KVPY-SX 2018 (BIOLOGY)

PART-I

1. What is the maximum number of oxygen atoms that a molecule of hemoglobin can bind?

   (a) 2 (b) 4 (c) 8 (d) 16

2. Bt toxin produced by Bacillus thuringiensis does not kill the producer because the toxin is

   (a) In an inactive protoxin form (b) rapidly secreted outside

   (c) Inactivated by an antitoxin (d) in unfolded form

3. An angiosperm was identified with its endosperm of 6n. Assuming that this is a self-pollinating species, which ONE of the following is the correct ploidy of the parent?

   (a) 3n (b) 4n (c) 6n (d) 8n

4. Which ONE of the following statements is TRUE about viruses?

   (a) All viruses possess a protein coat around its genetic material at all stages of their life cycle

   (b) All viruses contain RNA as genetic material

   (c) All viruses contain DNA as genetic material

   (d) All viruses replicate only within the host cell

5. Mitochondrial cristae are infoldings of the

   (a) Outer membrane and they increase the surface area

   (b) Outer membrane and they decrease the surface area

   (c) Inner membrane and they increase the surface area

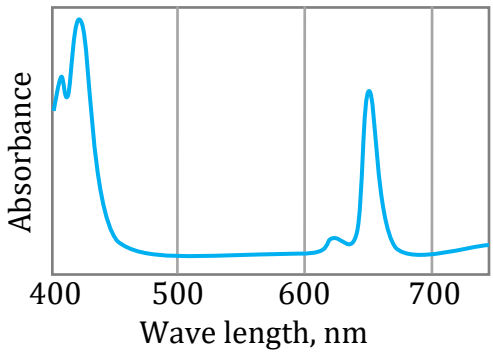
   (d) Inner membrane and they decrease the surface area

6. In biological nitrogen fixation, the enzyme nitrogenase converts

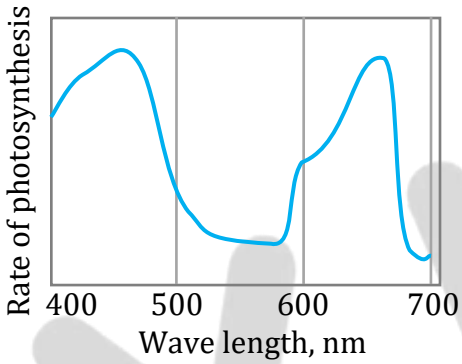
   (a) Nitrate to nitrite (b) atmospheric nitrogen to nitrite

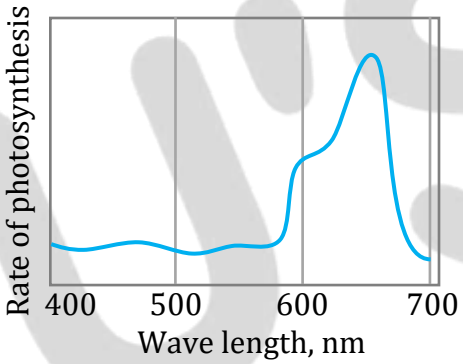
   (c) Nitrite to ammonia (d) atmospheric nitrogen to ammonia

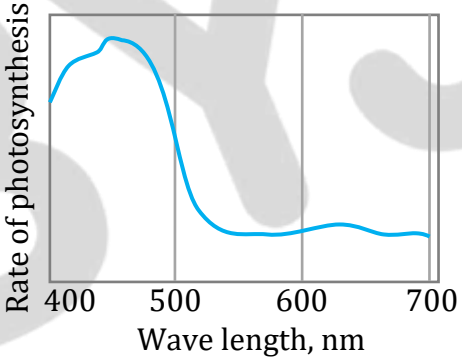
7. The graph below represents the absorption spectrum of a major pigment contributing to photosynthesis.

