SECTION – A

MULTIPLE CHOICE QUESTIONS (MCQ)

Q. 1 – Q.10 carry one mark each.

Q.1   Slime molds belong to

(A) bacteria   (B) fungi   (C) protists   (D) plants

Q.2   Which ion is required for association of ribosome subunits?

(A) Ca^{2+} (B) Mg^{2+} (C) Zn^+ (D) K^+

Q.3   Kreb's cycle occurs in the

(A) cytoplasm   (B) cristae of mitochondria   (C) mitochondrial matrix   (D) ribosomes

Q.4   Which of the following can bind to an antibody but cannot elicit an immune response in a healthy individual?

(A) Hapten   (B) Immunogen   (C) Antigen   (D) Alum as adjuvant

Q.5   Which one of the following ecosystems would have the maximum number of primary producers per unit area?

(A) Forest   (B) Pond   (C) Desert   (D) Grassland

Q.6   In the C_4 pathway, carbon dioxide is concentrated in

(A) pith   (B) mesophyll cells   (C) endodermis   (D) bundle sheath cells

Q.7 LD_{50} of the two pathogenic strains A and B are 20 and 60 cells, respectively. Which one of the following statements is **TRUE**?

(A) Strain A is more virulent   (B) Strain B is more virulent
(C) Both strains A and B are avirulent   (D) Both strains A and B are equally virulent

Q.8   Alpha-amanitin affects

(A) bacterial RNA polymerase   (B) mitochondrial RNA polymerase
(C) RNA polymerase II   (D) RNA polymerase I

Q.9   In bacteria, conjugation between one F^+ and one F^- cells results in

(A) two F^+ cells   (B) two F^- cells
(C) one F^+ cell and one F^- cell   (D) one Hfr cell and one F^+ cell

Q.10   Vaccination is an example of

(A) naturally acquired passive immunity   (B) naturally acquired active immunity
(C) artificially acquired passive immunity   (D) artificially acquired active immunity

Q. 11 – Q. 30 carry two marks each.

Q.11   The value of $\int_a^b e^{-10x} dx$ is
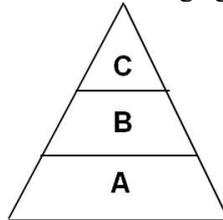
(A) $-\frac{1}{10} [e^{10b} - e^{10a}]$ (B) $-\frac{1}{10} [e^{-10b} - e^{-10a}]$

(C) $\frac{1}{10} [e^{-10b} - e^{-10a}]$ (D) $-\frac{1}{10} [e^{-10(b-a)}]$

Q.12   What does the graphic representation of age groups of a population given below show?

A : Pre-reproductive
B : Reproductive
C : Post-reproductive

(A) Declining population   (B) Stable population
(C) Increasing population   (D) Fluctuating population

Q.13   The beta oxidation of a saturated odd chain fatty acid in final thiolysis step yields

(A) one molecule of acetyl CoA
(B) two molecules of acetyl CoA
(C) one molecule of acetyl CoA and one molecule of propionyl CoA
(D) one molecule of acetyl CoA and one molecule of succinyl CoA

Q.14   The coordinates of the points of the intersections of the curves y = -x^2 and x= -y are

(A) (0,0) and (1,1)   (B) (0,0) and (1,-1)
(C) (0,0) and (-1,1)   (D) (0,0) and (-1,-1)

Q.15   Match the protein structures in **Group A** with their description in **Group B**

Group A	Group B
P. primary	i. association of protein subunits
Q. secondary	ii. spatial arrangement of amino acids due to their global interaction
R. tertiary	iii. linear amino acid sequence
S. quaternary	iv. spatial arrangement of amino acids near each other in the linear sequence

(A) P-iii, Q-ii, R-iv, S-i   (B) P-iv, Q-ii, R-iii, S-i
(C) P-iii, Q-iv, R-ii, S-i   (D) P-iv, Q-iii, R-ii, S-i

Q.16   A cell with 46 chromosomes undergoing meiosis will have

(A) 92 chromatids at metaphase I and 46 chromatids at metaphase II
(B) 23 chromosomes at metaphase I and 23 chromosomes at metaphase II
(C) 92 chromatids at metaphase I and 23 chromatids at metaphase II
(D) 23 chromatids at metaphase I and 23 chromatids at metaphase II

Q.17   Find out the **CORRECT** sequence of taxonomic hierarchy.

