I. 解釋名詞 (18%)：

(1) Epistasis
(2) Dosage compensation
(3) RNA interference
(4) Retrotransposon
(5) Homeobox
(6) C-value paradox

II. 單選題 (66%)： ※ 注意：請於試卷上「選擇題作答區」依序作答。

1. A new phenotype not seen in the parents can arise by:
A) gene interaction
B) co-dominance
C) complementation
D) none of the above
E) all of the above

2. What aspect of chromosome behavior most clearly accounts for Mendel's law of segregation?
A) Movement of sister chromatids to opposite poles at anaphase II of meiosis.
B) Movement of homologous chromosomes to opposite poles at anaphase I of meiosis.
C) Crossing over between homologous chromosomes during prophase I of meiosis.
D) Replication of chromosomes prior to meiosis.
E) Independent alignment of different homologous pairs on the metaphase I spindle.

3. In chickens, it is the females that have two different sex chromosomes (Z and W) while the males have two Z chromosomes. A Z-linked gene controls the pattern of the feathers with the dominant B allele causing the barred pattern and the b allele causing non-barred feathers. You cross a barred female with a non-barred male. What do you expect for the phenotype of the progeny?
A) daughters all one type, sons all the other type
B) daughters and sons of both types
C) sons of one type, daughters of both types
D) daughters of one type, sons of both types
E) none of the above

4. In tetrad analysis, second-division segregations result from:
A) single crossovers between linked genes
B) double crossovers between linked genes
C) single crossovers between a gene and a centromere
D) independent assortment of unlinked genes
E) nondisjunction of homologs

5. A suppressor tRNA can suppress a:
A) nonsense mutation
B) missense mutation
C) deletion mutation
D) frameshift mutation
E) silent mutation

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6. The hydrolysis of an -NH2 group from a base is called _____, while intercalating agents such as *proflavin* function as mutagens by causing _____:

A) deamination; transversions
B) deamination; deletions or insertions
C) excision repair; deletions or insertions
D) excision repair; transversions
E) deletion; transitions

7. The fact that the human proteome is larger than predicted by the genome is due to:

A) alternative splicing
B) chemical modifications of proteins
C) large number of paralogs
D) variations in domain architecture
E) all of the above

8. For linkage analysis, what variable most determines a marker's ability to predict genotype?

A) presence on the X chromosome
B) map distance from allele
C) size of restriction fragment
D) size of disease gene
E) recognition sequence

9. A normal female who is homozygous for a mutation in Xist which renders it inactive would have which of the following characteristics?

A) no telomerase activity
B) An inability to form Barr bodies
C) Inability to form constituative heterochromatin
D) Reduced levels of DNA replication
E) None of the above

10. Crossover suppression is a characteristic of _____:

A) translocations
B) transposition
C) deletions
D) aneuploidy
E) inversions

11. Which of the following can contribute to evolution of a species?

A) amphidiploidy
B) transposable elements
C) translocations
D) all of the above
E) none of the above

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12. A transposon inserts into an operon. What are the likely consequences?

A) all genes are knocked out

B) downstream genes are knocked out

C) flanking genes cotransduce less

D) a & c

E) b & c

13. You perform a generalized transduction mapping experiment by growing phage on a wild-type host and transducing a recipient that is mutant for three genes. The results are shown in the table below:

phenotype	number of transductants
$F^+M^-R^-$	116
$F^+M^+R^-$	447
$F^+M^-R^+$	7
$F^-M^+R^+$	490

What is the order of the genes?

A) RFM

B) MRF

C) FMR

D) a or b

E) b or c

14. A cross is conducted between isogamous algae that show uniparental inheritance where mtDNA is inherited from one parent and cpDNA is inherited from the other. A mutation in cpDNA causes a yellow color, and a mutation in mtDNA confers chloramphenicol resistance. From the following mating:

yellow/chloramphenicol resistant × green/chloramphenicol sensitive

Which of the following ratios might be observed in the resulting haploid progeny?