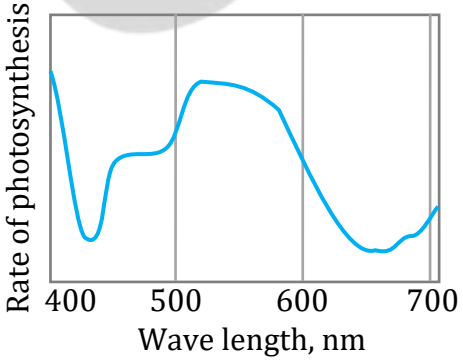


Which ONE of the following best represents the photosynthetic efficiency of

(a)


(b)


(c)


(d)


8. Which ONE of the following properties of normal cell is lost during its transition to cancerous cell?

(a) Glutamine utilization
(b) Contact inhibition
(c) Glucose utilization
(d) Membrane fluidity

9. Which ONE of the following gases is produced during fermentation by yeast?

(a) CO_2 (b) O_2 (c) H_2 (d) N_2

10. Serine proteases are called so because they
(a) Require free serine for their activity
(b) Cleave after serine residues in the substrate
(c) Are inhibited by the presence of free serine
(d) Have a serine residue at their active site

11. The maximum number of genotypes of the pollens produced by a tall pea plant with round, yellow seeds of the genotype TtRrYY, if the three loci are unlinked, would be
(a) 1 (b) 2 (c) 4 (d) 8

12. Which ONE of the following statements is TRUE with respect to human ovary?
(a) Estrogen is secreted by Graafian follicles and progesterone by corpus luteum
(b) Estrogen is secreted by corpus luteum and progesterone by Graafian follicles
(c) Both estrogen and progesterone are secreted by Graafian follicles
(d) Both estrogen and progesterone are secreted by corpus luteum

13. Which ONE of the following statements is INCORRECT with respect to human antibodies?
(a) They can neutralize microbes
(b) They are synthesized by T cells
(c) They are made up of four polypeptide chains
(d) Milk contains antibodies

14. Concentration (%) of NaCl isotonic to human blood is
(a) 0.085 – 0.09% (b) 1.7 – 1.8% (c) 3.4 – 3.6% (d) 0.85 – 0.9%

15. Which ONE of the following statements is TRUE about the Golgi apparatus?
(a) It is found only in animals
(b) It is found only in prokaryotes
(c) It modifies and targets proteins to the plasma membrane
(d) It is a site for ATP production

16. CreutzfeldtJakob Disease (CJD) is a transmissible disease caused by a

(a) Virus (b) bacterium (c) fungus (d)misfolded protein

17. A researcher found petrified dinosaur faeces. Which ONE of the following is unlikely to be found in this fossil?

(a) Decayed conifer wood (b) Bamboo

(c) Cycad (d) Giant fern

18. Which ONE of the pairs of amino-acids contains two chiral centres?

(a) Isoleucine and threonine (b)Leucine and valine

(c)Valine and isoleucine (d) Threonine and leucine

19. In photosynthetic carbon fixation, which ONE of the following reacts with CO_2?

(a)Phosphoglycolate (b) 3-Phosphoglycerate

(c) Ribulose-1, 5-bisphosphate (d) Ribose-5-phosphate

20. Match the diseases in Column I with the routes of infection in Column II. Choose the CORRECT combination.

Column I	Column II
P. Tuberculosis	i. Contaminated food and water
Q. Dysentry	ii. Inhalation of aerosol
R. Filariasis	iii. Contact via skin
S. Syphilis	iv. Sexual intercourse
	v. Mosquito bite

(a) P-ii, Q-i, R-v, S-iv (b) P-ii, Q-i, R-iii, S-v

(c) P-i, Q-iii, R-v, S-iv (d) P-ii, Q-iii, R-iv, S-v

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PART-II

21. What is the probability that a human individual would receive the entire haploid set of chromosomes from his/her grandfather?

(a) 1/2 (b) $(1/2)^{23}$ (c) $(1/2)^{2}$ (d) $(1/2)^{46}$

22. Which ONE among the following primer pairs would amplify the fragment of DNA given below?

5' –CTAGTCGTCGAT-$(N)_{300}$-GACTGAGCTGAGCTG-3'

3' –GATCAGCAGCTA-$(N)_{300}$-CTGACTCGACTCGAC-5'

(a) 5' –CTAGTCGTCGAT-3' and 5' –GACTGAGCTGAGCTG-3'

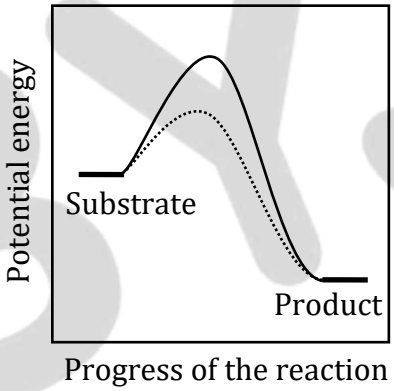
(b) 5' –CTGACTCGACTCGAC-3' and 5' –CTAGTCGTCGAT-3'