(A) Family ➡ Phylum ➡ Class ➡ Order   (B) Phylum ➡ Order ➡ Class ➡ Family
(C) Class ➡ Phylum ➡ Family ➡ Order   (D) Phylum ➡ Class ➡ Order ➡ Family

Q.18   Which one of the following is the correct Lineweaver-Burk plot? Where V, V_{max}, [S], and K_M denote initial velocity, maximum velocity, substrate concentration and Michaelis-Menten constant, respectively.

(A)   (B)

(C)   (D)
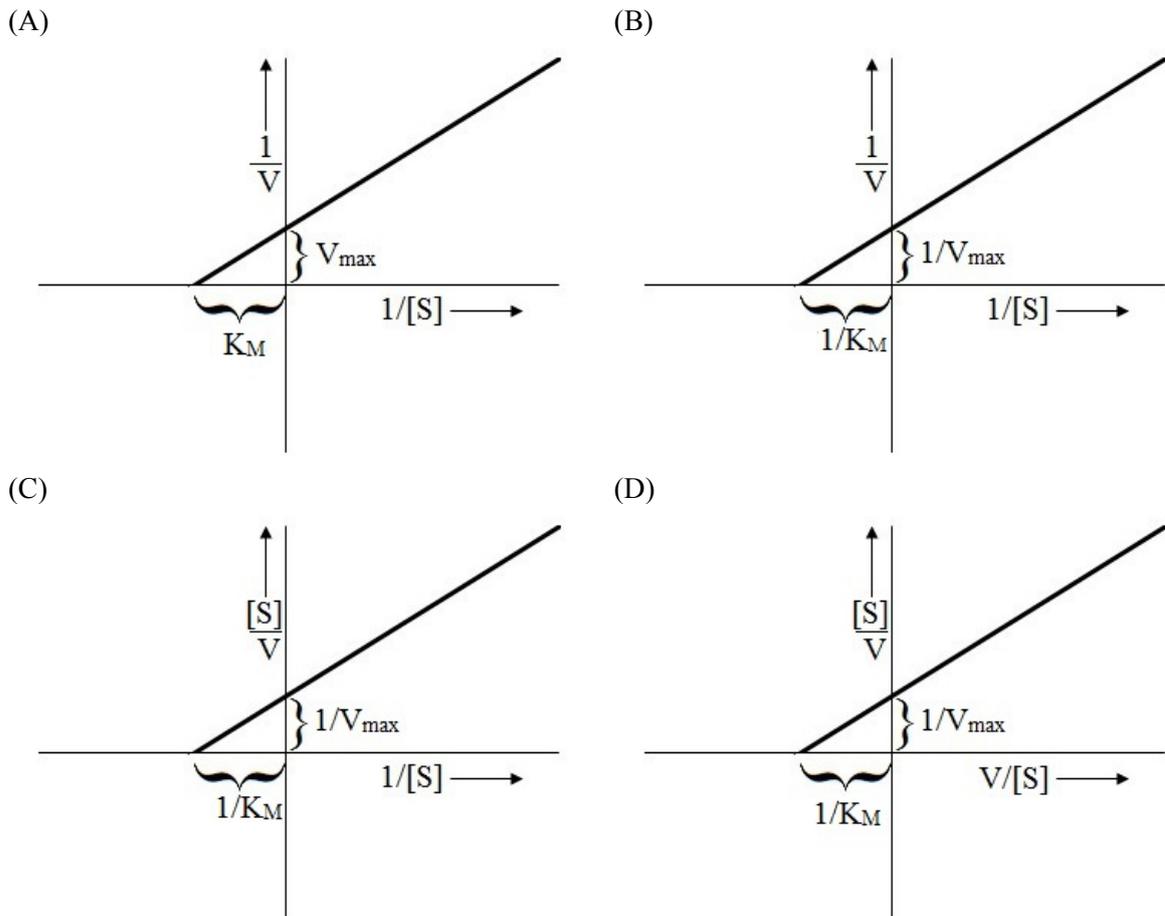
Q.19   Match the items in **Group A** with those of the items in **Group B**

Group A	Group B
P. Nucleus	i. Terpenes
Q. Chloroplast	ii. Telomerase
R. Mitochondria	iii. Rubisco
S. Leucoplasts	iv. Cytochrome reductase

(A) P-ii, Q-iv, R-iii, S-i   (B) P-i, Q-iii, R-iv, S-ii
(C) P-i, Q-iv, R-iii, S-ii   (D) P-ii, Q-iii, R-iv, S-i

Q.20   Which one of the following statements is **TRUE** for polymerization of actin and microtubules?

