

九十三學年度 生 命 科 學 系 (所) 甲 組碩士班入學考試
科目 遺 傳 學 科號 0807 共 4 頁第 1 頁 *請在試卷【答案卷】內作答

I. Multiple choice: Please pick the most suitable answer for each question (2 points each)

1. All of the following are different parts of a eukaryotic chromosome, except:
 - a. chromatid.
 - b. centrosome.
 - c. kinetochore.
 - d. telomere.
 - e. centromere.
2. What is the probability that a card drawn from a deck of cards is either an ace or a heart?
 - a. 16/52
 - b. 8/52
 - c. 1/4
 - d. 5/56
 - e. 4/52
3. If one parent is genotype *BbRr* and mates with another parent who is *bbrr*, what is the probability of one *Bbrr* offspring?
 - a. 1/2
 - b. 1/4
 - c. 3/4
 - d. 1/5
 - e. 1
4. Hemophilia is an example of an *X*-linked mutation. What is the probability of having a child with hemophilia if the grandmother of the mother is known to have the trait and the father is not a hemophiliac?
 - a. 1/2
 - b. 1/4
 - c. 1/8
 - d. 1/12
 - e. 1/16
5. A P_1 with blue-flowered, short-stalked plants and white-flowered, long-stalked plants is crossed as is the resulting F_1 . You find:
400 blue, short.
400 white, long.
100 blue, long.
100 white, short.
What is the recombination frequency?
 - a. 0.25
 - b. 0.2
 - c. 0.08
 - d. 0.1
 - e. 0.05

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6. The wobble hypothesis proposed:
- the existence of at least three tRNAs for each amino acid with codons that exhibit complete degeneracy.
 - the occurrence of four tRNAs for the six serine codons.
 - that when inosine is at the 5' end of an anticodon it can basepair with all four nucleotides.
 - that the distance and steric constraints of the 3' nucleotide of the anticodon would not allow all types of basepairing with the complementary mRNA to take place.
7. Which of the following is an operational definition of the gene?
- the basic unit of genetic information
 - the unit that controls a specific aspect of phenotype
 - the unit that specifies the synthesis of one polypeptide
 - the unit of function defined by the complementation test
 - all of the above
8. A mixture of two types of mitochondria within a cell is called:
- heteroplasmy.
 - homoplasmy.
 - alloplasmy.
 - heteroplastid.
 - none of the above.
9. Which of the following is not unique to eukaryotic gene regulation (i.e. it is also found in prokaryotes)?
- alternate splicing.
 - heat shock proteins.
 - hormone responsive elements.
 - euchromatin.
 - gene-dosage compensation.
10. Which of the following is a form of prezygotic reproductive isolation?
- Populations have different courtship patterns.
 - Gametes do not fuse.
 - Populations have different pollinators.
 - hybrids are inviable.
 - Populations live in different habitats.

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II. True or false – mark (T) for True and (F) for false statements (1 point each)

1. Mendelism

- (1). A chi-square is a statistic that a researcher uses to compare actual and expected data.
- (2). An allele is only the recessive form of a gene.
- (3). A genotype of an organism is the allelic constitution of that organism.
- (4). A true breeding strain of an organism maintains a large amount of genetic variability.
- (5). A principle of independent assortment states that in a heterozygote the 2 different alleles will separate from each other in gamete formation.
- (6). Recessive lethal mutations exist in a population for a very long period of time.

2. Complex traits

- (1). Covariance measures statistical association between two data sets; its sign is determined by the correlation coefficient.
- (2). A trait that varies widely will have a large variance.
- (3). A genotype that performs poorly in one environment will perform poorly in other environments.
- (4). Another name for a bell-shaped distribution is normal distribution.
- (5). Phenotypic variance includes both genetically and environmentally based variance.
- (6). The incidence of genetic diseases (whether multifactorial or single-gene) is higher in populations in which consanguineous marriages are common.

3. Linkage and mapping

- (1). A chromosomal inversion inhibits crossing over between sister chromatids.
- (2). A crossover cannot occur between an inverted and non-inverted chromatid of a tetrad.
- (3). The distance between 2 points on a genetic map of a chromosome is the total number of crossing over events between them.
- (4). Each crossover event produces two recombinant chromatids out of a possible four chromatids.
- (5). The larger the chromosome the more chiasmata it will have in Meiosis I.
- (6). If 18 out of 100 chromosomes are recombinant between two genes, then they are 0.18 cM apart.

4. Molecular genetics

- (1). The single origin of replication in *E. coli*, designated the *oriC*, has three repeat regions which are GC rich. These GC regions separate more easily than AT regions and are able to be opened with a lower input of energy.
- (2). In the experiment carried out by Meselson and Stahl, if the results of the first generation were DNA with hybrid density or "half heavy" and the second generation created molecules which were "quarter heavy", this would be indicative of dispersive replication.
- (3). The mechanism by which DNA replication is carried out is called semiconservative replication. Each of the parental strands of the DNA helix is paired with newly synthesized DNA in the new chromosomes.
- (4). In eukaryotes, two different polymerases are used in the synthesis of the leading and lagging strands, α and β respectively, whereas in prokaryotes the same polymerase is used in both.
- (5). Huberman and Riggs identified multiple replicons per chromosome and bi-directional replication in eukaryotes by pulse labeling cells with ^3H thymidine.

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- (6). Pol I is a single polypeptide capable of 5'→3' polymerase activity, 5'→3' and 3'→5' exonuclease activity, and is designated as the DNA replicase of *E. coli*.

5. Bacteria genetics

- (1). Conjugation can be defined as a process of DNA exchange which is insensitive to DNase and inhibited by the U-tube experiment.
- (2). A mating between *Hfr* × *F*⁻ converts the *F*⁻ to an *F*⁺ genotype.
- (3). The integrated *F* factor in an *Hfr* cell excises precisely during the formation of the *F'* plasmid.
- (4). Mapping genes using *Hfr*'s relies on the fact that during conjugation DNA moves from the donor to the recipient at a constant rate.
- (5). *Hfr*-generated maps measure distance in terms of the crossover frequency between two genes.
- (6). Specialized transduction requires a phage capable of lysogenic growth, such as λ or T phages, in order to integrate into the host chromosome.

III. Open end questions (10 points each)

1. What are the three main events of meiosis and what is its end result?
2. How does meiosis give rise to genetic variation and what is the significance of this?
3. A certain DNA virus has a base ratio of (A+G)/(C+T)=0.85. Is this a single- or double-stranded DNA? Please explain your answer.
4. Using two strains of T4, with genotypes *xyz* and *x⁺y⁺z⁺*, the results of recombination are as follows:

Class	Frequency
<i>x y z</i>	0.30
<i>x-y-z-</i>	0.31
<i>x y-z-</i>	0.05
<i>x-y z</i>	0.05
<i>x y z-</i>	0.12
<i>x-y-z</i>	0.14
<i>x y-z</i>	0.02
<i>x-y z-</i>	0.02

Are *x*, *y*, and *z* linked and what is the order of the genes?

5. According to Ernst Mayr, sympatric isolating mechanisms can be placed into two broad categories: premating and postmating. Give some examples of each of these. Which of the two is more adaptive, in terms of the metabolic energy investment of the population?