PAPER : IIT-JAM 2021

BIOTECHNOLOGY-BT

INSTRUCTIONS:

(*i*) This test paper has a total of 60 questions carrying 100 marks. The entire question paper is divided into three **sections**, **A, B** and **C**. All sections are compulsory. Questions in each section are of different types.

(*ii*) **Section-A** contains **Multiple Choice Questions (MCQ)**. Each MCQ type question has four choices out of which only one choice is the correct answer. This section has 30 Questions and carry a total of 50 marks. Q.1 – Q.10 carry **1 mark** each and Questions Q.11 – Q.30 carry **2 marks** each.

(*iii*) **Section-B** contains **Multiple Select Questions (MSQ)**. Each MSQ type question is similar to MCQ but a difference that there may be one or more than one choice(s) that are correct out of the four given choices. The candidate gets full credit if he/she selects all the correct choices only and no wrong choices. This section has 10 Questions and carry **2 marks** each with a total of 20 marks.

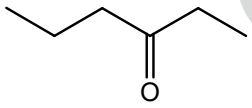
(*iv*) **Section-C** contains **Numerical Answer Type (NAT)** questions. For these NAT type questions, the answer is a real number which needs to be entered using the virtual numerical keypad on the monitor. No choices will be shown for these type of questions. This section has 20 Questions and carry a total of 30 marks. Q.1 – Q.10 carry 1 mark each and Questions Q.11 – Q.20 carry **2 marks** each.

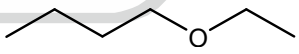
(*v*) In all questions, question not attempted will result in zero mark. In **Section – A** (MCQ), wrong answer will result in **NEGATIVE** marks. For all 1 mark questions, 1/3 marks will be deducted for each wrong answer. For all 2 marks questions, 2/3 marks will be deducted for each wrong answer. In **Section – B** (MSQ), there is **NO NEGATIVE** and **NO PARTIAL** marking provisions. There is **NO NEGATIVE** marking in **Section – C** (NAT) as well.

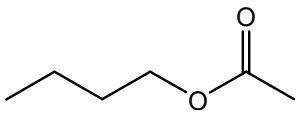
SECTION-A

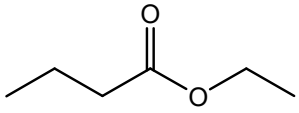
[Multiple Choice Questions (MCQ)]

1. Ethyl butyrate is responsible for the odor of pineapple. Which one of the following is the structure of ethyl butyrate?

(a) 

(b) 

(c) 

(d) 

2. Let $A=\begin{pmatrix}2 & 1\\ 1 & 1\end{pmatrix}$ and $B=\begin{pmatrix}2 & -5\\ 0 & 1\end{pmatrix}$. If $AX+3B=0$, then the determination of X is

(a) –6 (b) 6 (c) –18 (d) 18

3. If the blood groups of mother and father are AB and O, respectively, what are the blood groups possible for their child?

(a) AB or A (b) AB (c) AB, A, B or O (d) A or B

4. Which one of the following components of bacterial cell acts as endotoxin?

(a) Porins (b) Lipopolysaccharide

(c) Peptidoglycan of Gram-positive bacteria (d) Peptidoglycan of Gram-negative bacteria

5. The type of immunological protection provided by plasma therapy is
(a) Natural active (b) Artificial passive (c) Natural passive (d) Artificial active

6. An acid contains C, H and O atoms. On combustion analysis, 0.454 g of the acid gives 0.418g of H_2O and 1.023 g of CO_2. What is the empirical formula of the acid?
(a) $C_4H_5O_2$ (b) C_5H_8O (c) CH_2O (d) C_3H_6O

7. The moment of force in terms of fundamental dimensions is
(a) $ML^{-1}T^{-1}$ (b) MLT^{-2} (c) MLT^{-1} (d) ML^2T^{-2}

8. Ecosystem ecology is the study of
(a) An organism's behaviour towards environmental challenges
(b) Factors that affect the interactions among communities in an ecosystem
(c) Interactions among biotic and abiotic components
(d) Factors that affect the interactions of individuals in a population

