

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

1. The alleles of the genotypes, not the phenotype, are inherited.
2. The definition of 'trait' is the appearance or manifestation of a characteristic.
3. The chromosome theory of heredity states that genes are located on chromosomes.
4. Individuals with recessive phenotypes are always homozygote at the corresponding locus.
5. The wild type allele is always the dominant allele.
6. Phenotypes of the heterozygote is intermediate between the phenotypes of the two homozygotes is called partial dominance.
7. Penetrance is defined as the percentage of individuals having a particular genotypes that express the expected phenotypes.
8. Characteristics encoded by gene at many loci are called pleiotropic characteristics.
9. Linked genes do not assort independently.
10. The nonrandom association between alleles in a haplotype is called linkage disequilibrium.
11. Euchromatin regions of chromosomes have higher gene density than heterochromatin regions do.
12. Methylation of lysin 14 on histon H3 is associated with the condensation of chromatin at mitosis.
13. Arthur Kornberg won the Nobel Prize in Physiology or Medicine 1959 for his discovery of DNA polymerase involving DNA synthesis.
14. In eukaryotes, the flap of a single-stranded 5'-tail that contains the RNA primers is cleaved by DNA pol I.
15. Telomeres ensure the appropriate segregation of chromosomes.
16. Introns in pre-mRNAs begin with GU and end with AG.
17. RNA polymerase II transcribes all protein-coding genes as well as some non-coding regulatory RNA molecules.
18. Termination of transcription by eukaryotic RNA polymerase III.
19. Antibiotics are small molecules that are applied to prevent inflammation resulting by bacteria or fungi because antibiotics target different key steps in protein synthesis.
20. Because of deficiency in base excision repair, patients with Xeroderma pigmentosum cannot repair DNA damage caused by ultraviolet (UV) light.

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

1. Which of the following event takes place in anaphase II? (A) Contraction of chromosomes (B) Sister chromatids separate (C) Homologous chromosomes separate (D) Crossing over.
2. Which of the following statement is incorrect? (A) The purpose of the testcross is to identify the genotypes for individuals with dominant phenotypes. (B) The crossing scheme in a backcross is the same as the testcross that use the homozygous recessive genotypes as one of parental line for cross. (C) The principle of segregation states that each organism possesses two alleles that can encode a characteristic, and these alleles segregate when gametes are formed. (D) A complementation test also involves crosses of individuals with the homozygous recessive genotypes.
3. John had blood-type A, and Mary had blood-type B, their baby possessed blood-type A, what is the probability that their next baby also has blood type A? (A) 1 (B)  $\frac{1}{2}$  (C)  $\frac{3}{8}$  (D)  $\frac{1}{4}$ .
4. It is known that white eye in fruit fly is a sex-linked recessive mutant. You crossed a white eyed female with a red eye male, which is the correct phenotypic ratio for red-eyed females: white-eyed females: red-eyed males: white-eyed males in the F2 generation: (A) 1:1:1:1 (B) 2:0:1:1 (C) 1:0:0:1 (D) 1:0:1:0.
5. A number of all-white rats are crossed and they produced the following types of progeny: 12/16 all white, 3/16 black, and 1/16 gray. What is the genotype of the black progeny? (A) Aa (B) AbBb (C) A\_B\_ (D) A\_bb.
6. Inheritance of the shell coiling in snail is genetic maternal effect, and the allele for dextral is dominant over the allele for sinistral. You cross the female Dextral to a male sinistral, intercrossed the F1 progenies, and observed that all of the F2 progenies had sinistral phenotypes. Which of following genotypes are NOT the possible genotypes in the F2 progenies (A) homozygous allele for dextral (B) heterozygous (C) homozygous allele for sinistral.

