GA : GENERAL APTITUDE

1 – 5 carry one mark each.

1. Rajiv Gandhi Khel Ratna Award was conferred _____ Mary Kom, a six-time world champion in boxing, recently in a ceremony _____ the Rashtrapati Bhawan (the President's official residence) in New Delhi.

(A) with, at
(B) on, in
(C) on, at
(D) to, at

2. Despite a string of poor performances, the chances of K. L. Rahul's selection in the team are _____.

(A) slim
(B) bright
(C) obvious
(D) uncertain

3. Select the word that fits the analogy:
Cover : Uncover :: Associate : _____

(A) Unassociate
(B) Inassociate
(C) Misassociate
(D) Dissociate

4. Hit by floods, the kharif (summer sown) crops in various parts of the country have been affected. Officials believe that the loss in production of the kharif crops can be recovered in the output of the rabi (winter sown) crops so that the country can achieve its food-grain production target of 291 million tons in the crop year 2019-20 (July-June). They are hopeful that good rains in July-August will help the soil retain moisture for a longer period, helping winter sown crops such as wheat and pulses during the November-February period.

Which of the following statements can be inferred from the given passage?

(A) Officials declared that the food-grain production target will be met due to good rains.
(B) Officials want the food-grain production target to be met by the November-February period.
(C) Officials feel that the food-grain production target cannot be met due to floods.
(D) Officials hope that the food-grain production target will be met due to a good rabi produce.

5. The difference between the sum of the first $2n$ natural numbers and the sum of the first n odd natural numbers is _____.

(A) $n^2 - n$
(B) $n^2 + n$
(C) $2n^2 - n$
(D) $2n^2 + n$

6 – 10 carry two marks each.

6. Repo rate is the rate at which Reserve Bank of India (RBI) lends commercial banks, and reverse repo rate is the rate at which RBI borrows money from commercial banks.

Which of the following statements can be inferred from the above passage?

(A) Decrease in repo rate will increase cost of borrowing and decrease lending by commercial banks.

(B) Increase in repo rate will decrease cost of borrowing and increase lending by commercial banks.
(C) Increase in repo rate will decrease cost of borrowing and decrease lending by commercial banks.
(D) Decrease in repo rate will decrease cost of borrowing and increase lending by commercial banks.

7. P, Q, R, S, T, U, V, and W are seated around a circular table.
I. S is seated opposite to W.
II. U is seated at the second place to the right of R.
III. T is seated at the third place to the left of R.
IV. V is a neighbour of S.

Which of the following must be true?

(A) P is a neighbour of R.
(B) Q is a neighbour of R.
(C) P is not seated opposite to Q.
(D) R is the left neighbour of S.

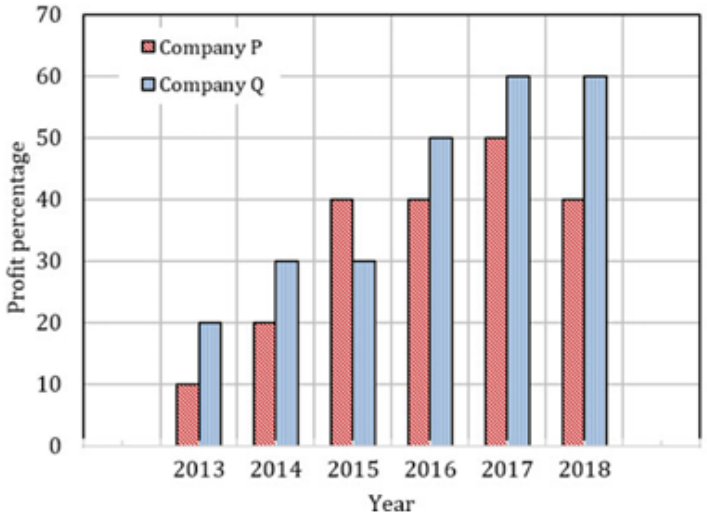
8. The distance between Delhi and Agra is 233 km. A car P started travelling from Delhi to Agra and another car Q started from Agra to Delhi along the same road 1 hour after the car P started. The two cars crossed each other 75 minutes after the car Q started. Both cars were travelling at constant speed. The speed of car P was 10 km/hr more than the speed of car Q. How many kilometers the car Q had travelled when the cars crossed each other?

(A) 66.6
(B) 75.2
(C) 88.2
(D) 116.5

9. For a matrix $M = [m_{ij}]$; $i, j = 1, 2, 3, 4$, the diagonal elements are all zero and $m_{ij} = -m_{ji}$. The minimum number of elements required to fully specify the matrix is_____.

(A) 0
(B) 6
(C) 12
(D) 16

10. The profit shares of two companies P and Q are shown in the figure. If the two companies have invested a fixed and equal amount every year, then the ratio of the total revenue of company P to the total revenue of company Q, during 2013–2018 is _____.



(A) 15 : 17
(B) 16 : 17
(C) 17 : 15
(D) 17 : 16

P: Chemistry (Compulsory)

1 – 5 carry one mark each.

