

True or false (2 points each question): ※ 注意：請於試卷內之「非選擇題作答區」標明題號依序作答。

1. The principle of segregation can be observed in mitosis.
2. The principle of independent assortment involves the random assortment of alleles from different homologs into separate daughter cells
3. Both the principle of segregation and the principle of independent assortment involve segregation of alleles during meiotic anaphase I.
4. Both the principle of segregation and the principle of independent assortment can be demonstrated only if the two parental plants possess different phenotypes encoding a character.
5. A single gene can only have two alleles.
6. Normal recessive genes typically do not produce functional products.
7. Sister chromatids are segregated in meiosis I.
8. Crossing over occurs in meiosis I
9. All enzymes are proteins.
10. Homologous recombination is not always required for a correctly occurred meiosis
11. *Taq* polymerase was isolated from budding yeast.
12. A trisomic $A/A/a$ can produce gamete of genotype a .
13. If a mutation inactivated telomerase in a cell, the length of the telomere would remain identical at each replication cycle.
14. A protein coding gene has one intron. The mutant site of its null allele can be positioned in the intron.
15. A mutant has not activity for alcohol dehydrogenase (coded by *Adh*). This is the proof that the mutation is within the *Adh* gene.
16. Both DNA methylation and histone modification are epigenetics marks.

Single or multiple choice (2 points each question): ※ 注意：請於試卷內之「選擇題作答區」依序作答。

1. 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.
2. An F_2 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 (D) 15:1.
3. Which of following phenomena can alter expected Mendelian phenotypic ratio in a genetic cross: (A) epistasis (B) linkage (C) chromosome translocation (D) environmental effect.
4. Red-green color blindness is X-linked recessive. A woman with normal color vision has a father who is red-green color blind. The woman has a child with a man with red-green color blind. Which phenotype is expected? (A) A color-blind female (B) A color-blind male (C) A noncolor-blind female (D) A noncolor-blind male.
5. Which of the following mutant allele is recessive to the wild-type allele? (A) Antimorph (B) Hypermorph (C) Hypomorph (D) Neomorph
6. What does 50% recombination mean for constructing a genetic map between a pair of genes? (A) They are on the different chromosome (B) They are on the different linkage group (C) These two genes is apart for 50 cM on the genetic map (D) These two genes are independent assortment.
7. Which of the following events take place in meiosis I? (A) crossing over (B) synthesis of DNA (C) separation of homologous chromosomes (D) contraction of chromosomes.
8. A number of all-white mice are crossed and they produce the following types of progeny: 12/16 all-white, 3/16 black, and 1/16 gray. The genotype of the black progeny can be (A) $AAbb$ (B) $aaBB$ (C) $AaBb$ (D) $aabb$.
9. Which one of the following is incorrect? (A) Homologous recombination occurs between any DNA molecules with extensive regions of similar sequence (B) Cell makes use of double strand breaks as a means to increase DNA
10. Which of the following is not consistent with the other options to describe a given diploid organism? (A) $2n = 6x = 42$ (B) This organism may be derived from the merging of six different genomes (C) 84 or more than 84 chromosomes can be found in a cell of this organism (D) The ancestor of this organism may have gone through whole genome duplication (E) This organism can be

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an allopolyploid.

11. Which of the following statements is not true? (A) mRNA encodes proteins (B) rRNA has no function (C) snRNA assemble with proteins in the spliceosome (D) miRNA is part of the RISC complex that represses gene expression.
12. Which of the following statement is not true? (A) rRNA function is highly conserved across organisms (B) antibiotics target bacterial ribosomal RNA. (C) Due to the highly-conserved nature, antibiotics sometimes harm eukaryotic cells. (D) Bacterial RNA do not possess nuclear localization sequences.
13. Which of the following is an example of post-transcriptional gene repression? (A) The amount of RNA transcribed from a gene is reduced because the DNA is methylated (B) The amount of protein is reduced by action of a miRNA (C) The amount of protein made is reduced by the action of a protease (D) The amount of RNA is reduced because the transcription factor is inactivated.
14. What is not the necessary feature of a model organism? (A) A simple genome (B) Rapid reproduction (C) Easy to grow (D) Mutant can be created easily.
15. Unlike retrotransposons, DNA transposons (A) have terminal inverted repeats (B) transpose via an RNA intermediate (C) do not exist in multiple copies in a genome (D) have long-terminal repeat.
16. Which of the following is associated with spontaneous mutation? (A) an occurrence of lung cancer due to smoking (B) an indel caused by the insertion of DNA transposons (C) chromosome breakage due to γ radiation (D) depurination by hydrolysis.

Short questions

1. You plan to conduct a gene pyramiding project by marker-assistant selection. You have three pure lines of rice in the same genetic background of Tainan11 (臺南 11 號), but each with a different allele resistant to bacterial blight: $x\alpha-5$, a recessive allele on chromosome 5; $X\alpha-21$, a dominant allele on chromosome 11; and $X\alpha-26$, another dominant allele on chromosome 11. The recombination frequency between $X\alpha-21$ and $X\alpha-26$ is 0.25. You like to have a 99% chance to obtain at least one plant carrying all these three resistant alleles with homozygous genotypes. Draw the scheme of your plan for crossing and selection (9 points), and then estimate at least how many progenies in each generation are required to obtain one plant with the expected genotype. (9 points)
2. Glyphosate is an herbicide used to kill weeds by inhibiting an enzyme in the shikimate pathway called EPSPS. This herbicide is considered safe because animals do not have the shikimate pathway. Glyphosate is first developed and marketed by the Monsanto company. As a companion product of glyphosate, several crop plants have been marked as a product of herbicide-resistance bio-engineering. Imagine that you are one of Monsanto scientists and that you have introduce successfully the resistant EPSPS gene into a corn chromosome. You find that some of the transgenic plants are resistant to the herbicide, where others are not, even though they have the transgene in their genome. Please explain why some plants are resistant while others are not, even they do have the transgene in their genome. (6 points)
3. Through the observation on maize, Barbara McClintock has discovered transposable elements. She noticed that, maize kernel colour could be purple (C), colourless (c), or sometime spotted. The kernel colour was related to the presence and activities of factors Ds and Ac . Different alleles of c exist in maize, which could be the results of insertion/deletion or of base-pair substitution.

Consider two maize plants:

- a. genotype C/c^m , where c^m is an unstable allele caused by Ds insertion and Ac is present in this genotype
- b. genotype C/c^{m2} , where c^{m2} is an unstable allele caused by Ac insertion

Assume that Ac and C are unlinked, that the chromosome-breakage frequency is negligible.

What phenotypes would be produced and in what proportions when (1) each plant is crossed with a base-pair-substitution mutant c/c which does not possess Ac and (2) the plant a is crossed with the plant b?

Please write down in a clear and comprehensive way your thinking process and clearly provide the conclusion. (12 points)