九十一學年度 生命科學院四所 碩士班研究生招生考試

科目 遺傳學 科號 0807 共 6 頁第 1 頁 *請在試卷【答案卷】內作答

I. 是非題，答案請填入答案卷上指定空格否則不予計分，○ for True and ， X for false，每題 0.5 分，答錯倒扣 0.2 分

1. Chromosome, meiosis and mitosis

(a) The structure that joins together the two sister chromatids after replication of chromosomes is called the telomere.

(b) The phase of the eukaryotic cell cycle during which growth and increase in cell mass occurs following cell division is called G_2 phase.

(c) Meiotic cell division is the process whereby the haploid chromosome number (n) is doubled to the diploid (2n) state during gamete formation.

(d) The characteristic feature of the centrosome is that it is not duplicated during mitosis so that only one of the daughter cells eventually receives it.

(e) The first stage of meiosis is called reductional division and the second stage is called equational division.

(f) Down syndrome is a genetic disorder that results from nondisjunction of chromosomes during mitosis.

(g) One of the most important features of meiotic cell division is that it minimizes genetic variation among sexually reproducing populations.

(h) Gametophytes are plants that produce haploid gametes that fuse to produce a diploid zygote.

2. Mutation

(a) mutation can be induced by mutagens

(b) point mutation, but not deletion, is very often reversible that a change in phenotype can mutate back to restore the original phenotype

(c) mutation on one gene can sometimes be suppressed by a mutation on a second gene and this is called an adaptive mutation

(d) mutation can be induced by needs

(e) cancer is believed to be a result of somatic mutation

(f) somatic mutations can be transmitted to the progeny

(g) spread of antibiotic resistant bacteria is a cause by a preferential mutation to antibiotic resistance

(h) spread of antibiotic resistant bacteria is a cause of selection

(i) mutation of mismatch repair genes increases the spontaneous mutation rate

(j) mutation abolishing the adenine methylation decreases the spontaneous mutation rate in *E. coli*

3. Bacterial gene expression

(a) An *LacI* mutant of *E. coli* can express the structure genes of *lactose* operon in the absence of lactose

(b) Catabolite repression of lactose operon gene expression is mediated by the *LacI*

(c) A nonsense mutation mapped to the *lacZ* gene will affect the transcription of the downstream *lacY-A* genes.

(d) A nonsense mutation mapped to the *lacZ* gene will affect the translation of the downstream *lacY-A* genes.

(e) *E. coli* with a deletion of the cAMP binding protein (*Cap*) gene cannot metabolize glucose

(f) *E. coli* with a deletion of *Cap* gene cannot efficiently utilize lactose and galactose.

(g) Bacterial mRNA is very often polycistronic that multiple polypeptides are transcribed from a single mRNA. These polypeptides are always translated in equal amount.

(h) Attenuation control of the transcription of *E. coli tryptophan* operon depends on the ability of a specific protein factor antagonizing the transcriptional termination factor rho.

(i) Attenuation control of the transcription of *E. coli tryptophan* depends on the ribosome pausing at specific site.

(j) bacteria express many different sigma factors that direct the binding of RNA polymerase to various promoters.

4. Genomics

(a) The budding yeast genome, *S. cerevisiae*, was the first prokaryotic organism to have its entire genome sequenced.

(b) Functional genomics does not include the three-dimensional structure of proteins.

(c) A sequence-tagged site is always expressed as part of a messenger RNA.

(d) A gene chip usually contains an array of sequences from known genes.

(e) Contig refers to cloned fragments of the genome and their physical relation to each other.

(f) In chromosome walking, cloning a gene affecting a phenotypic trait such as a disease is accomplished by moving from a molecular marker site to the gene of interest by sequential screening of the library with molecular probes at the ends of DNA clones.

(g) Chromosomal painting libraries of humans have been used to paint the chromosomes of primates to learn about human evolution.

(h) Genome evolution is unrelated to the genome sequencing projects currently underway.

(i) Genome sequencing projects have shown that blocks of genes are highly conserved.

5. Immunogenetics

(a) Antibody diversity is created by somatic hypermutation mutation in the B cell

(b) Antibody diversity is created by gene rearrangement in the germ line cell

(c) Mutations of the constant regions of an immunoglobulin are called monoclonal variation

6. Recombination

(a) A crossover cannot occur between an inverted and non-inverted chromatid of a tetrad.

(b) Map distance can be equal to the frequency of recombination.

(c) The distance between 2 points on a genetic map of a chromosome is the total number of crossing over events between them.

(d) If the frequency of recombination is greater than 50%, then the genes are linked.

(e) The larger the chromosome the more chiasmata it will have in Meiosis 1.

(f) If 18 out of 100 chromosomes are recombinant between two genes, then they are 0.18 cM apart.

(g) A chromosomal inversion inhibits crossing over between sister chromatids.

7. Mapping and linkage analysis

(a) If the genes are not linked, then nonparental ditype asci can be produced.

(b) Nonparental ditype asci can be produced by a two-strand double crossover between mutant loci.

(c) Ordered tetrads permit mapping of the loci responsible for chromosome movement.

(d) In duplication mapping, the duplication uncovers a recessive mutation that must lack a wild-type copy of the mutant gene.

(e) An lod value of -0.05 for two genes indicates that those genes are individually assorting.

