

I. 單選題 (55%; 1-10 題各 3 分, 11-15 題各 5 分): ※注意: 請於試卷上「選擇題作答區」依序作答。

1. In some genetically engineered corn plants the dominant allele (*BT*) produces a protein that is lethal to certain flying insect pests that eat the corn plants. If the corn plant is heterozygous for *BT* and the farmer collects self-fertilized corn for next year's crop, what proportion of those plants would be toxic to insects?

- A) All plants
- B) 1/4
- C) 1/3
- D) 1/2
- E) 3/4

2. In rabbits, full coat color (*C*) is the dominant trait. A second allele, chinchilla (*cch*) is recessive to full coat color. Himalayan coat color (*ch*) is recessive to chinchilla and full coat colors, and albino (*c*) is recessive to all coat colors. If two chinchilla rabbits mate, what coat color is not possible in their offspring?

- A) full coat color
- B) chinchilla coat color
- C) Himalayan coat color
- D) albino coat color
- E) all coat colors are possible

3. Wild-type genes that can cause cancer through a gain-of-function mutation are:

- A) tumor suppressor genes
- B) oncogenes
- C) protooncogenes
- D) CDK inhibitors
- E) cyclin-dependent kinases

4. A given allele that results in a disease state in humans may nevertheless be propagated in the population because:

- A) The disease has a late onset, typically after affected individuals have already reproduced.
- B) An individual heterozygous for the disease allele and a wild-type allele has a reproductively selective advantage.
- C) It impairs reproductive fitness but not individual fitness.
- D) A and B
- E) A, B and C

5. In a population of *Drosophila*, 200 individuals have bright red eyes and are homozygous for the wild type allele of a specific gene, 28 individuals have bright red eyes and are heterozygous at that locus, and 13 individuals have dull brown eyes and are homozygous for a mutant version of the gene. What is the homozygous recessive genotype frequency?

- A) 0.05
- B) 0.11
- C) 0.17
- D) 0.83
- E) 0.95

6. Which of the following statements best describes the ground state for expression of genes in eukaryotic cells?
- A) Gene expression is “on” unless specifically inhibited by the binding of repressor proteins.
 - B) Gene expression is “off” unless specifically turned on by the binding of transcriptional activator proteins.
 - C) Gene expression is constitutively “on” in heterochromatin but is constitutively “off” in euchromatin.
 - D) Gene expression is constitutively “off” in heterochromatin but is constitutively “on” in euchromatin.
 - E) None of the above
7. Nearly half the human genome consists of DNA that can be classified by sequence as “transposable elements” yet many of these sequences are incapable of moving throughout the genome. This is attributed to:
- A) Lack of any transposon sequence encoding reverse transcriptase in the human genome
 - B) Accumulation of mutations in transposon-derived sequences that has rendered the sequences no longer functional
 - C) Now that modern humans have evolved, the genome will no longer tolerate change.
 - D) All human transposons originated as retroviruses, but without the original parent virus present no transposon movement can occur.
 - E) All of the above.
8. A likely explanation for abnormal human phenotypes associated with trisomies is:
- A) The presence of multigene families in the extra chromosomal copy
 - B) The extra chromosome has typically undergone significant rearrangements
 - C) Meiotic recombination
 - D) Altered gene dosage
 - E) All of the above
9. Errors in DNA replication are most often corrected by _____.
- A) SOS systems
 - B) Base excision repair
 - C) Nucleotide excision repair
 - D) Methyl-directed mismatch repair
 - E) None of the above
10. Which of the following procedures may be used to map genes in a fungi with an unordered tetrad ascus?
- A) Testcross
 - B) Monohybrid cross
 - C) Dihybrid cross
 - D) Chi-square analysis
 - E) Analysis of interference
11. 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?
- A) 1/32
 - B) 1/16
 - C) 1/8
 - D) 1/4
 - E) 1/2

12. In a particular plant, hairy leaves (H) are dominant to smooth leaves (h) and vining growth habit (V) is dominant to bushy (v). A vining plant with hairy leaves of unknown genotype was crossed to a bushy plant with smooth leaves. The resulting progeny all had bushy growth habit, but half had hairy leaves and half had smooth leaves. What was the genotype of the unknown parental vining plant with hairy leaves?