(A) Actin requires ATP while microtubules require GTP
(B) Actin requires GTP while microtubules require ATP
(C) Both actin and microtubules require ATP
(D) Both actin and microtubules require GTP

Q.21   Reduction of nitrate to ammonia is possible by assimilatory and dissimilatory pathways. Which one of the following statements is **TRUE**?

(A) Both are inhibited by oxygen
(B) Only assimilatory nitrate reduction is inhibited by ammonia
(C) Only assimilatory nitrate reduction is inhibited by oxygen
(D) Both are inhibited by ammonia

Q.22   Match the inhibitors given in **Group A** with their site of action in **Group B**

Group A	Group B
P. Rotenone	i. Cytochrome c-oxidase
Q. Cyanide	ii. ATP-ADP translocase
R. Oligomycin	iii. NADH-Q oxidoreductase
S. Atractyloside	iv. ATP synthase

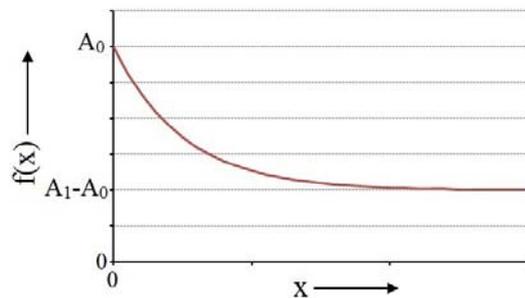(A) P-iii, Q-i, R-iv, S-ii   (B) P-iii, Q-ii, R-iv, S-i
(C) P-iii, Q-i, R-ii, S-iv   (D) P-i, Q-ii, R-iv, S-iii

Q.23   Which one of the following figures correctly represents the function $f(x) = A_0 + (A_1 - A_0)\exp(-x)$
(Given $0 < A_0 < A_1$)?
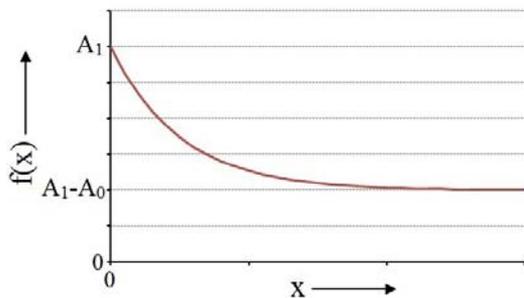
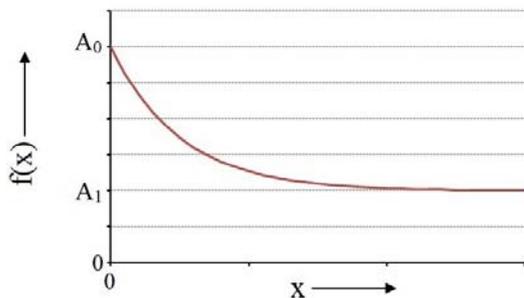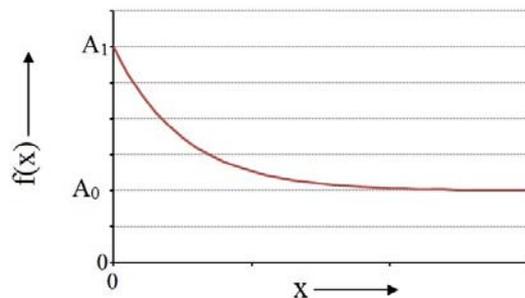(A)   (B)

(C)   (D)

Q.24   Match the items in **Group A** with those of the items in **Group B**

Group A	Group B
P. IgE	i. Crosses placenta
Q. IgA	ii. Secretory antibody present in breast milk
R. IgM	iii. First antibody made by B cells
S. IgG	iv. Involved in asthma

