I. True or False (2.0 points for each question, 40 points)

1. Sister chromatids are segregated in meiosis I.
2. Meiosis involves pairing of homologous chromosomes
3. Normal recessive alleles do not produce functional products.
4. Dominance is the condition in which one allele of a gene pair completely masks or inhibits phenotypic expression of the other allele.
5. A trait exhibiting incomplete penetrance is not expressed at the same degree among all individuals expressing it.
6. Epistasis involves intra-allelic gene interaction.
7. Pleiotropy is the condition where a single gene affects multiple, apparently unrelated, phenotypic traits.
8. Complementation test can be used to determine if mutations from different organisms that exhibit the same phenotype are allelic.
9. Chi-square independence test can be used to test if a population's genotypes are in Hardy-Weinberg equilibrium.
10. Criss cross is the equivalent term as reciprocal cross.
11. DNA is a string of deduced ribonucleotides.
12. The two strands of DNA are held together by nitrogen bonds.
13. Addition of a new nucleotide to a DNA molecule creates a phosphodiester bond and releases a pyrophosphate molecule.
14. During sexual reproduction, meiosis is only happened in the diploid germ-line cells.
15. Transposable element is not DNA.
16. When RNA polymerase binds to the 3' upstream of the DNA promoter region, the transcription initiates.
17. 20 amino acids are coded by only four unique bases (A, U, G, C) in mRNA.
18. Within all cells, the translation machinery resides within a specialized organelle called the nucleosome.
19. Genetic modified organism (GMO) is created by recombinant DNA technology.
20. RNA interference (RNAi) is a process that RNA inhibits gene expression.

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※ 本大題請於試卷內之「選擇題作答區」依序作答。

II. Choice (2.0 points for each question, 40 points)

1. Compare and contrast Mendel's principle of segregation and the principle of independent assortment. Please choose correct descriptions:

   (A). Both principles involve segregation of alleles during meiotic anaphase I.

   (B). Both principles can be demonstrated only if the two parental plants possess different phenotypes encoding a character.

   (C). The principle of segregation can be observed in mitosis.

   (D). All above answers.

2. Two gene loci, A and B, are unlinked (and thus assort independently), and alleles A and B are dominant over alleles a and b. A man has either an AaBB or AABb genotype with equal probability. What is the overall probability that the man will produce an AB gamete? (A) 0 (B) 1/4 (C) 1/2 (D) 1.

3. An F2 segregation population showed two distinct phenotypes: 152 pink color and 48 white color. Which of following expected ratios departure from this observation? (A) 3:1 (B) 13:3 (C) 9:7.

4. Which of following phenomena can **NOT** alter expected Mendelian phenotypic ratio in a genetic cross? (A) Linkage (B) Somatic mutation (C) Epitasis (D) Environmental Effect

5. In *Drosophila melanogaster*, cut wings (*ct*) is recessive to normal wings (ct^+), sable body (*s*) is recessive to gray body (s^+), and vermilion eyes (*v*) is recessive to red eyes (v^+). All three recessive mutations are X-linked. A female fly with cut wings, sable body, and vermilion eyes is crossed to a male with normal wings, gray body, and red eyes. The F_1 females produced by this cross were mated with cut, sable, vermilion males in a testcross. The following are the progeny resulting from the testcross.

v	*ct*	*s*	510
v^+	*ct*	*s*	1
v^+	ct^+	*s*	14
v^+	ct^+	s^+	500
v^+	*ct*	s^+	73
v	*ct*	s^+	20
v	ct^+	*s*	81
v	ct^+	s^+	1
Total	→		1200

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What following descriptions are corrected?

(A). The order of these genes is (s^+ v^+ ct^+) or (ct^+ v^+ s^+).

(B). The genetic distance between *s-v* is 13.0 cM.

(C). The interference is 0.417.