(c) 5' –CTAGTCGTCGAT-3' and 5' –CAGCTCAGCTCAGTC-3'

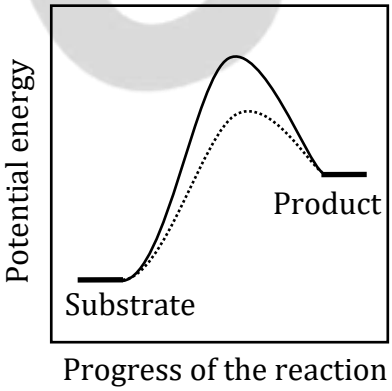
(d) 5' –CTAGTCGTCGAT-3' and 5' –GTCGAGTCGAGTCAG-3'

23. The following graphs with the solid and dotted lines correspond to the reactions without and with enzyme, respectively. Which of the following graph(s) correctly represent the concept of activation energy?

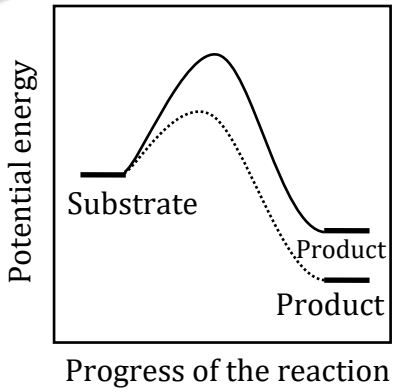
(i)



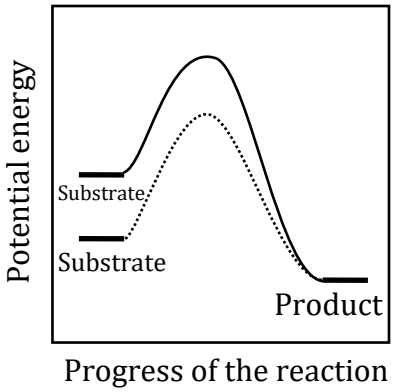
(ii)



(iii)



(iv)



(a) (i) only (b) (iii) and (iv) (c) (ii) only (d) (i) and (ii)

24. A novel species with double stranded genetic material consists of 5 bases namely P, Q, R, S, T, with percentages given below.

	P	Q	R	S	T
Percentage	22	28	22	12	16

Based on the above information, which ONE of the following inferences is NOT supported by the observations?

(a) S base pairs with T, and Q base pairs with R

(b) S base pairs with Q, and T base pairs with Q

(c) P base pairs with R, and S base pairs with Q

(d) P base pairs with R, and T base pairs with Q

25. How many different blood groups are possible in a diploid species with ABCO blood grouping system involving I^A, I^B, I^C and I^O alleles (I^O is recessive and others are co-dominant)?

(a) 4 (b) 6 (c) 7 (d) 8

26. Within the exponential phase of growth, if the initial surface area and the growth rate of a leaf are 10 mm^2 and 0.015 nm^2/hour respectively, the area of the leaf after 4 days would range from:

(a) 10 to 12 mm^2 (b) 20 to 24 mm^2 (c) 30 to 36 mm^2 (d) 40 to 48 mm^2

27. If the acidic, basic and hydrophobic residues of proteins are considered to be red, green and blue in color, respectively, then a globular protein in aqueous solution would have.

(a) Red and blue on the surface and green at the core

(b) Red and green on the surface and blue at the core

(c) Blue on the surface and red and green at the core

(d) Blue and green on the surface and red at the core

28. A lysosome vesicle of 1 μm diameter has an internal pH of 5.0. The total number of H^+ ions inside this vesicle would range from

(a) 10^3 to 10^4 (b) 10^4 to 10^5

(c) 10^5 to 10^{10} (d) 10^{10} to 6.023×10^{23}

29. Match the vitamins listed in Column I with their respective coenzyme forms in Column II. Choose the CORRECT combination.

Column I	Column II
P. Vitamin B_1	i. Thiamine pyrophosphate
Q. Vitamin B_2	ii. Flavine adenine dinucleotide
R. Vitamin B_6	iii. Methylcobalamin
S. Vitamin B_{12}	iv. Coenzyme A
	v. Pyridoxal phosphate

(a) P-v, Q-iii, R-i, S-iv (b) P-iii, Q-iv, R-ii, S-i

(c) P-i, Q-ii, R-v, S-iii (d) P-i, Q-iv, R-ii, S-iii

30. Two independent experiments related to photosynthesis were conducted – one with ^{18}O-labelled water (experiment P), and the other with ^{14}C-labelled CO_2 (experiment Q). Which ONE of the following options lists the first labelled products in experiments P and Q, respectively?