1. An aqueous solution contains a mixture of 10^{-8} M NaCl and 10^{-8} M HCl. Choose the correct statement about this solution.
   (A) The solution is a buffer with pH less than 7.00
   (B) The solution is a buffer with pH greater than 7.00
   (C) The solution is not a buffer but has its pH less than 7.00
   (D) The solution is not a buffer but has its pH greater than 7.00
2. The coordination complex which has a distorted octahedral structure is
   (Given: Atomic numbers of V: 23; Mn: 25; Ni: 28; Cu: 29)

   (A) $(Ni(H_2O)_6)^{2+}$
   (B) $(Mn(H_2O)_6)^{2+}$
   (C) $(V(H_2O)_6)^{2+}$
   (D) $(Cu(H_2O)_6)^{2+}$

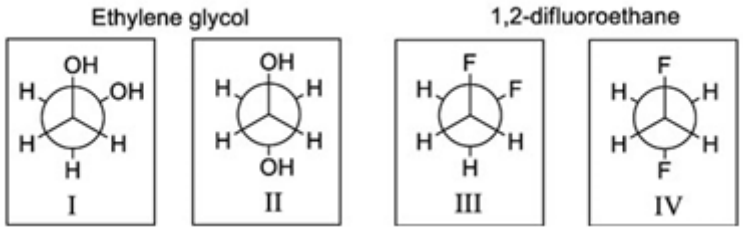
3. In naphthalene, the value of the integer "n" according to Hückel's rule of aromaticity is ____.
4. The azimuthal quantum number (l) of an electron in the d_2 orbital of a copper atom (atomic number: 29) is ____.
5. The standard enthalpy of reaction (in kJ mol^{-1}) for obtaining three moles of $H_2(g)$ from atomic hydrogen in gas phase is ____.
   (Given: Standard enthalpy of formation of atomic hydrogen in gas phase is 218 kJ mol^{-1})

6 – 11

6. The **correct** order of the first ionization energies of He, B, N and O in their corresponding ground state is

   (A) He > N > O > B
   (B) O > N > B > He
   (C) He > B > N > O
   (D) N > O > B > He

7. Based on the molecular orbital theory, which one of the following statements with respect to N_2, N_2^+, O_2 and O_2^+ is **correct**?
   (A) Bond orders of N_2 and O_2 are higher than their corresponding cations.
   (B) Bond energy of N_2^+ is higher than that of N_2, whereas bond energy of O_2^+ is lower than that of O_2.
   (C) The unpaired electrons in N_2^+ and O_2^+ are present in σ and π^* orbitals, respectively.
   (D) The bond in N_2^+ is shorter than that in N_2, whereas bond in O_2 is shorter than that in O_2^+.
8. Which one of the following statements is **incorrect** about the diborane molecule?
   (A) B-H^1 bond is a 2-centre-2-electron bond (H^1: terminal hydrogen).
   (B) BH^bB bond is a 3-centre-2-electron bond (H^b: bridged hydrogen).
   (C) The bond angle H^1BH^1 is 122° (H^1: terminal hydrogen).
   (D) The B-H^1 bond distance is longer than B-H^b bond distance (H^1: terminal hydrogen, H^b: bridged hydrogen).
9. Given below are Newman projections of ethylene glycol and 1,2-difluoroethane about their respective C–C bonds. The most stable conformations (lowest energy) of ethylene glycol and 1,2-difluoroethane are

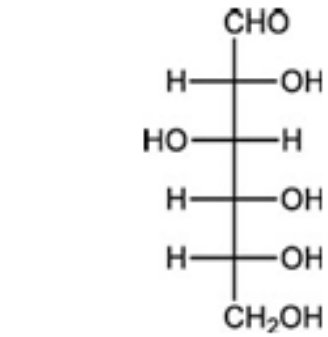


(A) I and III respectively.
(B) I and IV respectively.
(C) II and III respectively.
(D) II and IV respectively.

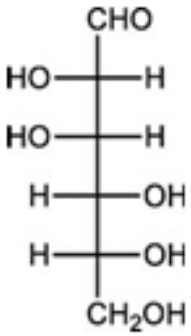
10. In the reaction given below, choose the condition that gives an anti-Markovnikov's product.

(A) Peroxide / HCl
(B) Aqueous mercuric acetate treatment
(C) Diborane addition
(D) Sulfuric acid addition

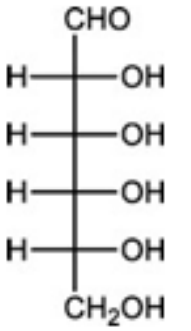
11. Which one of the following hexoses will give an osazone that has a different melting point from that of the osazone obtained from D (+) glucose?



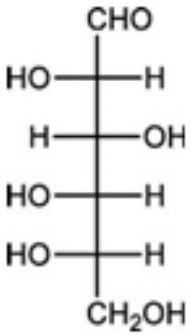
(B)



(C)



(D)



12. A molecule in solution crystallizes into two different crystal forms with rate constants of 0.02 s^{-1} and 0.13 s^{-1}. If the crystallization is assumed to be under kinetic control, then the half-life (in seconds, rounded off to one decimal place) of the molecule is _____.
13. The standard potential (E°_{cell}) for a cell reaction given below is +0.7 V. The standard reaction

free energy ($\Delta_r G^\circ$) for this cell is _____ kJ mol^{-1} (correct up to two decimal places). (Given: Faraday constant, F = 96500 C mol^{-1})
$Au^{3+}(aq) + 3\ Ag(s) \rightarrow Au(s) + 3\ Ag^{+}(aq)$

14. The activation energy (E_a) estimated for a reaction from the Arrhenius equation is 21 kJ mol^{-1}. If the frequency factor is assumed to be independent of temperature, then the ratio of the rate constants determined at 298 K and 260 K is _____ (rounded off to two decimal places). (Given: Gas constant, R = 8.315 J K^{-1} mol^{-1})
15. At a given pressure, a substance is heated from 2000 K to 2600 K. If the entropy of the substance is 60 J K^{-1} mol^{-1}, and is assumed to be constant over the given temperature range, then the change in the chemical potential (in kJ mol^{-1}) of the substance is _____.

Q: Biochemistry

1 - 10 carry one mark each.

