1. A diploid eukaryotic cell contains 2 billion base pairs of DNA. Approximately how many nucleosomes would be present in the cell?

   (A) 10^6 (B) 10^7 (C) 10^8 (D) 10^9

2. The *E. coli* chromosome contains 4.8 million base pairs (Mbp) of DNA. If synthesis at each replication fork takes place at a rate of 1000 nucleotides per second, how long will it take to completely replicate the *E. coli* chromosome with theta replication?

   (A) 1 hour 20 minutes   (B) 1 hour
   (C) 40 minutes   (D) 20 minutes

3. Suppose that a consensus sequence in the regulatory promoter of a gene encoding a protein (Protein A) were deleted. Which of the following effects would result from this deletion?

   (A) The mRNA for *Protein A* would be abnormally short.
   (B) Protein A would have a different amino acid sequence.
   (C) Protein A would be missing some amino acids.
   (D) The amount of the mRNA for *Protein A* transcribed would be affected.

4. Which of the following classes of RNA is correctly paired with its function?

   (A) Small nuclear RNA (snRNA): processes rRNA.
   (B) Transfer RNA (tRNA): attaches to an amino acid.
   (C) Ribosomal RNA (rRNA): carries out RNA interference.
   (D) MicroRNA (miRNA): carries information for the amino acid sequence of a protein.

5. If there were five different types of bases in mRNA instead of four, what would be the minimum codon size (number of nucleotides) required to specify the following numbers of different amino acid types: (i) 20, (ii) 30?

(A) (i): Two; (ii): Three   (B) (i): One; (ii): Two
(C) (i): Three; (ii): Four   (D) (i): One; (ii): Three

6. How do amino acids in DNA-binding proteins interact with DNA?

(A) By forming covalent bonds with DNA bases.
(B) By forming hydrogen bonds with DNA bases.
(C) By forming covalent bonds with DNA sugars.
(D) None of the above.

7. What is the advantage of using the Aminoglycoside 3'-phosphotransferase (*neo*) gene to disrupt the function of a gene in knockout mice?

(A) The *neo* gene is the right size for disabling other genes.
(B) The *neo* gene produces a selectable marker for finding cells that contain the disabled gene.
(C) The *neo* gene encodes an antibiotic that kills unwanted cells.
(D) The *neo* gene encodes a toxin, which inhibits the transcription of the target gene.

8. Which of the following is not a mechanism of epigenetic change?

(A) DNA methylation.
(B) Alteration of a DNA base sequence in a promoter.
(C) Histone acetylation.
(D) Nucleosome repositioning.

9. Why are centromeres often not included in a draft genome sequence?

   (A) It is extremely difficult to clone this sequence because it is very condensed.
   (B) Researchers are not interested in sequencing the DNA regions that lack genes.
   (C) Centromeres have the same sequences in all organisms.
   (D) It is difficult to get an accurate sequence of these long regions of repetitive DNA.

10. In RNA silencing, siRNAs and miRNAs usually bind to which part of the mRNA molecules that they regulate?

   (A) 5′ UTR.
   (B) 3′ poly(A) tail.
   (C) Segment that encodes amino acids.
   (D) 3′ UTR.

11. Which of the following mechanisms requires the ability to distinguish between the newly synthesized strand and the template strand of DNA during replication?

   (A) Nucleotide selection.   (B) DNA proofreading.
   (C) Mismatch repair.   (D) None of the above.

12. Which of the following events could lead to the evolution of a new gene that contains exons from two or more other genes?

   (A) Domain duplication.   (B) Domain shuffling.
   (C) Gene conversion.   (D) Gene duplication.

13. Which of the following changes is a transition base substitution?

(A) Adenine is replaced by thymine.
(B) Cytosine is replaced by adenine.
(C) Guanine is replaced by adenine.
(D) Three nucleotide pairs are inserted into DNA.

14. Which of the following vitamin is essential for blood clotting?

(A) Vitamin C.   (B) Vitamin D.
(C) Vitamin K.   (D) Vitamin E.

15. A locus has three alleles $A1$, $A2$ and $A3$ with frequencies 0.5, 0.4 and 0.1. Assuming random mating, the expected frequencies of all heterozygous in the population will be

(A) 0.58.   (B) 0.20.   (C) 0.04.   (D) 0.29.

16. DNA fragments that are 500 bp, 1000 bp, and 2000 bp in length are separated by gel electrophoresis. Which fragment will migrate farthest in the gel?

