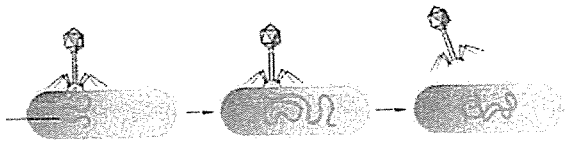
一、 選擇題: (2 points each) ※ 注意：請於試卷內之「選擇題作答區」依序作答。

1.



The above figure represents the research of Hershey and Chase. The significance of the Hershey and Chase experiments in which ^{32}P and ^{35}S were used is that

a. DNA labeled with ^{35}S and proteins labeled with ^{32}P can be traced in the course of an experiment.
b. they demonstrated that DNA labeled with ^{32}P is transferred from the bacteriophage to the virus.
c. they established that proteins labeled with ^{35}S become deactivated and unable to be transferred.
d. they demonstrated that bacteriophages transfer their DNA, not their protein coats, into their hosts.
e. DNA may be the hereditary material; although, bacteriophages transfer both DNA and proteins into their hosts.

2. DNA contains all of the following nitrogen-containing bases EXCEPT
a. adenine.
b. uracil.
c. guanine.
d. thymine.

3. DNA replication is
a. redundant.
b. semiconservative.
c. progressive.

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d. conservative.
e. repetitive.

4. DNA and RNA are alike in
a. the pentose sugar.
b. all the nitrogenous bases used to assemble the genetic code.
c. the number of strands.
d. their function in genetics.
e. none of these.

5. Before messenger RNA is mature,
a. all exons are deleted and removed.
b. a cap and a tail are provided.
c. anticodons are assembled.
d. the transfer RNA transfers the messenger RNA to the ribosome.
e. the single RNA strand duplicates itself in much the same way as DNA.

6. Of all the different genetic codons that exist, three of them
a. are involved in mutations.
b. do not specify a particular amino acid.
c. cannot be copied.
d. provide instructions such as STOP.
e. do not specify a particular amino acid and provide instructions such as STOP.

7. Which of the following statements is true?
a. Gene mutations occur independently of each other.
b. Gene mutations are relatively rare.
c. Ionizing radiation causes chromosomal damage and free radical formation.
d. Mutations are random; that is, it is impossible to predict exactly when a specific gene will mutate, but an expected frequency can be assigned.
e. All of these are true.

8. Adding acetyl groups makes genes accessible to transcription by
a. increasing the pH of the cell.

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b. making histones loosen their grip on the DNA molecule.
c. modifying the nucleotides of the promoter region of the DNA molecule.
d. enhancing the activity of RNA polymerase.
e. enhancing the development of a DNA-RNA hybrid.

9. Homeotic genes generally control
a. X chromosome inactivation.
b. mapping the basic body plan.
c. hormone synthesis.
d. dosage compensation.
e. none of these.

10. In the ABC model of flower development in *Arabidopsis thaliana*, mutation of the A group gene in *Arabidopsis thaliana* affects development in its flower's
a. first whorl only.
b. second whorl only.
c. third whorl only.
d. first and second whorls.
e. second and third whorls.

11. A gene can be silenced by the addition of what to a nucleotide?
a. $-CH_3$
b. -COOH
c. -OH
d. $-NH_2$
e. $-PO_4^{-3}$

12. Various forms of a single gene at a given locus is called
a. kinetochores.
b. alleles.
c. autosomes.
d. loci.
e. chromatids.

13. The most accurate description of an organism with genotype *AaBb* is

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a. homozygous dominant.
b. heterozygous.
c. heterozygous dominant.
d. homozygous recessive.
e. heterozygous recessive.

14. For Mendel's explanation of inheritance to be correct,
a. the genes for the traits he studied have to be located on the same chromosome.
b. the combination of gametes at fertilization has to be due to chance.
c. genes cannot be transmitted independently of each other.
d. only diploid organisms demonstrate inheritance patterns.
e. none of these apply.

15. In ____, a pair of nonidentical alleles affecting two phenotypes for a given trait are both expressed at the same time in heterozygotes.
a. pleiotropy
b. polygenic inheritance
c. complete dominance
d. codominance
e. a multiple allele system

16. Genes at one locus that affect the expression of genes at a different locus are said to be
a. epistatic.
b. linked.
c. codominant.
d. penetrant.
e. alleles.

17. A bell-shaped curve of phenotypic variation is indicative of
a. incomplete dominance.
b. continuous variation.
c. multiple alleles.

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d. epistasis.
e. environmental variables on phenotypes.

18. Which of the following is not potentially part of a chromosome in eukaryotes?
a. centromere.
b. histone.
c. sister chromatid.
d. nucleosome
e. all of these are part of a eukaryotic chromosome.

19. All of the different kinds of RNA are transcribed in the
a. mitochondria.
b. cytoplasm.
c. ribosomes.
d. nucleus.
e. endoplasmic reticulum.

20. Which of the following causes DNA to wrap tightly around histones essentially preventing transcription?
a. methylation
b. acetyl CoA
c. nitrogenation
d. dehydration
e. carbonation

21. James Watson and Francis Crick
a. were both English researchers working at Cambridge University.
b. performed elegant experiments in DNA chemistry.
c. constructed an accurate model of the DNA molecule illustrating its structural simplicity.
d. performed experiments that convinced scientists that DNA is a double-stranded molecule.
e. did all of these

22. Uracil will pair with

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a. ribose.
b. adenine.
c. cytosine.
d. thymine.
e. guanine.

23. The ABO blood types are controlled by
a. pleiotropy.
b. multiple alleles.
c. incomplete dominance.
d. codominance.
e. multiple alleles and codominance.