1. Which one of the following hormones initiates a signaling cascade by directly binding to an intra-cellular receptor?

(A) Insulin
(B) Gonadotropin
(C) Progesterone
(D) Epinephrine

2. Which one of the following bonds is NOT present in ATP?

(A) Phosphoester
(B) Phosphoanhydride
(C) N-Glycosidic
(D) α-Glycosidic

3. The reaction involved in the direct conversion of L-phenylalanine to L-tyrosine is

(A) Hydroxylation
(B) Decarboxylation
(C) Transamination
(D) Reduction

4. The human major histocompatibility complex (MHC) is

(A) Polygenic and monomorphic
(B) Polygenic and polymorphic
(C) Monogenic and polymorphic
(D) Monogenic and monomorphic

5. Har Gobind Khorana and Marshall Nirenberg elucidated the genetic code by using a cell-free protein synthesizing system. It was found that poly(U) and poly(C) result in the synthesis of poly(L-Phe) and poly(L-Pro), respectively. Based on these observations, which one of the following conclusions is correct?

(A) Codon GGG specifies L-Phe and codon AAA specifies L-Pro
(B) Codon CCC specifies L-Phe and codon UUU specifies L-Pro
(C) Codon AAA specifies L-Phe and codon GGG specifies L-Pro
(D) Codon UUU specifies L-Phe and codon CCC specifies L-Pro

6. Binding of an antibody to its cognate antigen does NOT involve

(A) Covalent bonds
(B) Electrostatic forces
(C) Van der Waals forces
(D) Hydrogen bonds

7. A globular protein of molecular weight 50 kDa exists as a mixture of monomers and dimers in solution. The most appropriate technique for the separation of these two forms of the protein is

(A) Thin layer chromatography
(B) Ion exchange chromatography
(C) Gel filtration chromatography
(D) Paper chromatography

8. Choose the correct order of molecules according to their ability to diffuse across a lipid bilayer.

(A) CO_2 > H_2O > Glucose > RNA
(B) CO_2 > Glucose > H_2O > RNA
(C) RNA > Glucose > CO_2 > H_2O
(D) H_2O > CO_2 > RNA > Glucose

9. When one glucose unit from glycogen gets converted to lactate in the muscle, the net number of ATP molecules produced is _____.
10. Considering that the three pK_as of histidine are pK_1=1.8, pK_2=9.2 and pK_R=6.0, its isoelectric point will be _____ (rounded off to one decimal place). **11 - 20 carry two marks each.**
11. One mole of a native protein upon N-terminal analysis yielded one mole each of Asp and Val. Therefore, the protein in its native state exists as a

(A) Monomer
(B) Homo-dimer
(C) Hetero-dimer
(D) Tetramer

12. The prosthetic groups/cofactors involved in both $1e^-$ and $2e^-$ transfer in the mitochondrial electron transport chain are

(A) NAD and NADP
(B) NAD and FAD
(C) Heme and FMN
(D) Coenzyme Q and FMN

13. Match the items in **Group I** with the most appropriate items in **Group II** and choose the correct option.

Group I	Group II
P. Integrin	1. Phagocytosis in the neural tissue
Q. Microglial cell	2. Antigen processing by cross-presentation
R. TLR-7	3. Single stranded RNA recognition
S. Dendritic cell	4. Binding of cells to endothelium

(A) P-2, Q-1, R-3, S-4
(B) P-4, Q-1, R-3, S-2
(C) P-1, Q-2, R-3, S-4
(D) P-4, Q-1, R-2, S-3

14. The correct combination of glycosidic linkages present in glycogen is

(A) α 1→4 and α 1→6
(B) α 1→4 and β 1→6
(C) α 1→6 and β 1→4
(D) α 1→6 and β 1→6

15. Polypeptides are either biosynthesized on the ribosomes using an mRNA template or chemically synthesized by the Merrifield's solid phase method. The correct directions of peptide synthesis are
(A) C→N direction on the ribosomes and N→C direction on the solid phase
(B) N→C direction on the ribosomes and C→N direction on the solid phase
(C) N→C direction in both cases
(D) C→N direction in both cases
16. A solution absorbs 20% of the incident light in a cuvette of path length 1.0 cm. The amount of light transmitted by the same solution in a cuvette of 3.0 cm path length is _____% (rounded off to one decimal place).
17. The second pK_a of phosphoric acid is 6.8. The ratio of Na_2HPO_4 to NaH_2PO_4 required to obtain a buffer of pH 7.0 is _____ (rounded off to two decimal places).

18. A PCR in a 100 μL reaction volume, containing two primers at a concentration of 0.2 μM each, is set up to amplify a 250 base pair DNA fragment. Consider the average molecular weight of one base pair as 660 Da. If the primers are fully consumed by the end of the reaction, the amount of the final PCR product formed is _____ μg (rounded off to one decimal place).
19. An enzyme obeying Michaelis-Menten kinetics shows a reaction velocity (v) of 10 μmol/min when the substrate concentration [S] equals its K_M. The maximal velocity V_{max} for this enzyme is _____ μmol/min (correct to integer number). (K_M is Michaelis-Menten constant)
20. The enzyme glucose isomerase catalyzes the inter-conversion of glucose and fructose as shown.

    Glucose $\rightleftharpoons$ Fructose

    The ΔG° for this reaction is zero kcal/mol. After adding glucose isomerase to a 0.12 M glucose solution and allowing the reaction to attain equilibrium, the final concentration of fructose in the reaction mixture will be _____ mM.

R: BOTANY

1 - 10 carry one mark each.

1. Indefinite stamen is a characteristic feature of which of the following plant families?

(A) Malvaceae
(B) Apocynaceae
(C) Poaceae
(D) Brassicaceae

2. In natural condition, which of the following plants **DOES NOT** exhibit anomalous secondary growth?

(A) Rice
(B) Aloe
(C) Yucca
(D) Dracaena

3. In a typical angiosperm under natural condition, primary meristems are usually established during

(A) Gametogenesis
(B) Embryogenesis
(C) Vegetative phase development
(D) Secondary growth

4. 2-Methoxy-3, 6-dichlorobenzoic acid belongs to which class of plant growth regulators?