(a)P: O_2, Q: 3-Phosphoglycerate

(b)P: 3-Phosphoglycerate, Q: NADPH

(c)P: O_2, Q: ATP

(d)P: 3-Phosphoglycerate, Q: 3-Phosphoglycerate

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ANSWER KEY

1. (b)	2. (a)	3. (b)	4. (d)	5. (c)
6. (d)	7. (a)	8. (b)	9. (a)	10. (d)
11. (c)	12. (a)	13. (b)	14. (d)	15. (c)
16. (d)	17. (b)	18. (a)	19. (c)	20. (a)
21. (b)	22. (c)	23. (d)	24. (a)	25. (c)
26. (a)	27. (b)	28. (a)	29. (c)	30. (a)

SOLUTIONS

PART-I

1. (b)

Haemoglobin, or Hb, is a protein molecule found in red blood cells (erythrocytes) made of four subunits: two alpha subunits and two beta subunits. Each subunit surrounds a central heme group that contains iron and binds one oxygen molecule, allowing each haemoglobin molecule to bind four oxygen molecules.

2. (a)

Bt toxin is produced by bacteria Bacillus thuriengiensis. Bt toxin does not kill the bacterium that produces it, but kill the insect that ingests it because the endotoxin that accumulates in the bacterium is an inactive precursor. It gets activated only in the alkaline gut of insect.

3. (b)

- The endosperm of a plant is formed during the triple fusion of the embryo.
- The polar nuclei fuse to form a diploid nucleus and with the secondary male gamete to form a tripod nucleus.
- If the plant is tetraploid, then the gametes of the plant will be diploid that is 2n.
- Then, the polar nuclei will be diploid that is 2n each, which will give rise to a tetraploid single polar nucleus after fusion.
- It will then fuse with the secondary male gamete which is again 2n or diploid. Thus, the endosperm will be 6n.

4. (d)

Viruses are intracellular parasites that replicate only after infecting specific host cells. Host-cell ribosomes and enzymes are used to express viral proteins, which then replicate the viral genome and package it into viral coats

5. (c)

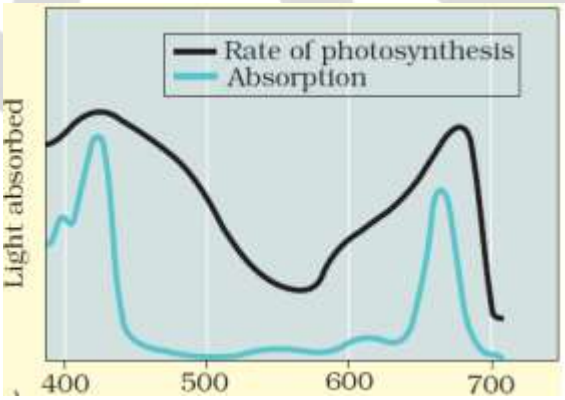
Mitochondrial cristae are infolding of inner mitochondrial membrane and increase the surface area for faster production of ATP.

6. (d)

Nitrogenase enzyme which are essential for nitrogen metabolism. Nitrogenase enzyme under biological N-fixation reduce atmospheric N_2 ($N \equiv N$) into NH_3.

$N \equiv N + 8e^- + 8H^+ + 16ATP \longrightarrow 2NH_3 + H_2 + 16ADP + 16Pi$

7. (a)



Graph showing action spectrum of photosynthesis superimposed on absorption spectrum of chlorophyll a

8. (b)

Contact inhibition enables noncancerous cells to cease proliferation and growth when they contact each other. This characteristic is lost when cells undergo malignant transformation. In cancerous cells they lose the property of Contact inhibition and get attached with each other and form clusters of cells.

9. (a)

Dough, which is used for making bread, is fermented using baker's yeast (Saccharomyces cerevisiae). The puffed-up Appearance and leavening of dough or softness and porous is due to the production and release of CO_2 gas.

Yeasts break downglucose and produce alcohol and carbon dioxide as their by-products.

10. (d)

Serine proteinases are the largest class of mammalian proteinases. They are so called because they have a catalytically essential serine residue at their active sites. Serine proteinases are optimally active at neutral pH and play major roles in extracellular proteolysis.