A) 2 yellow/resistant, 2 yellow/sensitive

B) 2 green/resistant, 2 green/sensitive

C) 4 green/sensitive

D) 4 green/resistant

E) 1 yellow/resistant, 1 yellow/sensitive, 1 green/resistant, 1 green/sensitive

15. Which of the following is a common consequence of mutations that eliminate cell-cycle checkpoints?

A) increased DNA repair

B) decreased frequency of cell division

C) arrest

D) aneuploidy

E) decreased mutation

16. Eukaryotic cells are able to carefully regulate precise levels of transcription in specific genes encoding structural proteins through:

A) complex enhancer elements that can associate with multiple activator and repressor proteins

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B) production of different types of sigma factors
C) attenuation
D) all of the above
E) none of the above

17. If a yeast *cdc28* mutant arrests as unbudded cells and a *cdc7* mutant arrests as budded cells after a shift from permissive to restrictive temperature, what will the phenotype of the double mutant be at restrictive temperature if the *cdc28* gene product acts before the *cdc7* gene product in the cell cycle?
A) arrests as budded cells
B) arrests as unbudded cells
C) arrests as a mixture of budded and unbudded cells
D) lethal
E) wild-type (cells in various stages of the cell cycle)

18. Which of the following statements is false?
A) Haploinsufficiency describes a situation where one wild-type copy of a gene is not enough for normal development to occur.
B) RNAi can be used to create a phenocopy that mimics a loss-of-function mutation
C) Gain-of-function mutations produce either excess protein or a new form of a protein
D) The ectopic phenotype is the one that is expressed in the double mutant
E) *In situ* RNA hybridization can be used to determine where in a developing organism a gene is expressed

19. Which of the following is not a form of a loss-of-function mutation?
A) ectopic gene expression
B) hypomorphic mutation
C) conditional mutation
D) knockout mutation
E) all of the above are loss-of-function mutations

20. In humans, *brachydactyly* is a dominant condition. 173 people in a population of 372 show the disease [50 are *BB*, 123 are *Bb*] and 199 are normal phenotypes (*bb*). The frequency of the *b* allele in this generation is:
A) 0.58
B) 0.30
C) 0.70
D) 0.53
E) 0.13

21. *The enzyme primase is required for DNA replication because:*
A) primase breaks the hydrogen bonds holding the two strands together
B) DNA polymerase can only add bases to an existing nucleic acid strand
C) the enzyme binds small pieces of DNA together
D) the primase corrects any errors made by the DNA polymerase
E) None of the above

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22. A feature of chromatin remodeling is that:

A) it can turn on transcription but cannot silence genes

B) the modified state of chromatin can be passed on when DNA replicates

C) it involves only the addition of methyl groups to DNA

D) it requires RNAi

E) None of the above

III. 問答題 (16%):

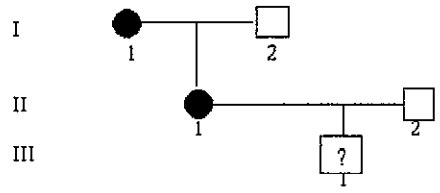
1. A trihybrid (3 genes heterozygous) produces the following gametes:

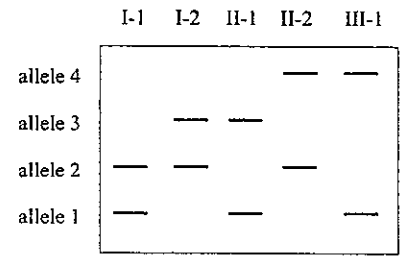
ABC	46
Abc	63
ABc	4
aBc	381
abc	38
aBC	71
abC	2
AbC	395
Total	1000

What is the order and map distance between the three genes? (8%)

2. In a certain breed of plants, thorns are determined by the dominant allele *T* and thornless is determined by the recessive allele *t*. *T* is 80% penetrant in the heterozygote; 20% of heterozygotes will appear thornless. If you make the parental cross *TT* × *tt*; what would be the expected number of phenotypes (thorny: thornless) observed in a population of 500 F2 plants? (4%)

3. Microsatellites are very useful as DNA markers. The multiple alleles can be detected as PCR products of different sizes. One particular microsatellite has 4 alleles in the population and is closely linked to an autosomal dominant form of early Alzheimer's disease. A pedigree and microsatellite analysis of a family with a history of early Alzheimer's disease is indicated below:





(1) Which allele is associated with early Alzheimer's disease in this family? (2%)

(2) Will the male III-1 develop early Alzheimer's disease? (2%)

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