(A) Synthetic auxin
(B) Synthetic cytokinin
(C) Strigolactone
(D) Brassinosteroid

5. In a typical green plant, the first stable product of Calvin cycle is

(A) Oxaloacetic acid
(B) Succinic acid
(C) Maleic acid
(D) 3-Phosphoglyceric acid

6. Among the following, which best describes an organism that lives at the expense of other organisms, harmful but usually not killing?

(A) Predator
(B) Symbiotic
(C) Prey
(D) Parasite

7. The oleo-gum resin asafoetida (hing) is obtained from the cut surface of

(A) Stem
(B) Root
(C) Leaf
(D) Fruit

8. ‘Bakanae’ disease or ‘foolish seedling’ disease is caused by

(A) Fungus
(B) Bacterium
(C) Virus
(D) Mycoplasma

9. Which of the following chemicals is used for doubling of chromosome numbers during production of ‘doubled haploids’ in crop plants?

(A) Hygromycin
(B) Kanamycin
(C) Colchicine
(D) Glufosinate

10. An mRNA of a nuclear encoded plant gene, *DSH20* has an ORF of 1353 nucleotides. Provided that average molecular weight of amino acid is 110 Dalton (Da), calculated molecular weight of DSH20 protein in kDa (*round off to 1 decimal place*) is _____.

11 - 20 carry two marks each.

11. **Group I, Group II and Group III** represent enzyme, product of the enzymatic reaction, and metabolic process, respectively.

Group I	Group II	Group III
P. Hexokinase	i. Malate	1. Glycolysis
Q. Fumarase	ii. Glucose 6-P	2. Photorespiration
R. PEP Carboxylase	iii. Hydrogen peroxide	3. TCA cycle
S. Glycolate oxidase	iv. Cinnamic acid	4. Photosynthesis
	v. Oxaloacetic acid	

The **CORRECT** combination for Group I, Group II and Group III is

(A) P-ii-1, Q-iv-3, R-v-2, S-iii-4
(B) P-ii-1, Q-i-3, R-v-4, S-iii-2
(C) P-ii-2, Q-v-3, R-i-4, S-iii-1
(D) P-iii-1, Q-i-3, R-iv-4, S-ii-2

12. Match the following in **CORRECT** combination between Group I and Group II with reference to the agents that interfere with oxidative phosphorylation.

Group I	Group II
P. Cyanide	i. Blocks electron transfer from cyt b to cyt c_1
Q. Antimycin A	ii. Inhibits F_1
R. Aurovertin	iii. Uncoupling of phosphorylation from electron transfer
S. 2,4-Dinitrophenol	iv. Inhibits cytochrome oxidase
	v. Inhibits K^+ ionophore

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

13. In relation to Agrobacterium mediated genetic engineering in plants, match the following in CORRECT combination.

Gene name	Function
P. virA	i. Acetosyringone receptor
Q. virB	ii. Conjugal tube formation
R. virD1	iii. Topoisomerase
S. virG	iv. Inducer of all vir operons
	v. Octopine synthesis

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

14. Match the plant part (Group I) with the product obtained (Group II) and the representative plant species (Group III) in CORRECT combination.

Group I	**Group II**	**Group III**
P. Bark	i. Tannins	1. Papaver somniferum
Q. Leaf	ii. Saffron	2. Camellia sinensis
R. Flower	iii. Codeine	3. Cinnamomum zeylanicum
S. Fruit	iv. Aromatic oil	4. Crocus sativus

(A) P-ii-1, Q-i-3, R-iv-2, S-iii-4
(B) P-ii-1, Q-i-2, R-iv-4, S-iii-3
(C) P-ii-2, Q-iv-3, R-i-4, S-iii-1
(D) P-iv-3, Q-i-2, R-ii-4, S-iii-1

15. Select the CORRECT combination by matching the disease, causal organism and the affected plant.

Group I	**Group II**	**Group III**
P. Bark	i. Tannins	1. Papaver somniferum
Q. Leaf	ii. Saffron	2. Camellia sinensis
R. Flower	iii. Codeine	3. Cinnamomum zeylanicum
S. Fruit	iv. Aromatic oil	4. Crocus sativus

(A) P-iv-1, Q-iii-3, R-i-2, S-ii-4
(B) P-ii-1, Q-i-6, R-iv-4, S-iii-2
(C) P-iii-1, Q-iv-3, R-i-5, S-ii-4
(D) P-iv-1, Q-ii-3, R-iii-2, S-i-5

16. Match the following alkaloids with their uses and source plants in CORRECT combination.

Alkaloid	Use	Source plant
P. Morphine	i. Anti-cancer	1. Cinchona officinalis
Q. Quinine	ii. Analgesic	2. Catharanthus roseus
R. Atropine	iii. Anti-cholinergic	3. Papaver somniferum
S. Vinblastine	iv. Anti-malarial	4. Hyoscyamus niger

(A) P-ii-3, Q-iv-1, R-iii-4, S-i-2
(B) P-ii-1, Q-i-3, R-iv-4, S-iii-2
(C) P-ii-2, Q-iv-1, R-i-4, S-iii-3
(D) P-iii-4, Q-ii-1, R-iv-3, S-i-2

17. Match the following ecological terms with their appropriate definitions.

Term	Definition
P. Niche	i. Position of a species in food chain
Q. Biotas	ii. Place of a living organism in the biotic environment and its relations to food and
R. Trophic level	iii. Physical environment of an organism
S. Habitat	iv. Totality of organisms (flora and fauna) in a given place or region

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

18. Arrange the following 'water reservoirs of earth' in decreasing order of water volume.
P- Streams Q- Groundwater R- Glaciers S- Lakes and inland seas

(A) R-Q-S-P
(B) P-Q-R-S
(C) S-P-R-Q
(D) R-P-Q-S

19. Selection markers and the corresponding genes used in plant genetic engineering are given below:

Selection Marker	**Gene**
P. Kanamycin	i. *hptIV*
Q. Hygromycin	ii. *bar*
R. Bialaphos	iii. *pmi*
S. Mannose	iv. *nptII*

Choose the **CORRECT** combination

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

20. A double homozygous mutant develops green and wrinkled seeds. When it was crossed with a true-breeding plant having yellow and round seeds, all the F1 plants developed yellow and round seeds. After self-fertilization of F1, the calculated percentage probability of plants with green and wrinkled seeds in the F2 population (*rounded off to 2 decimal places*) is _____.