9. Bacterial strains that do not grow in the absence of a specific nutrient are called
(a) Autotrophs (b) Heterotrophs (c) Auxotrophs (d) Chemotrophs

10. Which one of the following features distinguishes between gymnosperms and angiosperms?
(a) Vascular tissues (b) Seed cover (c) Seed formation (d) Gamete production

11. The difference between mitosis and meiosis I is
(a) The DNA is double helical in meiosis I but not in mitosis
(b) The nuclear membrane is absent during mitotic metaphase, but not in meiotic metaphase
(c) Sister chromatids separate in mitosis, whereas homologous chromosomes separate in meiosis I
(d) Unlike in mitotic metaphase, chromosomes do not align at the equatorial plate in meiosis I

12. Which one of the following features/properties does glucose acquire through intramolecular hemiacetal formation?
(a) Ability to form epimers
(b) Ability to function as a reducing agent
(c) An additional chiral carbon
(d) Ability to form anhydride linkage with non-carbohydrate moieties such as the inorganic phosphate

13. Which one of the following microscopic techniques provides a 3-dimensional perspective of live unstained and transparent specimens obtained from the wild?
(a) Fluorescence microscopy
(b) Differential interference contrast (Nomarski) microscopy
(c) Confocal microscopy
(d) Phase contrast microscopy

14. The value of the integral $\int_0^4 (x - f(x))\,dx$, where $f(x) = \begin{cases} 0, & 0 \le x < 1 \\ 1, & 1 \le x < 2 \\ 2, & 2 \le x < 3 \\ 3, & 3 \le x < 4 \\ 4, & 4 \le x < 5 \end{cases}$, is
(a) –2 (b) –1 (c) 2 (d) 1

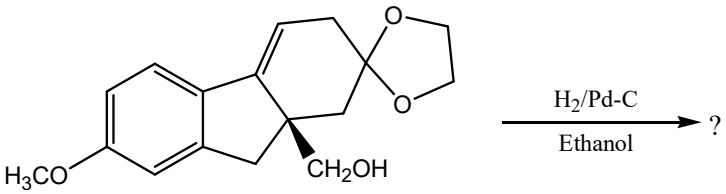
15. Match the cell junctions listed in **Group-A** with their correct functions listed in **Group-B**.

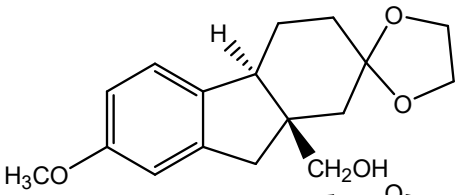
Group-A	**Group-B**
(I) Adherens junction	(P) Joins actin bundles in neighboring cells
(II) Desmosome	(Q) Joins intermediate filaments in neighboring cells
(III) Tight junction	(R) Seals neighboring cells
(IV) Gap junction	(S) Allows diffusion of molecules between adjacent cells

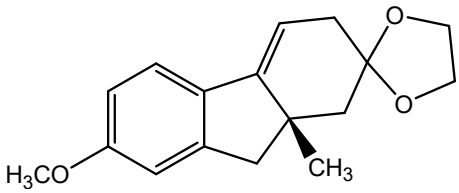
(a) I-P; II-Q; III-R; IV-S (b) I-Q; II-R; III-P; IV-S

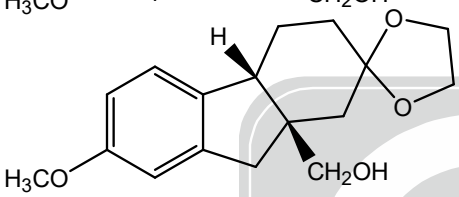
(c) I-S; II-P; III-Q; IV-R (d) I-Q; II-R; III-S; IV-P

16. Which one of the following is the major product of the hydrogenation reaction given below?



(a)


(b)


(c)


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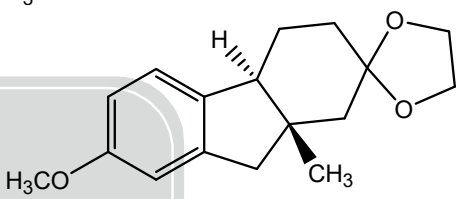
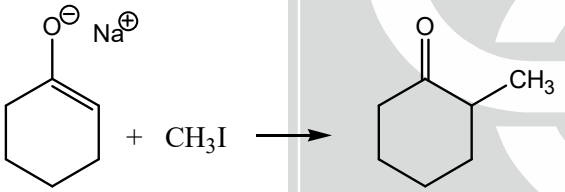


17. The following methylation is carried out in various solvents such as benzene, tetrahydrofuran (THF), dimethoxyethane (DME), dimethyl sulfoxide (DMSO) and N, N-dimethylformamide (DMF). Which one of the following is TRUE for the effect of solvent on the reaction rate?