(A) P-iv, Q-ii, R-iii, S-i   (B) P-i, Q-iii, R-ii, S-iv
(C) P-iv, Q-ii, R-i, S-iii   (D) P-ii, Q-iv, R-iii, S-i

Q.25   Commensalism is an interaction between two species, in which

(A) both the species are harmed
(B) both the species benefit
(C) one species benefits and the other remains unaffected
(D) one species benefits and the other is harmed

Q.26   A dominant gene **B** is responsible for the wild type body color of *Drosophila*, its recessive allele **b** produces black body color. A test cross of a wild type female gave 52 black and 58 wild type in the F_1. If the wild type F_1 females are crossed with black F_1 males, what would be the expected genotypic ratio in the F_2.

(A) Heterozygous wild : Homozygous black = 1:1
(B) Homozygous wild : Heterozygous black = 1:1
(C) Homozygous wild : Heterozygous wild : Homozygous black = 1:2:1
(D) All heterozygous black

Q.27   Match the precursors of coenzymes (vitamins) listed in **Group A** with the type of reactions listed in **Group B**

Group A	Group B
P. Thiamine	i. Oxidation-reduction
Q. Pyridoxine	ii. Acyl group transfer
R. Pantothenate	iii. Aldehyde transfer
S. Riboflavin	iv. Group transfer to/from amino acid

(A) P-iii, Q-iv, R-ii, S-i   (B) P-ii, Q-iii, R-iv, S-i
(C) P-i, Q-ii, R-iii, S-iv   (D) P-iv, Q-iii, R-ii, S-i

Q.28   Match the diseases due to inborn errors of amino acid metabolism in **Group A** with enzyme deficiencies listed in **Group B**

Group A	Group B
P. Albinism	i. Cystathionine beta-synthase
Q. Phenylketonuria	ii. Homogentisate oxidase
R. Alcaptonuria	iii. Tyrosinase
S. Homocystinuria	iv. Phenylalanine hydroxylase

(A) P-iii, Q-iv, R-ii, S-i   (B) P-ii, Q-iii, R-i, S-iv
(C) P-i, Q-ii, R-iv, S-iii   (D) P-iii, Q-iv, R-i, S-ii

Q.29   Which one of the following events does **NOT** occur in fungi during mitosis?

(A) Segregation of chromosomes
(B) Replication of the genetic material
(C) Formation of spindle fibres
(D) Disintegration of nuclear envelope

Q.30   Match the plant hormones listed in **Group A** with their major effects given in **Group B**.

| Group A	Group B
P. Auxin	i. Ripening of fruits
Q. Gibberellins	ii. Phototropism
R. Abscisic acid	iii. Stimulate stomatal closure
S. Ethylene	iv. Break dormancy of seeds and buds

(A) P-ii, Q-iv, R-iii, S-i   (B) P-i, Q-ii, R-iii, S-iv
(C) P-iii, Q-iv, R-ii, S-i   (D) P-iv, Q-iii, R-ii, S-i

SECTION - B

MULTIPLE SELECT QUESTIONS (MSQ)

Q. 31 – Q. 40 carry two marks each.

Q.31   The sedimentation velocity of particles depends on

(A) mass of the particles
(B) density of solution
(C) shape of particles
(D) extinction coefficient of particles

Q.32   Rubisco catalyzes condensation of one molecule of carbon dioxide or oxygen with ribulose-1,5-bisphosphate to yield

(A) one molecule of phosphoglycerate and one molecule of glyceraldehydes-3-phosphate
(B) one molecule of phosphoglycolate and one molecule of 3-phosphoglycerate
(C) three molecules of phosphoglycolate
(D) two molecules of 3-phosphoglycerate

Q.33   Cyclic electron flow in higher plants involves

(A) PS I
(B) NADPH production
(C) PS II
(D) ATP synthesis

Q.34   Which of the following processes take place after antigenic stimulation of B cells?

(A) Class switching
(B) Somatic hypermutation
(C) Affinity maturation
(D) Allelic exclusion

Q.35   Which of the following statements are the assumptions of Hardy-Weinberg equilibrium?