S : MICROBIOLOGY

1 – 10 carry one mark each.

1. The technique of microbial "pure culture" was pioneered by

(A) Edward Jenner (B) Louis Pasteur (C) Robert Hooke (D) Robert Koch

2. The antibacterial trimethoprim is an inhibitor of

(A) dihydrofolate reductase
(B) dihydropteroate synthase
(C) N5,N10-methenyl tetrahydrofolate synthetase
(D) serine hydroxymethyl transferase

3. Choose the correct taxonomical hierarchy among the following:

(A) Species, Genus, Family, Order, Class, Phylum, Domain
(B) Species, Genus, Order, Class, Family, Phylum, Domain
(C) Species, Genus, Order, Family, Class, Phylum, Domain
(D) Species, Genus, Family, Class, Order, Phylum, Domain

4. Shifting a *Saccharomyces cerevisiae* culture from fermentative to aerobic respiratory mode will

(A) decrease carbon dioxide production
(B) increase alcohol production
(C) increase glucose consumption
(D) decrease ATP generation per mole of glucose

5. Which one of the following diseases is treated by a neuraminidase inhibitor?

(A) Chickenpox
(B) Polio
(C) Influenza
(D) Japanese encephalitis

6. Which one of the following does NOT provide three-dimensional images?

(A) Atomic force microscopy
(B) Confocal scanning laser microscopy
(C) Differential interference contrast microscopy
(D) Phase-contrast microscopy

7. Which one of the following will increase the resolution of a light microscope?

(A) Decreasing the numerical aperture of the objective lens
(B) Using an objective lens with a longer working distance
(C) Using a medium of higher refractive index
(D) Increasing the wavelength of light

8. Which one of the following conditions favors maximum expression of lac operon genes in *E. coli*?

(A) Glucose-low, lactose-low, cAMP-high
(B) Glucose-high, lactose-low, cAMP-high
(C) Glucose-low, lactose-high, cAMP-high
(D) Glucose-high, lactose-high, cAMP-low

9. Match the cellular organelle in Group I with its function in Group II.

Group I	Group II
P. Golgi apparatus	1. Lipid degradation
Q. Nucleolus	2. Protein degradation
R. Peroxisome	3. Protein sorting
S. Proteasome	4. Ribosomal RNA synthesis

(A) P-3, Q-2, R-1, S-4
(B) P-3, Q-4, R-1, S-2
(C) P-1, Q-2, R-4, S-3
(D) P-3, Q-1, R-4, S-2

10. A 250 μl of bacteriophage stock containing 8×10^8 phages/ml is added to 500 μl of *E. coli* culture containing 4×10^8 cells/ml. The multiplicity of infection is _____.

11 – 20 carry two marks each.

11. Digestion of an immunoglobulin G (IgG) molecule with pepsin will NOT
(A) generate a bivalent antigen binding fragment
(B) generate monovalent antigen binding fragments
(C) destroy the complement binding site
(D) cleave the heavy chain of IgG molecule

12. Match the process involved in nitrogen or sulfur cycle in Group I with the corresponding microbe in Group II.

Group I	Group II
P. Denitrification	1. Azotobacter
Q. Nitrogen fixation by free-living microbe	2. Beggiatoa
R. Oxidation of H_2S to sulfur	3. Pseudomonas
S. Nitrogen fixation by a symbiotic microbe	4. Rhizobium

(A) P-2, Q-3, R-4, S-1
(B) P-2, Q-1, R-3, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-3, Q-1, R-2, S-4

13. Determine the correctness or otherwise of the following Assertion [a] and the Reason [r].
Assertion [a]: Diphtheria exotoxin is an example of A-B type toxin.
Reason [r]: The A component of the toxin is released from the host cell while the B component inhibits protein synthesis and kills the host cell.
(A) Both [a] and [r] are true and [r] is the correct reason for [a]
(B) Both [a] and [r] are true but [r] is not the correct reason for [a]
(C) Both [a] and [r] are false
(D) (a) is true but [r] is false

14. Which one of the following statements about control of microbial growth is NOT correct?
(A) Nonionizing radiation leads to thymine dimers formation in DNA
(B) Spirochetes and mycoplasma can pass through membrane filters (0.22-0.45 μm)
(C) Use of high concentration of salt and sugars to preserve food is a chemical method of microbial control
(D) Thermoduric bacteria can survive pasteurization

15. An example of a differential and selective medium in which colonies of Gram-negative bacteria produce large amounts of acidic products and appear green with a metallic sheen is

(A) Blood agar
(B) EMB agar
(C) MacConkey agar
(D) Mannitol salt agar

16. Which one of the following is an example of substrate level phosphorylation?
    (A) Glucose to Glucose-6-phosphate
    (B) Fructose 6-phosphate to Fructose 1,6-bisphosphate
    (C) 1,3-bisphosphoglycerate to 3-phosphoglycerate
    (D) 2-phosphoglycerate to Phosphoenolpyruvate
17. A bacterial culture containing 3×10^8 live cells was exposed to a newly developed sterilizing agent. After 30 minutes of exposure, 3 live cells remained in culture. The decimal reduction time (in minutes) for the new agent is _____.
18. A bacterial culture has a generation time of 34 minutes. The time taken (in minutes, rounded off to two decimal places) for the OD_{600} of this exponentially growing culture to increase from 0.25 to 0.85 is _____. Assume that OD_{600} has a linear relationship with the cell density.
19. A 100 μl aliquot (10^{-4} dilution) of the bacterial culture plated on nutrient agar gave 4 colonies. The bacterial stock concentration (in million cells/ml, rounded off to one decimal place) is _____.
20. A continuous bacterial culture carried out in a chemostat is set to a flow rate of 40ml/hr. The culture volume is equivalent to that of a cubical container having 10cm sides. The dilution rate (in hr^{-1}, rounded off to two decimal places) of this system is _____.