(a) DME > DMSO > DMF > THF > Benzene (b) Benzene > THF > DME > DMF > DMSO

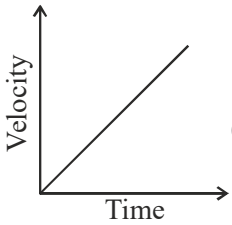
(c) THF > Benzene > DME > DMSO > DMF (d) DMSO > DMF > DME > THF > Benzene

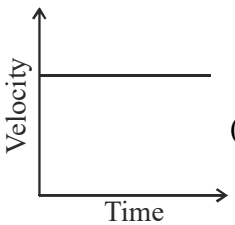
18. In mammals, females have two X chromosomes and males have one X chromosome. Equal expression of X-chromosome genes in both sexes is ensured by

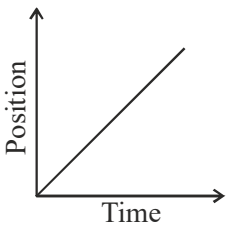
(a) RNA silencing (b) Histone code

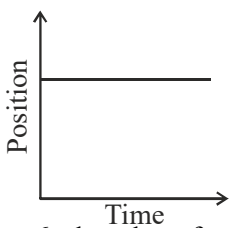
(c) Dosage compensation (d) Heterochromatin formation

19. Which one of the following represents the motion of an object with a positive acceleration?

(a)


(b)


(c)


(d)


20. What is the significance of the isomerization of glucose 6-phosphate to fructose 6-phosphate for the progression of glycolysis?

(a) Phosphorylation of glucose 6-phosphate to glucose 1, 6-bisphosphate is irreversible

(b) The carbonyl group at carbon-2 (C-2) in fructose facilitates the cleavage of the bond between C-3 and C-4

(c) Cleavage of glucose 1, 6-bisphosphate will not yield dihydroxy acetone phosphate and glyceraldehyde 3-phosphate

(d) As functional groups, ketones are more reactive than aldehydes

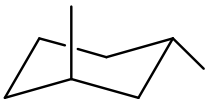
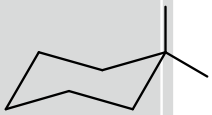
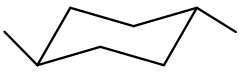
21. Presence of which one of the following in the urine indicates pregnancy in human?
(a) Estrogen
(b) Follicle-stimulating hormone and luteinizing hormone
(c) Progesterone
(d) Human chorionic gonadotropin

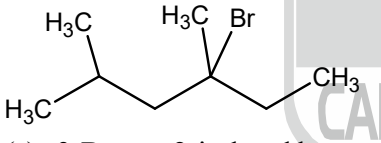
22. If $x+\frac{1}{x}=1$, then the value of $x^6+\frac{1}{x^6}$ is
(a) –1 (b) 2 (c) 1 (d) –2

23. In plants, the ovules are attached to the ovary by
(a) Tube cells (b) Placenta (c) Embryo sac (d) Synergids

24. A stationary enemy ship is docked in the sea at a distance of 1.0 km from the coastline. A gun located at the sea level on the coastline can fire projectiles at a velocity of 120 m/s. What is the angle (in degrees) above the horizontal at which the gun must fire to hit the ship? [g = 9.8 m/s^2]
(a) 21.4 (b) 42.9 (c) 47.1 (d) 23.6

25. What is the role of bile salts in the mammalian digestive system?
(a) Bile salts emulsify fat, and thus aid in fat digestion
(b) Bile salts convert pepsinogen to pepsin, and thus facilitate protein digestion
(c) Bile salts facilitate digestion of all types of macromolecules in the small intestine
(d) Bile salts are excretory products produced by the liver, and do not participate in digestion