(A) The allelic frequencies (p and q) are equal
(B) The population is randomly mating
(C) The allelic frequencies (p and q) of the population are not affected by migration
(D) Natural selection has no effect

Q.36   The intracellular messengers formed by the activation of phosphoinositide cascade are

(A) phoshophatidylinositol-4,5-bisphosphate
(B) inositol-1,4,5-triphosphate
(C) diacylglycerol
(D) inositol-4-phosphate

Q.37   Which of the following events take place in meiosis I but not in meiosis II?

(A) Crossing over   (B) Compaction of chromosomes
(C) Separation of chromatids   (D) Separation of homologous chromosomes

Q.38   Rolling circle model of replication in viruses

(A) initiates with a nick on one strand
(B) originates at *oriC*
(C) results in only one copy of the genome
(D) results in concatemers

Q.39   The conversion of IMP to AMP needs

(A) ATP   (B) GTP   (C) Aspartate   (D) Glutamate

Q.40   Which of the following option(s) is/are **TRUE** regarding the first derivative $\frac{df}{dx}$ and second derivative $\frac{d^2f}{dx^2}$ of the function f(x) shown below?
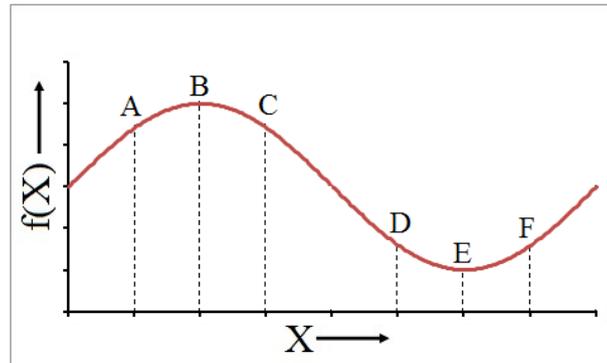
(A) $\frac{df}{dx} < 0$ at D, $\frac{d^2f}{dx^2} < 0$ at E and $\frac{df}{dx} > 0$ at F

(B) $\frac{df}{dx} < 0$ at D, $\frac{d^2f}{dx^2} > 0$ at E and $\frac{df}{dx} > 0$ at F

(C) $\frac{df}{dx} > 0$ at A, $\frac{d^2f}{dx^2} < 0$ at B and $\frac{df}{dx} < 0$ at C

(D) $\frac{df}{dx} < 0$ at A, $\frac{d^2f}{dx^2} > 0$ at B and $\frac{df}{dx} > 0$ at C

SECTION – C

NUMERICAL ANSWER TYPE (NAT)

Q. 41 – Q. 50 carry one mark each.

Q.41   The number of pairs of contrasting characters in pea pods chosen by Mendel for his study were_____.

Q.42   Circadian rhythms typically have a periodicity of _____ hours.

Q.43   The number of copies of H2B histones found in 50 nucleosomes is _____.

Q.44   The number of hypervariable regions present in one human IgG is _____.

Q.45   If the D-value at 70° C is 0.3 min for spores of *Clostridium botulinum*, the time taken to reduce 10^8 spores to one spore is _____minutes.

Q.46   The number of high energy phosphate bonds needed for the formation of aminoacyl-tRNA is _____.

Q.47   The total number of tetra-peptide chains, where each chain consists of four amino acids (two molecules of Val, one molecule of Ala and one molecule of Ser), is _____.

Q.48   Assuming that malate/aspartate shuttle is operating, the number of ATP molecules generated during complete oxidation of phosphoenol pyruvate to carbon dioxide and water is _____

Q.49   The assembly of _____ ribosome (in Svedberg units) in prokaryotes requires joining of 50 S and 30 S ribosomal subunits.