T : ZOOLOGY

1 – 10 carry one mark each.

1. Which ONE of following leucocytes is phagocytic and has clear cytoplasm?

(A) Eosinophil (B) Monocyte (C) T-lymphocyte (D) Basophil

2. Which ONE of the following techniques can be used for detecting the subcellular localization of serotonin receptor in intact cells?

(A) Immunoelectron microscopy
(B) SDS-PAGE
(C) Fluorescence in-situ hybridization
(D) Differential centrifugation

3. Which ONE of the following is NOT a site for in situ conservation?

(A) Biosphere reserve
(B) Wild life sanctuary
(C) Zoological garden
(D) Biodiversity hotspot

4. Which ONE of the following is the precursor molecule for corticosteroids?

(A) Androgen (B) Estrogen (C) Pregnenolone (D) Mineralocorticoids

5. Transitional epithelia is found in which ONE of the following organs?

(A) Liver (B) Lung (C) Brain (D) Urinary bladder

6. Visual signal transduction cascade is activated by rhodopsin and involves degradation rather than synthesis of which ONE of the following second messenger molecules?

(A) CAMP (B) IP3 (C) CGMP (D) DAG

7. The genomes of both human and Drosophila code for an amylase that acts on the same substrate. However, the sequence of nucleotides in the genes encoding the two is dissimilar. This is an example of which ONE of the following types of evolution?

(A) Neutral (B) Directional (C) Convergent (D) Divergent

8. ”Round dance” is performed by forager bees to indicate the distance between a food source and their colony. Which ONE of the following best represents this distance?

(A) 45 meters
(B) 450 meters
(C) 1000 meters
(D) More than 2000 meters

9. Which ONE of the following phyla have choanocytes?

(A) Ctenophora (B) Nematoda (C) Cnidaria (D) Porifera

10. Which ONE of the following glial cells is NOT derived from the ectoderm?

(A) Astrocytes (B) Microglial cells (C) Oligodendrocytes (D) Ependyma

11 – 20 carry two marks each.

11. Tarantulas and mosquitoes both belong to the phylum Arthropoda. Which ONE of the following represents the correct number of legs in them respectively?

(A) 6 and 6 (B) 6 and 8 (C) 8 and 8 (D) 8 and 6

12. Match the following subcellular organelles in **Column I** with associated functions in **Column II**.

Column I	**Column II**
P. Nucleolus	(i) Glycoprotein biosynthesis
Q. Peroxisomes	(ii) Oxidation of fatty acids and amino acids
R. Endoplasmic reticulum	(iii) Protein trafficking
S. Golgi bodies	(iv) Ribosome biogenesis

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

13. Match the following genetic disorders in **Column I** with associated typical chromosomal changes mentioned in **Column II**.

Column I	**Column II**
P. Klinefelter syndrome	(i) 45,XO
Q. Down syndrome	(ii) 5p minus
R. Turner syndrome	(iii) 47,XXY
S. Cri-du-chat syndrome	(iv) Trisomy 21

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

14. Match the following components listed in **Column I** with their respective organs in **Column II**.

Column I	**Column II**
P. Endolymph	(i) Testes
Q. Vitreous humour	(ii) Ear
R. Vas deferens	(iii) Ovary
S. Corpus luteum	(iv) Eye

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

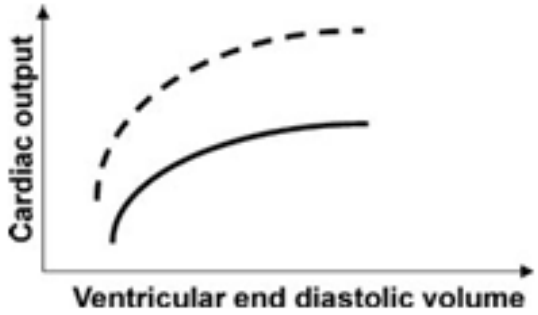
15. Match the following digestive enzymes in **Column I** with their respective functions in **Column II**.

Column I	**Column II**
P. Erepsin	(i) converts proteins to peptides
Q. Steapsin	(ii) activates trypsinogen to trypsin
R. Pepsin	(iii) converts fat into fatty acid and glycerol
S. Enterokinase	(iv) converts polypeptides to amino acids

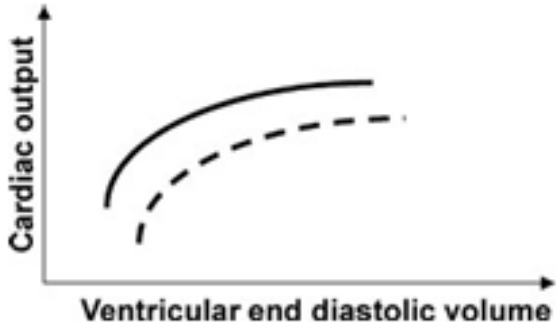
(A) P-(iv), Q-(iii), R-(i), S-(ii)
(B) P-(iv), Q-(ii), R-(i), S-(iii)
(C) P-(iii), Q-(iv), R-(ii), S-(i)
(D) P-(iii), Q-(iv), R-(iii), S-(i)

16. Which ONE of the following graphs represents the relationship between ventricular end-diastolic volume and cardiac output in a healthy adult individual at rest (solid line) and upon exercise (dotted line)?

