1. Which of the following enzymatic activities does not play a role in DNA mismatch repair?

   (A) Helicase

   (B) Single-stranded exonuclease

   (C) DNA ligase

   (D) Primase

2. Why is $CO_2$ used in an incubator to culture mammalian cells?

   (A) To prevent bacterial contamination

   (B) To maintain pH of the culture medium

   (C) To control $O_2$ consumption of the cells

   (D) None of the above

3. Which of the following non-Mendelian inheritance explains the pattern of transmission where all offspring have the same phenotype as their mother?

   (A) Epigenetic inheritance

   (B) Genomic imprinting

   (C) Dosage compensation

   (D) Extracellular inheritance

4. An investigator would be able to distinguish a solution containing RNA from one containing DNA by

   (A) heating the solution to 85° C and then measuring the absorbance at 260 nm.

   (B) comparing the Tm of each solution.

   (C) monitoring the change by measuring the absorbance at 260 nm while elevating the temperature.

   (D) measuring the absorbance at 260 nm.

5. What will happen if the ratio of dideoxynucleotide triphosphates (ddNTPs) to deoxynucleotide triphosphates (dNTPs) is increased in a DNA sequencing reaction?

   (A) Shorter DNA strand will be produced

   (B) Longer DNA strand will be produced

   (C) Reaction will be terminated

   (D) There will not be any change in the sequencing reaction

6. Treatment of mouse fibroblast cells with 5-azacytidine causes some cells to differentiate into muscle cells. Which of the following possible effects of 5-azacytidine would best account for its ability to cause this differentiation?

   (A) Activation of Mediator complex

   (B) Inhibition of DNA demethylase

   (C) Inhibition of specific riboswitch

   (D) Inhibition of histone modification

7. If replication had to be accomplished in an 8-hour S phase and replication fork moved at 50 nucleotides per second, what would be the minimum number of origins required to replicate the human genome? (Assume that human genome comprises $6.4 \times 10^9$ nucleotides)

(A) 1111 (B) 2222 (C) 3333 (D) 4444

8. A mixture of amino acids containing glutamic acid (pI = 3.2), arginine (pI = 10.8), and valine (pI = 6.0) were subjected to electrophoresis. Which of the following amino acid(s) will migrate towards the anode when the electrophoresis is carried out at a pH of 7.1?

(A) Glutamic acid and arginine

(B) Arginine and valine

(C) Only glutamic acid

(D) Glutamic acid and valine

9. Consider a biallelic locus with alleles ***A*** and ***a***, with ***aa*** individuals displaying a disease while all others are normal. Under Hardy-Weinberg, if frequency of allele ***a*** is 0.001, what fraction of all ***aa*** individuals had both parents as carriers?

(A) 0.999 (B) 0.001 (C) 0.998 (D) 0.00001

10. The total number of cells in a culture is counted using the trypan blue exclusion assay and is found to be $5.2 \times 10^6$ cells/ml. Each well in a 6 well plate requires $2 \times 10^5$ cells. How should the solution be diluted so that 1ml can be added to each well?

(A) $1:5.2$ then $1:10$

(B) $1:2.6$ then $1:10$

(C) $1:5.2$ then $1:2$

(D) $1:2.6$ then $1:2$

11. Consider an autosomal biallelic locus ***A*** and ***a*** with frequencies of 0.6 and 0.4. In each generation, ***A*** mutates to ***a*** at a rate of $1 \times 10^{-5}$ and ***a*** mutates to ***A*** at a rate of $2 \times 10^{-5}$. Assume that the population is infinitely large, and no other evolutionary forces are acting. What will be the frequency of ***A*** at equilibrium?

(A) 0.6 (B) 0.4 (C) 0.67 (D) 0.33

12. The guanidinium isothiocyanate is used in the gel during RNA gel electrophoresis because

(A) the RNA may not have been completely denatured in the heating step.

(B) RNA needs to be protected from ribonucleases in the gel and buffer.

(C) the denatured status of the RNA needs to be maintained during the gel run.

(D) formamide and formaldehyde will not break H-bonds in the agarose gel.

