1. For each of the terms in the upper section (a to o), choose the best matching phrase in the lower section (1 to 15). 請從 **1** 至 **15** 的選項中，選出最適合形容或解釋 **a** 到 **o** 的遺傳學專有名詞 (15 points, 1 point each)

a. Alleles
b. Law of segregation
c. Epistasis
d. Chiasma
e. Okazaki fragments
f. Hydrogen bond
g. Locus
h. Nondisjunction
i. Interphase
j. Incomplete dominance
k. Law of independent assortment
l. Synapsis
m. Anaphase
n. Pleiotropy
o. Hemizygous

1. Failure of homolog separation in meiosis I or chromatid separation in meiosis II
2. Describes genes present in only one copy such as those on the X in males
3. Alternate forms of a gene
4. Alleles of one gene separate into gametes randomly with respect to alleles of other genes
5. The alleles of one gene mask the effects of alleles of another gene
6. The heterozygote resembles neither homozygote
7. One gene affects more than one trait
8. The part of the cell cycle during which the chromosomes are not visible
9. The time during mitosis when sister chromatids separate
10. Pairing of homologous chromosomes
11. Structure formed at the spot where crossing-over occurs between homologs
12. The relative chromosomal location of a gene
13. Short DNA fragments formed by discontinuous replication of one of the strands
14. Noncovalent bonds that hold the two strands of the double helix together
15. The separation of the two alleles of a gene into different gametes

2. In a cross between a tall pea plant with yellow and round seeds *(TT Yy Rr)* and a tall pea plant with yellow and wrinkled seeds *(Tt Yy rr)*, what proportion of the following offspring could be expected: (6 points, 2 points each)
   (a) Tall, yellow, round
   (b) Tall, green wrinkled
   (c) Dwarf, green, round

3. Considering two pairs of alleles, A/a and B/b, each pair located on a different pair of chromosomes in the somatic cells of an organism. With regard to these alleles, what "allele combination" would you find in cells that are in the Metaphase stage of the cell cycle? (3 points)

4. Which of the following <u>is true</u> regarding the genetic code? (2 points)
   (a) The genetic code is overlapping
   (b) The genetic code is degenerate
   (c) One genetic code has 4 unique nucleotides
   (d) The genetic code has three start codons and one stop codon

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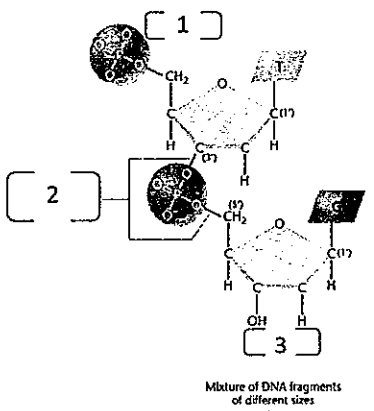
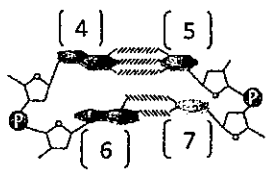
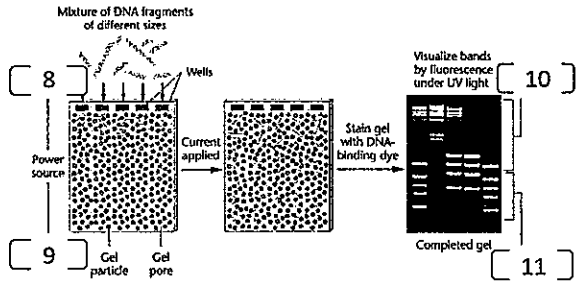
5. The classic Hershey and Chase (1952) experiment that offered evidence in support of DNA being the genetic material in bacteriophages made use of which of the following radioactive labelling component(s)? (2 points)
   (a) Nitrogen and oxygen
   (b) Hydrogen and sulfate
   (c) Phosphorus and sulfur
   (d) Oxygen and phosphorus

6. Please find the proper term from the left list (A to N) to describe [1] to [11] in the figure. Each term can only be used once in the figure, same term is not allowed to appear in multiple places (22 points, 2 points each)

A. Longer fragments
B. Phosphodiester bond
C. 5' end
D. Anode (+)
E. Guanine
F. Thymine
G. Hydrogen bond
H. Cathode (–)
I. Shorter fragments
J. Cytosine
K. 3' end
L. Adenine
M. Uracil
N. ATP







7. 224 F1 cowpea plants were derived from a cross of a plant with inflated green pod and a plant with restricted green pod. These plants can be classified as four distinct types, based on pod phenotypes: 42 yellow inflated; 14 yellow restricted; 70 green inflated; 98 green restricted. We assign A_1A_1, A_2A_2, B_1B_1, and B_2B_2 genotypes represent phenotypes for yellow pod, green pod, inflated pod, and restricted pod, respectively. Also, *A* and *B* are two loci controlling pod color and pod shape, respectively.
   (a) Write down the genotypes of two parents and each of four classes of those F1 plants. (10 points)
   (b) Please use the *Chi*-square test of independence to check whether locus A and locus B are independent assortment? (10 points)

8. You are working on a marker-assisted backcross breeding project in rice, and the goal is to pyramiding three genes (*Rc*, *Sdr4*, and *Xa21*) from three rice near isogenic lines (NILs). These lines have the same genetic background but different favorable alleles were introduced: the *Rc* (red pericarp) NIL: a dominant allele on chromosome 7 (the phenotype for the recessive allele is colorless pericarp); the *Sdr4* (strong seed dormancy) NIL: a dominant allele on chromosome 7; the *Xa21* (bacterial blight resistance) NIL: a dominant allele on chromosome 11. All these three NILs were validated as pure lines. The recombination frequency between *Rc* and *Sdr4* is 0.16. The working plan is as below. The first step is to make a cross between the *Rc* NIL and the *Xa21* NIL, and another cross between the

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Sdr4 NIL and *Xa21* NIL simultaneously. The second step is to make a cross between the two F1 hybrids produced from the first step. The third step is to select individuals with heterozygous genotypes at the loci *Rc* and *Sdr4*, and with homozygous genotypes at the locus *Xa21*. Then, to produce self-pollinated seeds. The fourth step is to selected individuals with homozygous genotypes at all three loci *Rc*, *Sdr4*, and *Xa21*.

(a)Please draw the crossing scheme, and add annotation of correct genotype(s) that were selected in each generation. Each generation corresponds to each step described above. (10 points)

(b)Please estimate how many progenies are required with 95% chance to obtain at least one plant in each steps (generation). (20 points)

Critical values of the χ^2 distribution

df	1	2	3	4	5
P=0.05	3.841	5.991	7.815	9.488	11.07

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