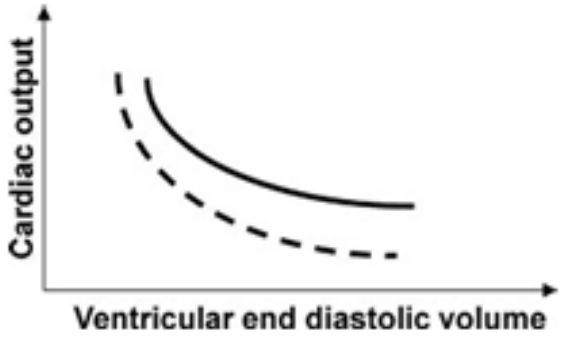
(A)



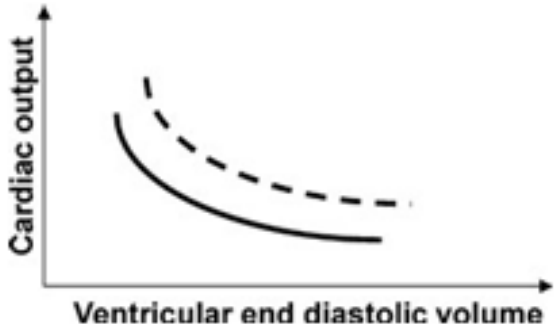
(B)



(C)



(D)



17. Match the household insect vectors in **Column I** with their associated diseases in **Column II**.

Column I	**Column II**
P. Kissing bug (Hemiptera)	(i) Bubonic plague
Q. Sand fly (Diptera)	(ii) Tularemia
R. Deer fly (Diptera)	(iii) Chagas disease
S. Oriental rat flea (Siphonaptera)	(iv) Kala azar

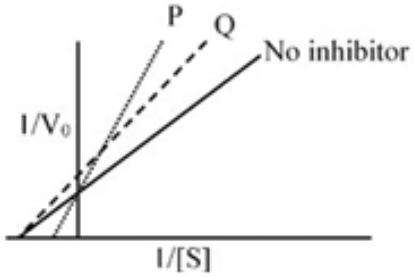
(A) P-(ii), Q-(iii), R-(i), S-(iv)
(B) P-(iii), Q-(iv), R-(ii), S-(i)
(C) P-(ii), Q-(iv), R-(iii), S-(i)
(D) P-(iii), Q-(iv), R-(ii), S-(i)

18. Match the proteins in **Column I** with the organs in which they are maximally expressed in **Column II**.

Column I	**Column II**
P. Keratin	(i) Liver
Q. Surfactants	(ii) Pancreas
R. Pro-carboxypeptidase	(iii) Lung
S. Albumin	(iv) Skin

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

19. The graph below shows the activity of enzyme pepsin in the presence of inhibitors aliphatic alcohols (P) or N-acetyl-L-phenylalanine (Q). Which ONE of the following represents the nature of inhibition by P and Q, respectively?



(A) Non-competitive and competitive
(B) Competitive and non-competitive
(C) Non-competitive and uncompetitive
(D) Competitive and uncompetitive

20. In Drosophila, the red eye phenotype (W) is dominant over the recessive white eye mutant (w). In a mixed population of red and white eye flies of 10,000 individuals, 3,600 flies were white eyed. The percentage of the heterozygous red eye flies in this population is _____.

U : FOOD TECHNOLOGY

1 – 10 carry one mark each.

1. The enzyme majorly involved in postmortem degradation of muscle proteins is:

(A) Trypsin
(B) Cathepsin
(C) Transglutaminase
(D) Pepsin

2. Which of the following is the correct pair of essential fatty acids?

(A) Oleic acid and Lenoleic acid
(B) Lenoleic acid and Linolenic acid
(C) Stearic acid and Palmitic acid
(D) Linoleic acid and Oleic acid

3. Nisin A is produced by

(A) Aspergillus niger
(B) Saccharomyces cerevisiae
(C) Lactobacillus lactis
(D) Clostridium perfringens

4. Which of the following bacteria will stain purple color after Gram staining?

(A) Bacillus subtilis
(B) Escherichia coli
(C) Pseudomonas aeruginosa
(D) Yersinia pestis

5. The enzyme system used for removal of glucose from egg white prior to its drying consists of

(A) Glucose oxidase and Catalase
(B) Glucoamylase and Glucoisomerase
(C) Gluconisomerase and Catalase
(D) Glucoamylase and Glucose oxidase

6. The INCORRECT pair of food borne illness and its causative microorganism is

(A) Brucellosis – Brucella Sp.
(B) Peptic ulcers – Bacillus subtilis
(C) Bubonic plague – Yersinia pestis
(D) Q fever – Coxiella burnetii

7. Which of the following is commonly used as a preservative in the tomato sauce?

(A) Sodium sulphite
(B) Potassium sorbate
(C) Potassium sulphite
(D) Sodium benzoate

8. A fluid with flow behaviour index less than one ($n < 1$) is

(A) Dilatant
(B) Pseudoplastic
(C) Bingham plastic
(D) Newtonian

9. The velocity of 2.2 μm diameter fat particles inside a centrifuge, running at 6000 rpm and 20°C, is 0.25 mm s^{-1}. The velocity of 1.5 μm diameter fat particles inside the same centrifuge running at 7500 rpm and same temperature (round off to 2 decimal places) will be _____ mm s^{-1}.

10. The initial population of a bacterial strain increases from 1×10^3 cells per mL to 1×10^8 cells per mL in 120 minutes. The generation time for this strain (round off to 2 decimal places) is _____ minutes.

11 – 20 carry two marks each.