13. Which of the following methods is used to assess the genome-wide chromatin accessibility regions in mammalian cells?

(A) MNase-seq

(B) ChIP-seq

(C) ATAC-seq

(D) RIP-seq

14. Which of the following characteristics best describe a positive stranded RNA virus?

(A) Their genomic RNA can be translated directly as mRNA

(B) They need to transcribe their genomic RNA to a mirror image copy as a mRNA

(C) This genome is circular

(D) Their RNA genome is segmented

15. If a solution of double stranded DNA is heated above its melting temperature, its absorbance will

(A) decrease.

(B) increase.

(C) remain unchanged.

(D) initially increase and then decrease.

16. HLA-B27 allele is primarily associated with

(A) Ankylosing spondylosis.

(B) Parkinson disease.

(C) Lung cancer.

(D) Type I diabetes.

17. Which of the following statements is true?

(A) The variance of two equal numbers is always less than the variance of two unequal negative numbers.

(B) The variance of two equal numbers is always greater than the variance of two unequal negative numbers.

(C) The variance of two equal numbers is always greater than the variance of two unequal positive numbers.

(D) The variance of two equal negative numbers is always less than the variance of two equal positive numbers.

18. A mutation within a codon that leads to the substitution of one amino acid with another is called

(A) nonsense mutation.

(B) missense mutation.

(C) frameshift mutation.

(D) synonymous mutation.

19. Consider a X-linked recessive disorder such that the incidence of this disorder among females is 0.01. Assuming that the population is in Hardy-Weinberg equilibrium among females, what will be the expected frequency of affected males?

(A) 0.10 (B) 0.20 (C) 0.01 (D) 0.02

20. If $pK_1 = 6.24$ and $pK_2 = 10.60$, then the isoelectric point (pI) is

(A) 2.18 (B) 4.36 (C) 8.42 (D) 16.84

21. Which of the following reactions is irreversible in glycose oxidation?

(A) Glucose-6-phosphate to Fructose-6-phosphate

(B) Glyceraldehyde-3-phosphate to dihydroxy-acetone-phosphate

(C) Phospho-enol-pyruvate to pyruvate

(D) 3-phosphoglycerate to 2-phosphoglycerate

22. The first step of amino acid degradation is

(A) decarboxylation.

(B) deamination.

(C) dehydrogenation.

(D) denitrification.

23. Which one of the following is an optically inactive amino acid?

(A) Serine (B) Threonine (C) Glycine (D) Valine

24. Using whole-genome DNA-sequencing, one can identify

(A) both common and rare variants.

(B) common but not rare variants.

(C) rare but not common variants.

(D) neither rare nor common variants.

25. Which of the following defines the ‘type II error’?

(A) Acceptance of an incorrect null hypothesis

(B) Rejection of an incorrect null hypothesis

(C) Acceptance of a correct null hypothesis

(D) Rejection of a correct null hypothesis

26. DNA is usually dissolved in TRIS-EDTA buffer, EDTA is added to the buffer to ensure that

(A) pH is kept neutral.

(B) monovalent cations are chelated.

(C) divalent cations are chelated.

(D) pH is kept alkaline.

27. Suppose that $x$, $y$ and $z$ are positive numbers such that $x^2$, $y^2$, $z^2$ are respectively the probability of success, the probability of failure and the square of the number of trials of a binomial distribution. Then, the variance of the distribution is given by

(A) $x^2 \times y^2 \times z^2$.

(B) $x \times y \times z^2$.

(C) $x^2 \times y^2 \times z$.

(D) $x \times y \times z$.

28. Assume that the mother is a carrier for hemophilia and the father does not have hemophilia. Then, the chance of getting hemophilia among their sons and daughter will be

(A) 50% for the sons and 50% for the daughters.

(B) 50% for the sons and 0% for the daughters.

(C) 25% for the sons and 25% for the daughters.

(D) 25% for the sons and 0% for the daughters.

29. The two sample t-test requires the assumptions:

(A) the observations are normally distributed in each group and the variance of each observation is the same.

(B) the observations need not be normally distributed in each group but the variance of each observation is the same.

(C) the observations are normally distributed in each group but the variance of each observation need not be the same.

(D) the observations need not be normally distributed in each group and the variance of each observation need not be the same.

30. In the human genome, a spontaneous deamination of 5-methylcytosine in the context of CpG dinucleotides results in the creation of

(A) thymine.

(B) uracil.

(C) unmethylated cytosine.

(D) 5-hydroxymethylcytosine.