6. Red-green color blindness is X-linked recessive. A woman with normal color vision has a father who is color blind. The woman has a child with a man with normal color vision. Which phenotype is NOT expected for the child? (A) A color-blind female (B) A color-blind male (C) A noncolor-blind female (D) A noncolor blind male.
7. If the probability of being blood-type A is 1/8 and the probably of blood-type O is 1/2, what is the probability of being either blood-type A or blood-type O ? (A) 1/8 (B) 1/16 (C) 5/8 (D) 1/2.
8. A plant heterozygous for three independent assorting genes AaBbCc is self-fertilized. How many self-fertilized progenies you need to sow in order to have 95% confidence to find at least one plant having the AAbbCC genotype? (A) 1280 (B) 320 (C) 191 (D) 64.
9. Species A has 2n=14 chromosomes and species B has 2n=10. How many chromosomes would be found in an allotetraploid derived from species A and B? (A) 28 (B) 24 (C) 20 (D) 12.
10. Which of the following factor can change allele frequency in a population over time? (A) Inbreeding (B) Recombination (C) Epitasis (D) Mutation.
11. Which of the following components does **NOT** essential for a success PCR (polymerase chain reaction)? (A) DNA oligo primers (B) dNTP (C) $CaCl_2$ (D) DNA polymerase.
12. Reverse transcriptase (RT) is an enzyme used to generate: (A) cRNA from DNA (B) DNA from protein (C) cDNA from RNA (D) cDNA from protein
13. Which of the following items is **NOT** a molecular marker used for DNA fingerprinting? (A) Short tandem repeat (B) Single nucleotide polymorphism (C) Restriction fragment length polymorphism (D) Zinc-finger motif.
14. DNA fragments that are 1 kb, 100 bp and 500 bp in length are separated by 1% agarose gel electrophoresis. Which fragment will migrate farthest in the gel? (A) 500 bp fragment (B) 100 bp fragment (C) 1kb fragment (D) All migrate equal distances.

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15. The Ti plasmid can be used to transfer gene into plants. The Ti plasmid was originated from (A) Virus (B) Phage (C) Agrobacterium (D) Arabidopsis.
16. Gene expression can be regulated by changes in RNA stability. Which of the following does **NOT** control the stability of eukaryotic mRNA? (A) 3'UTR (B) 5'cap (C) TATA box (D) 5'UTR.
17. Through wobble, a single "X" can pair with more than one "Y". (A) X =codon, Y=anticodon (B) X=anticodon, Y=codon (C) X=amino acid, Y=tRNA (D) X=group of three nucleotides in DNA, Y=codon in mRNA.
18. What is the function of the signal sequence at the amino end of the protein? (A) Bind the protein to DNA (B) Fold the protein into secondary structure (C) Tell the protein to degrade after translation (D) Directs the protein to a specific location in the cell.
19. Typical restriction enzymes recognize and make "X" in "Y" at specific site. (A) X=single-stranded cuts, Y=DNA (B) X=single-stranded cuts, Y=Protein (C) X=double-stranded cuts, Y=DNA (D) X=double-stranded cuts, Y=RNA.
20. Epigenetic changes modify the expression of the gene by (A) adding acetyl group to DNA (B) adding methyl group to DNA (C) adding ribose to DNA (D) adding RNA to DNA.

III. Assay (20 points)

1. (5 points) In rice, two pure-breeding lines without awns were intercrossed, and all F1 progenies had no awn. However, by self-pollinating an F1 progeny, 131 F2 progenies had no awn, while 29 F2 progenies showed awns. Please deduce the genotypes of these phenotypes (including two parental lines, F1 and F2 progenies) with clearly defined gene symbols and use Chi-square goodness-of-fit test to validate your answer.

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2. (5 points) Hybrid male sterility was found in the F1 hybrid made from intercross between cultivated rice T65 and the wild rice *Oryza glumaepatula*. The F1 hybrid exhibits partial pollen sterility, but its pistils can accept fertile pollen and produce mature seeds. By cross-pollinating T65 (as the paternal parent) to an F1 plant, 73 BC1 progenies showed complete fertile and 27 BC1 progenies showed partial pollen sterility. In addition, by self-pollinating an F1 progeny, 141 F2 progeny exhibited complete fertile and 109 F2 progenies exhibited partial pollen sterility. Please deduce the genotypes of these phenotypes with clearly defined gene symbols and use Chi-square goodness-of-fit test to validate your answer.

Critical values of the χ^2 distribution				
df	1	2	3	4
α=0.05	3.841	5.991	7.815	9.488

3. (10 points) Your professor gave you a tomato plant and told you this tomato plant has a special jellyfish gene (GFP) to make it fluorescent in the dark. Your professor also gave you the DNA sequence of this GFP gene, and asked you to design experiments to answer the following questions:
   (1) Several methods can check the copy number of the GFP gene in the plant, please describe one technology.
   (2) How do you confirm the RNA expression of the GFP gene? Please describe one method.
   (3) If you detect the jellyfish gene and its expression in this tomato plant, but the plant does not fluorescent in the dark, please explain why.

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