromosome are resistant to bacterial blight. If a farmer crosses a plant homozygous for *sd1* with a plant homozygous for *Xa4* (assume the

plants are otherwise isogenic), which of the following statements is correct?

- A) The progeny will be monohybrids.
- B) The progeny will be dihybrids.
- C) 3/4 of the progeny will be resistant to bacterial blight, while 1/4 will be short.
- D) A and C
- E) A and B

22. A human disease associated with dysfunction of mitochondria, that results from a mutation in a single autosomal gene locus in nuclear DNA is most likely to:

- A) Be inherited from the mother, because mitochondria are not inherited from the father
- B) Show heteroplasmy in the progeny of affected individuals, depending on chance events during meiosis
- C) Show a nonMendelian inheritance pattern, because the number of mitochondria varies from cell to cell
- D) Show a Mendelian inheritance pattern
- E) None of the above

23. In humans, the Y-linked *SRY* gene encoded a protein that acts as a “master switch” to initiate sex determination and differentiation into a male. The expression of genes “downstream” of *SRY* result in, for example, elevated levels of the hormone testosterone; testosterone binding to a protein called the androgen receptor leads to further development of male characteristics. It turns out that certain mutations in the *SRY* gene result in phenotypic females who are genotypically XY; in addition, feminization of XY individuals can occur as a result of mutations in the androgen receptor that render it unable to respond to testosterone. The fact that feminization occurs in these individuals despite having a functional *SRY* gene is best described as an example of:

- A) Pleiotropy
- B) Polygenic inheritance
- C) Variable expressivity
- D) Incomplete penetrance
- E) Epistasis

24. *Ubx* (Ultrabithorax) is a *Drosophila* homeotic gene that normally has two key functions: Promote hind-wing development and repress forewing development. A nonlethal loss-of-function allele of *Ubx* might reasonably be expected to:

- A) Transform the forewing into a hindwing
- B) Transform the hindwing into a forewing
- C) Result in no development of either hindwing or forewing
- D) Result in growth of an eye structure instead of a wing structure
- E) Result in growth of an antenna structure instead of a wing structure

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二、問答題 (20%)

1. *Drosophila* females heterozygous for three recessive mutations, *a*, *b*, and *c*, were crossed to males homozygous for all three mutations. The cross yield the following results:

Phenotype	Number
+++	75
++c	348
+bc	96
a++	110
ab+	306
abc	65

(i) Construct a linkage map showing the correct order of these genes, and (ii) estimate the distances between them (10%).

2. Transposable elements can cause corn kernels to be spotted if they jump in or out of the color genes during the development of the kernel. However, the size of the spots can vary greatly. Please describe (in words and diagrams) the difference between the two kernels shown below at the molecular and developmental levels (10%).



Kernel A



Kernel B