Q.50   The diagram below shows offsprings in the F_1 and F_2 generations
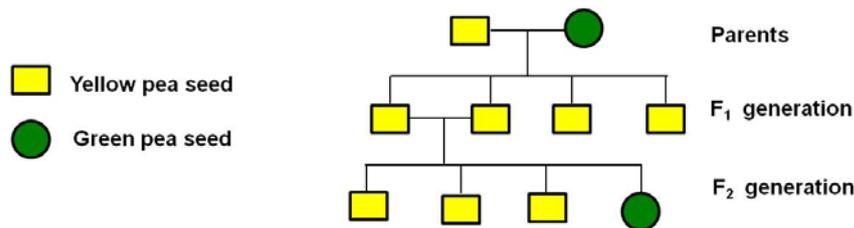
How many of the following statements are **TRUE**? _____

(i) On average, one out of four offsprings of heterozygous parents will be homozygous recessive
(ii) The yellow allele is dominant over the green one. However, this does not completely explain why three are yellow and one is green.
(iii) The green allele is dominant over the yellow one
(iv) The F_1 generation offsprings are homozygous yellow

Q. 51 – Q. 60 carry two marks each.

Q.51   If the molar extinction coefficient for double stranded DNA at λ_{260} is 6700, the concentration of DNA solution with the absorbance of 0.268 at λ_{260} in mM will be _____. Calculate the value up to the second place of decimal.

Q.52   The rectangle of length p meters and width 2 meters is kept inside a square of area 100 square meters such that all four corners of the rectangle touch the sides of the square as shown in the figure below. The value of p is _____ meters. ($\sqrt{2} = 1.414$). Keep value of p up to second place of decimal.
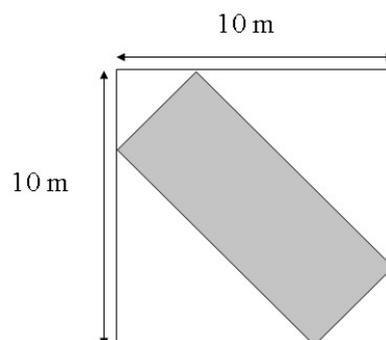
Q.53   The value of $\sin^{-1}(x) - \cos^{-1}(-x)$ is _____. ($\pi = 3.14$). Answer up to second place of decimal.

Q.54   The area of the grey region in the figure given below is _____.
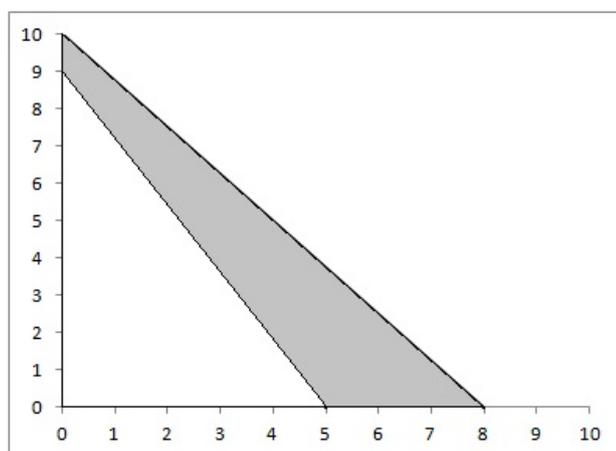
Q.55   The number of codons that can be constructed using nucleotides A, G, U, and C, when repetition of nucleotide is not allowed within a codon, is _____.

Q.56   The total surface area of a solid hemisphere of radius 1 cm is _____ cm^2 ($\pi = 3.14$). Provide value of area up to second place of decimal.

Q.57 ΔS and ΔH for a reaction are 0.1 Kcal.mol^{-1}K^{-1} and -14.8 Kcal.mol^{-1}, respectively. The free energy (ΔG) for a reaction at t=0°C will be _____ Kcal.mol^{-1}.

Q.58   For a reaction involving enzymes and substrates, the reaction velocity becomes half of the maximal velocity V_{max} when concentration of substrate becomes 1.2×10^{-2} M. When substrate concentration is 3.6×10^{-2} M, the reaction velocity will be _____ times V_{max}. Answer up to second place of decimal.

Q.59   Consider the reaction $Z \xrightarrow{k} 2X + Y$, where one molecule of Z is disintegrating to form two molecules of X and one molecule of Y with rate k =50 s^{-1}. Suppose the reaction starts with 10000 molecules of Z at time t=0. The average number of molecules of X at time t=55 s will be _____.

Q.60   A Ph.D. student visits three research stations X, Y and Z in a random order to collect samples. The probability that the student visits research station Y before visiting research station Z is _____.

END OF THE QUESTION PAPER