(A) 2000 bp fragment
(B) 1000 bp fragment
(C) 500 bp fragment
(D) All will migrate equal distances.

17. Base analogs are mutagenic because of which characteristic?

(A) They produce changes in DNA polymerase that cause it to malfunction.
(B) They distort the structure of DNA.
(C) They are similar in structure to the normal bases.
(D) They chemically modify the normal bases.

18. Which of the following types of mutations in telomerase could be associated with cancer cells?

(A) Mutations that produce an inactive form of telomerase.
(B) Mutations that decrease the expression of telomerase.
(C) Mutations that increase the expression of telomerase.
(D) None of the above.

19. The enzyme involved for the conversion of glutamate to glutamine is

(A) glutamine synthetase.   (B) glutamate dehydrogenase.
(C) glutamate isomerase.   (D) glutamate decarboxylase.

20. Arrange the following events in the correct temporal sequence during eukaryotic cell division, starting with the earliest: (I) condensation of the chromosomes, (II) movement of chromosomes to the poles, (III) duplication of the chromosomes, (IV) formation of the nuclear membrane, (V) attachment of microtubules to the kinetochores, and (VI) migration of centrosomes to positions on opposite sides of the nucleus.

(A) (VI), (I), (III), (V), (II), (IV).
(B) (VI), (V), (I), (III), (II), (IV).
(C) (III), (VI), (I), (V), (II), (IV).
(D) (III), (VI), (I), (II, (V), (IV).

21. During DNA renaturation, the rate of renaturation is proportional to the

(A) concentration of the single strand.
(B) square of the concentration of the single strands.
(C) square root of the concentration of the single strand.
(D) None of the above.

22. Helper T-cells express

    (A) CD8 markers and are MHC class I restricted.
    (B) CD4 markers and are MHC class I restricted.
    (C) CD8 markers and are MHC class II restricted.
    (D) CD4 markers and are MHC class II restricted.

23. Acetyl-CoA is transported from mitosol to cytosol via

    (A) Malate-aspartate shuttle system.
    (B) Carnitine shuttle system.
    (C) Citrate-malate shuttle system.
    (D) Glycerolphosphate shuttle system.

24. Hypermethylation is thought to contribute to cancer by

    (A) inhibiting DNA replication.
    (B) inhibiting the expression of tumor-suppressor genes.
    (C) stimulating the translation of oncogenes.
    (D) stimulating telomerase.

25. Which of the following is a precursor molecule of glycerol?

    (A) Dihydroxyacetone phosphate.
    (B) Acetyl-CoA.
    (C) 3-phosphoglyceric acid.
    (D) None of the above.

26. Sequential steps of fatty acid synthesis are

    (A) condensation→reduction→dehydration→reduction.
    (B) reduction→dehydration→reduction→condensation.
    (C) dehydration→reduction→condensation→ceduction.
    (D) reduction→condensation→reduction→dehydration.

27. Let a and b are two positive real numbers satisfying the relation (arithmetic mean − geometric mean) = x. Then, consider the following statements.

(i) x never be zero.

(ii) x can take negative values.

(iii) x must be non-negative.

Choose the correct alternative.

(A) Both (i) and (iii) are correct.

(B) Only (ii) is correct.

(C) Only (iii) is correct.

(D) None of the statements (i), (ii) and (iii) is correct.

28. Consider the following statements for linear regression of y on x:

(i) The predicted mean of y must be equal to the observed mean of y.

(ii) Variance of residuals is zero if x and y have a perfectly linear association.

(iii) Regression lines of x on y and y on x can never intersect.

Choose the correct alternative.

(A) Both (i) and (ii) are correct.

(B) Both (ii) and (iii) are correct.

(C) Only (iii) is correct.

(D) None of the statements (i), (ii) and (iii) is correct.

29. In simple random sampling without replacement (SRSWOR), what is the probability that a specific element is selected in a sample of size n from a population of size N?

(A) $\frac{n}{N}$.
(B) $\frac{n-1}{N-1}$.
(C) N^n.
(D) $\frac{n(n-1)}{N}$.

30. If the computed two-sample t-test statistic is not significant at a 5% significance level, what does this mean?

    (A) The two population means must be exactly equal.
    (B) There is insufficient evidence to reject the null hypothesis.
    (C) There is sufficient evidence to reject the null hypothesis.
    (D) The sample means must be the same.