- A) $HHVV$
- B) $hhVv$
- C) $HHvv$
- D) $HhVv$
- E) $Hhvv$

13. Fruit flies can have black or tan body color. Black bodies are the result of a mutation in either the black (b) or ebony (e) gene. For both genes, the black body alleles are recessive to the tan body alleles. You have a vial of true-breeding flies with black bodies and decide to do a complementation test to determine the genotype of your flies. You cross your flies to two other black body mutant strains, $BBee$ and $bbEE$. In both cases, the F1 flies all have black bodies. The genotype of your unknown flies is:

- A) $bbee$
- B) $BBEE$
- C) $BbEe$
- D) $BBee$
- E) $bbEE$

14. A female fruit fly with singed bristles was mated with a male from a true-breeding wild type stock with long bristles. All of the F1 females had wild-type bristles and all of the F1 males had singed bristles. If the F1 flies are intercrossed, the expected ratio of long to singed bristles in the F2 flies is:

- A) 1:0 in both sexes (*i.e.* males and females will all have long bristles).
- B) 3:1 in both sexes.
- C) 3:1 in females, while all the males will have singed bristles.
- D) 1:1 in females, while all the males will have singed bristles.
- E) 1:1 in both sexes.

15. You conduct matings with two different Hfr strains and obtain the following data:

marker	% exconjugants carrying marker from	
	Hfr1	Hfr2
A	0	78
B	50	0
C	73	0
D	48	93
E	0	69
F	81	0
G	90	0

What is the order of these markers?

- A) DGFACBE
- B) DAEGFCB
- C) GFCBDEA
- D) BECAFGE
- E) CBDAEFG

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II. 問答題 (25%):

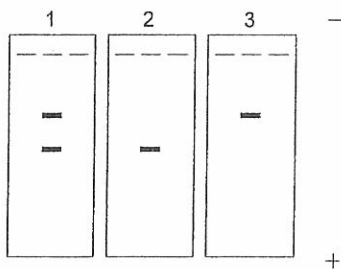
1. The allele *b* gives *Drosophila* flies a black body, and *b*⁺ gives brown, the wild-type phenotype. The allele *wx* of a separate gene gives waxy wings, and *wx*⁺ gives nonwaxy, the wild-type phenotype. The allele *cn* of a third gene gives cinnabar eyes, and *cn*⁺ gives red, the wild-type phenotype. A female heterozygous for these three genes is testcrossed, and 1000 progeny are classified as follows: (15%)

wild type	5
black, waxy, cinnabar	6
waxy, cinnabar	69
black	67
cinnabar	382
black, waxy	379
waxy	48
black, cinnabar	44

- Determine if any of these three loci are linked and, if so, show map distances
- Show the allele arrangement on the chromosome of the triple heterozygote used in the testcross.
- Calculate the interference, if appropriate.

2. The SBE1 gene in peas encodes “Starch Branching Enzyme 1.” When the dominant allele (“*R*”) of SBE1 is present, peas are round. The recessive allele (“*r*”) no longer encodes functional enzyme, due to the insertion of a fairly large segment of DNA (a transposon) in the SBE1 gene. If the dominant allele is SBE1 and is denoted by “*R*” and the recessive allele is ΔSBE1 and is denoted by “*r*”, answer the following questions and please **explain it**. (10%)

You prepare DNA samples from three pea plants and analyze the SBE-1 gene by agarose gel electrophoresis. Your results:



(1) If the DNA seen on gel 1 is from a pea plant heterozygous for “*R*” and “*r*” at the SBE1 locus, the DNA in lane 2 is most likely from a pea plant: (**explain your answer**)

- Homozygous for the “*R*” allele
- Homozygous for the “*r*” allele
- Unable to make functional starch branching enzyme 1
- That is making twice the normal amount of starch branching enzyme 1
- None of the above

(2) The relationship between the “*R*” and “*r*” alleles in a heterozygous pea plant when the phenotype of “DNA banding pattern on a gel” is considered, it is best described as: **(explain your answer)**

- A) Complete dominance (“*R*”) and complete recessiveness (“*r*”)
- B) “*R*” and “*r*” show incomplete dominance
- C) “*R*” and “*r*” show codominance
- D) Impossible to establish, because relationships of dominance and recessiveness only apply to easily detectable visible traits

III. 配合題 (20%)

1. (1) Prevents supercoiling ahead the replication fork.
(2) Responsible for the majority of DNA replication
(3) Fills in small regions of DNA where the RNA primers were located.
(4) Manufactures a 10-12 base segment of RNA.
(5) Synthesizes the lagging strand of the DNA

For the above question, choose from the following:

- a. DNA ligase
- b. DNA primase
- c. Topoisomerase
- d. DNA polymerase I
- e. DNA polymerase III

2. (1) Involves the addition or deletion of nucleotides.
(2) Converts an amino-acid codon to a termination codon.
(3) Does not involve a change in the amino acid structure of the protein.
(4) Changes a single amino acid in the protein.
(5) When a change in a single amino acid does not have a noticeable effect on the protein

For the above question, choose from the following:

- a. nonsense mutation
- b. missense mutation
- c. silent mutation
- d. frameshift mutation
- e. neutral mutation

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