7. Which of the following information is not the essential information to construct a genetic linkage map? (A) Allele configurations from both parental lines (B) number of recombinant progenies (C) number of non-recombinant progenies (D) mapping function.
8. Which of the following events can lead to no genetic distance between two loci ? (A) chromosome duplication (B) chromosome inversion (C) chromosome translocation (D) lethal allele.
9. If the environmental variance decreases and all other variance components remain the same, what will the effect be? (A) Broad-sense heritability will decrease (B) Broad-sense heritability will increase (C) the overall phenotypic variance will increase (D) narrow-sense heritability will decrease.
10. Which statement is not an assumption of the Hardy-Weinberg law? (A) The allelic frequencies ( $p$  and  $q$ ) are equal. (B) The population is randomly mating. (C) The population is large. (D) Natural selection has no effect.
11. DNA replication is not fully completed at the end of which strand(s) in chromosome? (A) Leading strand in circular chromosomes (B) Leading strand in linear chromosomes (C) Lagging strand in circular chromosomes (D) Lagging strand in linear chromosomes (E) Neither strand
12. The condition of crossing over repressor is most closely associated with: (A) chromosomal duplications. (B) inversion heterozygotes. (C) inversion homozygotes. (D) translocation heterozygotes. (E) translocation homozygotes.
13. Some DNA polymerases have proofreading activity in which erroneously added nucleotides are removed. What type of activity is represented by this proofreading? (A) 5' to 3' endonuclease (B) 3' to 5' endonuclease (C) 5' to 3' exonuclease (D) 3' to 5' exonuclease (E) topoisomerase
14. Which one is involved in detection of homology and strand exchange? (a) Rad51 (b) BRAC2 (c) MRX (d) RuvAB (e) RuvC
15. The reaction of CSSR (conservative site specific recombination) is the same as (a) DNA polymerase I (b) RNA polymerase (c) exonuclease (d) topoisomerase (e) restriction enzyme
16. How does a bacterial cell protect its own DNA from restriction enzymes? (a) by adding methyl groups to adenines and/or cytosines (b) using DNA ligase to seal the bacterial DNA into a closed circle (c) adding histones to protect the double-stranded DNA (d) by forming "sticky ends" of bacterial DNA to prevent the enzyme from attaching (e) by reinforcing bacterial DNA structure with covalent phosphodiester bonds
17. Which of the following is not source of siRNA? (A) Genes that have extensive hairpin structure (B) the product of specific genes (C) transcription of antisense RNA (D) viral RNA (E) none of above
18. What is ChIP used for? (A) To test protein : protein interaction (B) To test protein:DNA interaction (C) To test protein:RNA interaction (D) To test DNA:DNA interactions (E) To test DNA:RNA interactions
19. What would be the most appropriate technique to look at the difference in global gene expression in rice leaves before and after a salt treatment? (A) PCR (B) RT-PCR (C) RNA-seq (D) Northern analysis (E) Southern analysis
20. Which of the following describes a means of performing genome annotation? (A) The process of obtaining the DNA sequence of a whole genome (B) assigning function to genes by mutating them (C) Comparing the genes from one chromosome in an organism to those on another chromosome (D) Using similarity of DNA sequence among organism to suggest gene function (E) all above

III. Assay (20 points)

1. (5 points) Mendel conducted a dihybrid testcross by crossing the round yellow pea seeds with the wrinkled green pea seeds. It is known that round and yellow are complete dominant to wrinkle and green, respectively. How many F1 progeny seeds that Mendel need to sow in order to have 99% confidence to state that the round yellow pea is homozygote for both loci?

2. (5 points) The table on the right showed the results of a series of complementation tests between 8 recessive dwarf mutants. Please indicate how many gene involves in the dwarf mutant phenotypes, and how many mutant alleles in each genes. (X represented that the F1 progeny remained the dwarf phenotypes; O represented that the F1 progenies showed normal height.)

	1	2	3	4	5	6	7
2	O	X	X	X	X	X	X
3	X	O	X	X	X	X	X
4	O	O	O	X	X	X	X
5	O	X	O	O	X	X	X
6	X	O	X	O	O	X	X
7	O	O	O	O	O	O	X
8	O	O	O	X	O	O	O

3. (10 points) In eukaryotic genomes, transposable elements are found to distribute whole genomes, specifically revealed by genome sequence projects

- (a) List different kinds of transposable elements and describe how they can move around genomes? (4 points)
- (b) How transposable elements result into dynamic genomes? (3 points)
- (c) How transposable elements can be applied to study gene function via reverse genetics? (3 points)