26. Which one of the following isomers is thermodynamically most stable?
(a)  (b)  (c)  (d) 

27. IUPAC name of the following molecule is


(a) 3-Bromo-2-isobutyl butane (b) 4-Bromo-2-methyl-4-ethyl pentane
(c) 4-Bromo-2, 4-dimethyl hexane (d) 3-Bromo-3, 5-dimethyl hexane

28. Which one of the following processes emerged earliest during the course of evolution?
(a) Thymic education (b) Antigen presentation
(c) Antibody production (d) Phagocytosis

29. The lack of linear correlation between the genome sizes and genetic complexities among various species is known as
(a) C-value paradox (b) G-value paradox
(c) Central dogma (d) Genetic diversity

30. In a genetic cross between plants bearing violet flowers and green seeds (*VVGG*), and white flower and yellow seeds (*vvgg*), the following phenotypic distribution was obtained in the F_2 progeny (assume both parents to be pure breeding for both the traits, and self-cross at F_1 generation):
(i) 2340 plants with violet flowers and green seeds
(ii) 47 plants with violet flowers and yellow seeds
(iii) 43 plants with white flowers and green seeds
(iv) 770 plants with white flowers and yellow seeds

Which one of the following interpretations explains the above phenotypic distribution?

(a) Flower color in this plant species is a polygenic trait
(b) Same genes control both flower and seed colors
(c) Genes for flower and seed colors are genetically interacting
(d) Genes for flower and seed colors are present on the same chromosome

SECTION-B

[Multiple Select Questions (MSQ)]

1. Which of the following is/are involved in the initiation of DNA replication?
(a) RhoA (b) oriC (c) Sigma factor (d) DnaA

2. Which of the following is/are common to both prokaryotic and eukaryotic gene expression?
(a) Presence of the sequence TATA in the promoter
(b) Coupled transcription and translation
(c) Post-translational modification
(d) Genetic code

3. A charged particle accelerated by a potential V moves in a circular path with a velocity v in a uniform magnetic field B that is perpendicular to the motion. Which of the following is/are correct if the value of V is increased?
(a) Time period of the motion increases
(b) Work done by the magnetic field increases
(c) Radius of the circular path increases
(d) Kinetic energy of the particle increases

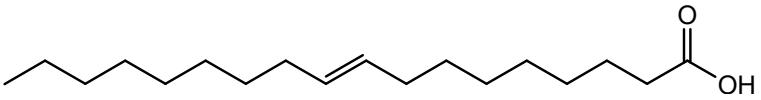
4. A function $f : D \to \mathbb{R}$ is defined as $f(x) = \dfrac{x^2+1}{x^2+x+1}$, where $D \subseteq \mathbb{R}$ is the domain. The domain(s) on which the function $f(x)$ is one to one is/are
(a) Natural numbers (b) Integers
(c) Rational numbers (d) Irrational numbers

5. Infrared (IR) spectroscopy is used for determining certain aspects of the structure of organic compounds. Which of the following statement(s) is/are FALSE?
(a) Each element absorbs at a characteristic wavelength
(b) IR peak intensities are related to molecular mass
(c) Most organic functional groups absorb in a characteristic region of the IR spectrum
(d) IR radiation induces electronic transitions

6. Which of the following is/are TRUE about the electron carrier, ubiquinone (coenzyme Q)?
(a) Being small and hydrophobic, ubiquinone readily shuttles between protein-based electron transfer complexes within the membrane
(b) Its hydrophilic nature and high affinity for protons enable ubiquinone to transport protons readily within the intermembrane space of mitochondria
(c) Its ability to interact with Heme C of cytochromes enables electron transport in the mitochondrial membrane
(d) Its ability to accept two electrons, one at a time, enables ubiquinone to function at the junction between a 2-electron donor and a 1-electron acceptor

7. Cyclic AMP (cAMP) acts as a second messenger for which of the following primary signaling molecule(s)?
(a) Epinephrine (b) Prostaglandins (c) Cortisol (d) Retinoic acid