24. A gene that produces multiple effects is called
a. a multiple allele.
b. an autosome.
c. an epistatic gene.
d. a pleiotropic gene.
e. an incompletely dominant gene.

25. The relationship between strands of RNA and DNA is
a. antagonistic.
b. opposite.
c. complementary.
d. an exact duplicate.
e. unrelated.

26. Two parents affected with a genetic disease have five children, all of whom are affected. Which one statement must be true?
a. Both parents must have at least one mutant allele; the trait might be dominant or recessive.
b. Both parents must be homozygous for a recessive trait.
c. At least one parent must be homozygous.
d. At least one parent must be homozygous for a dominant trait.

27. One difference between epistasis and dominance is that

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a. epistasis occurs between two different genes while dominance occurs between alleles at one gene.
b. only epistasis is influenced by environmental interactions.
c. dominant traits are completely penetrant, while epistatic interactions may not be.
d. dominant traits may show variable penetrance, epistatic interactions may not.

28. If the genes a and b show 50 percent recombination, genes a and c show 35 percent recombination, and genes b and c show 32 percent recombination, then
a. genes a and b are on the same chromosome, and 50 map units apart.
b. genes a and b are on different chromosomes.
c. genes a and b are on the same chromosome, and 67 map units apart.
d. One cannot tell if genes a and b are on the same or different chromosomes from the given data.

29. Transcription in eukaryotes is activated if activators are bound to
a. enhancer elements
b. promoter elements
c. the operator
d. both a and b

30. Which of the following is true about both mitochondrial and chloroplast genomes?
a. both are small in size, typically only 16-18 kb.
b. Both have only one copy of rRNA genes.
c. Both have a similar density in a CsCl density gradient.
d. Both have double-stranded, circular, supercoiled genomes that typically exist in multiple copies per organelle.

二、 簡答題

1. In tomatoes, cut leaf and potato leaf are alternative characters, with cut (*C*) dominant to potato (*c*). Purple stem and green stem are another pair of alternative characters, with purple (*P*) dominant to green (*p*). A true-breeding cut, green tomato plant is crossed with a true-breeding potato, purple plant, and the F1 plants are allowed to interbreed. The 320 F2 plants were phenotypically 189 cut, purple; 67 cut, green; 50 potato, purple; and 14 potato, green. Propose a hypothesis to explain the data, and use the X^2 (Chi Square) test to test the hypothesis. **(10 points)**

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Degrees of Freedom (df)	Probability (p)									
	0.95	0.90	0.80	0.70	0.50	0.30	0.20	0.10	0.05	0.01	0.001
1	0.004	0.02	0.06	0.15	0.46	1.07	1.64	2.71	3.84	6.64	10.83
2	0.10	0.21	0.45	0.71	1.39	2.41	3.22	4.60	5.99	9.21	13.82
3	0.35	0.58	1.01	1.42	2.37	3.66	4.64	6.25	7.82	11.34	16.27
4	0.71	1.06	1.65	2.20	3.36	4.88	5.99	7.78	9.49	13.28	18.47
5	1.14	1.61	2.34	3.00	4.35	6.06	7.29	9.24	11.07	15.09	20.52
6	1.63	2.20	3.07	3.83	5.35	7.23	8.56	10.64	12.59	16.81	22.46
7	2.17	2.83	3.82	4.67	6.35	8.38	9.80	12.02	14.07	18.48	24.32
8	2.73	3.49	4.59	5.53	7.34	9.52	11.03	13.36	15.51	20.09	26.12
9	3.32	4.17	5.38	6.39	8.34	10.66	12.24	14.68	16.92	21.67	27.88
10	3.94	4.86	6.18	7.27	9.34	11.78	13.44	15.99	18.31	23.21	29.59
	Nonsignificant								Significant		

2. In maize, a dominant allele *A* is necessary for seed color, as opposed to colorless (*a*). Another gene has a recessive allele *wx* that results in waxy starch, as opposed to normal starch (*Wx*). The two genes segregate independently. An *Aa Wx Wx* plant is testcrossed. What are the phenotypes and relative frequencies of offspring? **(5 points)**
3. Why are polyploids with even multiples of the chromosome set generally more fertile than polyploids with odd multiples of the chromosome set? Explain it. **(5 points)**
4. Both fragile X syndrome and Huntington disease are caused by trinucleotide repeat expansion. Individuals with fragile X syndrome have at least 200 CGG repeat at the 5'end of the FMR-1 gene. In contrast, individuals with Huntington disease have 36 or more in-frame CAG repeats within the protein-coding region of the *huntingtin* gene.
   a. Do you expect gene expression at the two genes to be affected in the same way by these repeat expansions? Explain your answer. **(3 points)**
   b. Based on your answer to (a), why might fragile X syndrome be recessive, whereas Huntington disease is dominant? **(4 points)**
   c. Generate a hypothesis to explain why is the number of trinucleotide repeats needed to cause a disease phenotype is different at each gene. **(3 points)**
5. In Drosophila mutants *A*, *B*, *C*, *D*, *E*, *F*, and *G*, all have the same phenotype: the red pigment in the eyes. In pairwise combinations in complementation tests, the following results were produced, where + = complementation and − = no complementation.

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	A	B	C	D	E	F	G
G	+	−	+	+	+	+	−
F	−	+	+	−	+	−	
E	+	+	−	+	−		
D	−	+	+	−			
C	+	+	−				
B	+	−					
A	−						

a. How many genes are present? **(2 points)**

b. Which mutants have defects in the same gene? **(3 points)**

6. Use the following two-point recombination data to map the genes concerned, and show the order and the length of the shortest intervals. **(5 points)**

Gene Loci	% Recombination
a,b	50
a,c	15
a,d	38
a,e	8
b,c	50
b,d	13
b,e	50
c,d	50
c,e	7
d,e	45

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