(f) Cell hybridization is helpful in mapping human genes on a specific chromsosome.

8. DNA replication of prokaryotes

Multiple DNA polymerases are found in *Escherichia coli* (bacteria). DNA polymerase III is the key enzyme to replicate *E. coli* chromosome.

(a) 5' to 3' exonuclease activity of DNA polymerase is important for decreasing the rate of replicating error

(b) 3' to 5' exonuclease activity of DNA polymerase is important for decreasing the rate of replicating error

(c) DNA polymerase III is the key enzyme to replicate *E. coli* chromosome and its role in DNA replication cannot be replaced by other DNA polymerases. Consequently, we cannot isolate a DNA polymerase III mutant of any kind lacking polymerase activity.

(d) A DNA polymerase I mutant with a defective DNA polymerase is viable.

(e) A mutant lacking the 5' to 3' exonuclease activity of DNA polymerase I will affect the ligation of Okazaki fragments.

(f) The existence of Okazaki fragments proves that DNA replicate bidirectionally.

(g) The existence of Okazaki fragments proves that DNA replicated discontinuously.

(h) *E. coli* chromosome is a circular form DNA and has a single origin of replication. Consequently, the origin of replication is also the terminator of replication.

9. DNA replication of eukayotes

"Eukaryotic chromosome is linear. Eukaryotic chromosomes have a unique structure at their ends called telomere."

(a) Multiple origin of replication exist on a single eukaryotic chromosome.

(b) To replicate the linear chromosome, eukaryotic cells express a DNA polymerase that is capable of polymerization in a 3' to 5' direction.

(c) To replicate the linear chromosome, eukaryotic cells express a specific enzyme that can add short repeated sequence to the ends of chromosome without a template

(d) To replicate the linear chromosome, eukaryotic cells use an RNA-dependent DNA polymerase.

(e) Most of the normal human somatic cells lack the activity of enzyme to replicate telomere.

(f) There is a correlative relationship between telomere length and cell senescence.

10. Bacterial genetics

(a) Lambda phage can mediate specialized transduction because its integration into *E. coli* chromsome is not random.

(b) P1 phage can mediate generalized transduction because its integration into *E. coli* chromosome is random.

(c) Extrachromosomal copy of F plasmid can mediate chromosomal gene transfer at high frequency.

(d) An integrated F plasmid cannot transfer all the chromosomal genes at the same frequency.

(e) Transposable elements provides the portable homology for F plasmid to integrate at multiple chromosomal sites.

(f) If genes *a* and *b* are cotransduced at a frequency of 0.1%, while *a* and *c* are cotransduced at a frequency of 0.5%. The distance between genes *a* and *b* is shorter than *a* and *c*, because recombination rate is lower between genes *a* and *b*.

11. Repair

(a) DNA photolyase repairs the thymidine-dimer caused by ultraviolet irradiation

(b) excision repair requires the activity of RecA

(c) postreplication repair utilizes the activity of RecA

(d) postreplication repair is error prone

(e) Induction of SOS repair requires the activity of RecA

(f) SOS repair is error prone

(g) Ames test utilizes a bacterial strain with a low RecA activity to reduce the repair activity. In this case, the mutagenic effect of a mutagen is enlarged by reducing the repair activity.

12. Hybrid dysgenesis in *Drosophila* was discovered in the cross between laboratory strain and flies caught in the wild.
    (a) Hybrid dysgenesis can be observed in crosses of paternal flies from wild and maternal flies from a laboratory strain, but not in the reciprocal crosses
    (b) When hybrid dysgenesis occurs, only the male progeny of the cross can hatch (survive)
    (c) When hybrid dysgenesis occurs, the survived progeny is sterile
    (d) Hybrid dysgenesis is caused by a transposable element
    (e) It is a sex-linked inheritance
    (f) It is a sex-influenced trait

II. 簡答題，每題七分

1. For the following tabulation of testcross progeny phenotypes and numbers, state which locus is in the middle, and construct the genotype of the tested triple heterozygotes (genotypes of the parents).

C D E	9
C D e	78
C d e	35
C d E	275
c D E	27
c D e	256
c d E	81
c d e	11

2. Hemophilia, a genetic disease in humans which causes the afflicted to have problems forming blood clots, is caused by a recessive allele of an *X*-linked gene. In a sample of 2000 (50% female and 50% male) you find 95 males and 5 females have hemophilia. Calculate the allele and genotype frequencies in this population, assuming males are in Hardy-Weinberg equilibrium. Do females appear to be in Hardy-Weinberg equilibrium?

3. How would you determine if a trait was dominant or recessive?

4. Assuming wobble can occur, what two codons could be recognized by the anticodon 3'-GAG-5'? Write the codon in the 5'-3' direction.

5. What kind of cytogenetic evidence would be needed to prove that recombination was caused by physical exchange between paired chromosomes?

6. How do you determine whether a particular mutation in phage is a deletion?

III. 申論題 15 分

1. You are interested in studying a dominant disease gene X of mouse. You have cloned a piece of genomic DNA that you suspect to carry the disease X gene. Assuming that you can do all the experiments you want to. How can you prove that the understudied genomic DNA carries the candidate gene of disease X? **(Multiple experimental approaches are preferred)** Can you predict (guess) the function of this gene once you have the gene cloned? How?