8. Oleic acid, shown below, is



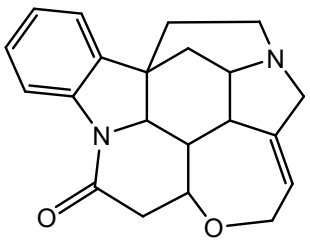
(a) Insoluble in water
(b) A saturated fatty acid
(c) Soluble in acetone
(d) An unsaturated fatty acid

9. Which of the following molecular genetic technique(s) is/are used in forensic science?
(a) Restriction fragment length polymorphism
(b) Electrophoretic mobility shift assay
(c) DNA fingerprinting
(d) Coimmunoprecipitation

10. Which of the following pairs is/are analogous structures?
(a) Human hands and bat wings
(b) Dolphin flippers and fish fins
(c) Butterfly wings and bat wings
(d) Bat wings and bird wings

SECTION-C

[Numerical Answer Type (NAT)]

1. The molar concentration of water in pure water is _____ M (rounded off to 1 decimal)
2. The number of triplet codon(s) for methionine is _____
3. The maximum number of genotypes possible for gametes formed from a diploid cell of the genotype *AaBBcCDd* is _____
4. 1.45 g of sucrose ($C_{12}H_{22}O_{11}$) is dissolved in 30.0 ml of water. Molality (rounded off to 3 decimals) of the resulting solution is _____m.
5. When the molecular weight of human immunoglobulin light chain is 24 kDa, the total molecular weight of human IgG is _____kDa.
6. The distance between the parallel lines $2x+5y=7$ and $2x+5y=15$ is (rounded off to 2 decimals).
7. The de Broglie wavelength of a proton moving at a speed of 1.0 m/s is _____Å.
[Planck's constant = 6.626×10^{-34} m^2 kg/s; $m_p = 1.67 \times 10^{-27}$ kg]
8. For a gene present on human chromosome 4, the maximum number of alleles that may be detected by sequencing the genome of 5 males and 10 females is _____
9. The number of peptide bonds in a 20-residue linear peptide is _____
10. The amount of hydrogen required to reduce 30 g of 2-butene is _____g (rounded off to 2 decimals).
11. The equation $\sin\frac{\theta}{2}\left(\sin\frac{\theta}{2}+\cos\frac{\theta}{2}\right)=\beta$ has a solution, where β is a natural number. Then β is _____
12. 

Strychnine

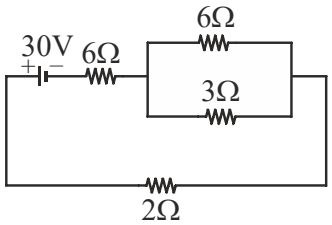
The number of chiral carbons in strychnine is _____

13. In a compound microscope, the magnification power of the objective lens is 100x, and that of the eye piece (ocular lens) is 10x. The magnification power of the microscope is _____x.

14. The number of polypeptide chains in a core nucleosome is _____

15. A double helical DNA molecule is composed of 32 mol % of adenosine. The mol % of cytosine in this DNA molecule is _____

16. In the circuit shown below, the power dissipated across the 3Ω resistor is _____W.



17. The velocity of blood in a blood vessel of 2.0 cm radius is 30 cm/s. When the blood vessel bifurcates into 2 smaller vessels of radius 1.0 cm each, the velocity of blood in each of the smaller vessels is _____cm/s. Assume that the vessel walls are rigid, and blood is incompressible.

18. While performing a PCR, the student forgot to add one of the two primers. The number of molecules of single-stranded DNA produced after 25 PCR cycles is _____

19. At 25ºC and pH 7.0, the concentrations of glucose 1-phosphate and glucose 6-phosphate are 2.0 mM and 38 mM, respectively at equilibrium. The standard free energy change for the conversion of glucose 1-phosphate to glucose 6-phosphate is _____ J/mol [R = 8.315 J mol^{-1} K^{-1}]

20. In a population at Hardy-Weinberg equilibrium, for *gene*-X only two alleles, namely *A* and *a*, are found. If frequency of allele *A* is 0.2 and the frequency of allele *a* is 0.8, the frequency of the heterozygote genotype *Aa* in that population will be _____ (correct to 2 decimal places).