11. Match the protein in **Column I** with its food source in **Column II**.

Column I	**Column II**
P. Zein	1. Soybean
Q. Gluten	2. Maize
R. Glycinin	3. Egg
S. Ovalbumin	4. Wheat

(A) P-4, Q-1, R-2, S-3
(B) P-4, Q-3, R-1, S-2
(C) P-2, Q-3, R-1, S-4
(D) P-2, Q-4, R-1, S-3

12. Match the carbohydrate in **Column I** with corresponding enzyme used for its hydrolysis in **Column II**.

Column I	**Column II**
P. Pectin	1. Xylanase
Q. Lactose	2. β-galactosidase
R. Hemicellulose	3. Polygalacturonase
S. Inulin	4. β-fructofuranosidase

(A) P-3, Q-2, R-1, S-4
(B) P-2, Q-4, R-1, S-3
(C) P-1, Q-2, R-3, S-4
(D) P-4, Q-3, R-1, S-2

13. Match the edible oil refining stage in **Column I** with its purpose in **Column II**.

Column I	**Column II**
P. Degumming	1. Separation of triglycerides
Q. Neutralization	2. Removal of pigments
R. Bleaching	3. Removal of phosphatides
S. Winterization	4. Removal of free fatty acids

(A) P-3, Q-1, R-2, S-4
(B) P-1, Q-4, R-2, S-3
(C) P-4, Q-3, R-1, S-2
(D) P-3, Q-4, R-2, S-1

14. Match the food material in **Column I** with its related term in **Column II**.

Column I	**Column II**
P. Coffee	1. Wort
Q. Cocoa	2. Must
R. Beer	3. Arabica
S. Wine	4. Theobroma

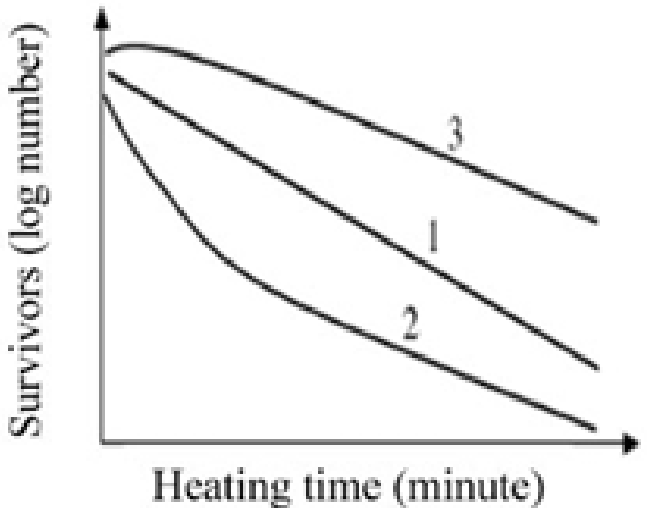
(A) P-4, Q-2, R-1, S-3
(B) P-3, Q-4, R-1, S-2
(C) P-3, Q-4, R-2, S-1
(D) P-1, Q-3, R-4, S-2

15. Match the component/system in **Column I** with the peeling method for fruits and vegetables in **Column II**.

Column I	**Column II**
P. Lye solution	1. Flash peeling
Q. Carborundum rollers	2. Flame peeling
R. Pressure vessel	3. Abrasion peeling
S. Conveyor belt	4. Caustic peeling

(A) P-4, Q-3, R-2, S-1
(B) P-3, Q-4, R-1, S-2
(C) P-4, Q-3, R-1, S-2
(D) P-3, Q-4, R-2, S-1

16. Which among the given options correctly explains the nature of the microbial culture represented by lines 1, 2 and 3 in the following figure?



(A) 1. Germination of spores; 2. Homogeneous population; 3. Mixed population of spores and vegetative cells
(B) 1. Homogeneous population; 2. Mixed population of heat sensitive and heat resistant microbes; 3. Germination of spores
(C) 1. Composite population; 2. Spores activated by short exposure to heat; 3. Thermo sensitive and thermo resistant microbes
(D) 1. Mixed population; 2. Microorganisms activated by short exposure to heat; 3. Germination of spores

17. Match the equation/law in **Column I** with its application in **Column II**.

Column I	**Column II**
P. Plank's equation	1. Terminal velocity
Q. Arrhenius equation	2. Freezing time
R. Guggenheim-Anderson-de Boer equation	3. Activation energy
S. Stoke's law	4. Monolayer moisture content

(A) P-1, Q-3, R-4, S-2
(B) P-2, Q-3, R-1, S-4
(C) P-2, Q-3, R-4, S-1
(D) P-4, Q-3, R-1, S-2

18. Match the absorber used in modified atmosphere packaging and storage in **Column I** with the scavenger in **Column II**.

Column I	**Column II**
P. Oxygen absorber	1. Calcium chloride
Q. Carbon dioxide absorber	2. Magnesium oxide
R. Ethylene absorber	3. Ferric oxide
S. Moisture absorber	4. Potassium permanganate

(A) P-3, Q-2, R-4, S-1
(B) P-1, Q-2, R-4, S-3
(C) P-2, Q-3, R-4, S-1
(D) P-3, Q-2, R-1, S-4

19. During extrusion cooking, food materials are generally subjected to a combination of

(A) high shear and low pressure
(B) high temperature and high shear
(C) low shear and high temperature
(D) low shear and low pressure

20. An orange juice flowing at 0.80 kg/s enters a counter current double pipe heat exchanger at 20°C and leaves at 72°C. Inlet and outlet temperatures of the hot water used as heating medium in the exchanger are 81°C and 74°C, respectively. The specific heat of the orange juice is 3.74 kJ/(kg K) and overall heat transfer coefficient is 492 W/(m^2 K). The heat transfer surface area (round off to 2 decimal places) will be _____ m^2.