11. (c)

To find out possible number of genotype = 2^n

n = number of heterozygous condition

inTtRrYy the number of heterozygous condition is 2(TtRr)

So, the possible number of genotype = $2^2 = 2 \times 2 = 4$

12. (a)

Graafian follicle - A fluid-filled structure in the mammalian ovary within which an ovum develops prior to ovulation.

Corpus luteum - A hormone-secreting structure that develops in an ovary after an ovum has been discharged but degenerates after a few days unless pregnancy has begun.

Estrogen is secreted by Graafian follicles and progesterone by corpus luteum

13. (b)

Antibody, also called immunoglobulin, a protective protein produced by the immune system in response to the presence of a foreign substance, called an antigen.

B cells, also known as B lymphocytes, are a type of white blood cell of the lymphocyte subtype .They function in the humoral immunity component of the adaptive immune system by secreting antibodies

14. (d)

A 0.9% NaCl solution is said to be isotonic: when blood cells reside in such a medium, the intracellular and extracellular fluids are in osmotic equilibrium across the cell membrane, and there is no net influx or efflux of water.

15. (c)

Golgi apparatus is found in all plant and animal cells.

Golgi apparatus is found in Eukaryotic cells

It modifies and targets proteins to the plasma membrane (Golgi is responsible for glycosylation protein and lipids. The glycosylated proteins are modified proteins of plasma membrane) site for ATP production is Mitochondria.

16. (d)

Creutzfeldt–Jakob disease (CJD), also known as subacute spongiform encephalopathy or neurocognitive disorder due to prion disease, is a fatal degenerative brain disorder. Early symptoms include memory problems, behavioural changes, poor coordination, and visual disturbances. CJD can be transmitted from an affected person to others, but only through an injection or consuming infected brain or nervous tissue.

17. (b)

Dinosaur extinct in the cretaceous – tertiary extinction approximately 66 mya. The estimated origin of the bamboo is 30 mya in the quaternary period of cretaceous.

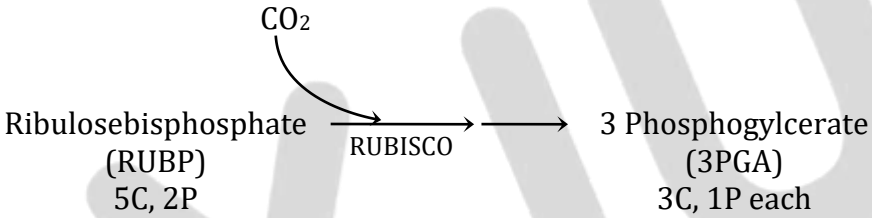
18. (a)

Isoleucine, an essential amino acid, is one of the three amino acids having branched hydrocarbon side chains. It is usually interchangeable with leucine and occasionally with valine in proteins.

The β carbon of isoleucine is optically active, just as the β carbon of threonine. These two amino acids, isoleucine and threonine, have in common the fact that they have two chiral centers.

19. (c)

Ribulose–1,5–bis–phosphate, 1st CO_2 acceptor in C_3 cycle. The first part of the Calvin cycle is the carboxylation step. The carboxylation reaction converts one 5 carbon molecule, RUBP, into two three carbon molecules, two 3-PGAs.



20. (a)

Tuberculosis	----	Inhalation of aerosol
Dysentry	----	Contaminated food and water
Filariasis	----	Mosquito bite
Syphilis	----	Sexual intercourse

PART-II

21. (b)

During zygote formation, the human male receives 23 chromosomes from the mother and 23 chromosomes from the father which makes up 46 chromosomes. His son/daughter receives the same sets of the chromosome from his grandparent As the chance is 50%, it can be inferred that, the individual may receive $\left(\frac{1}{2}\right)^{23}$.

22. (c)

5' – CTAGTCGTCGAT – $(N)_{300}$ – GACTGAGCTGAGCTG– 3'

CTGACTCGACTCGAC – 5'

5' – C T A G T C G T C G A T – 3'

3' – G A T C A G C A G C T A – $(N)_{30}$ – C T G A C T C G A C T C G A C – 5'

5' → 3' is the direction of primer.

23. (d)

The activation energy of a chemical reaction is closely related to its rate. Specifically, the higher the activation energy, the slower the chemical reaction will be. This is because molecules can only complete the reaction once they have reached the top of the activation energy barrier. The higher the barrier is, the fewer molecules that will have enough energy to make it over at any given moment.

24. (a)

P and R have the same percentage (P = R = 22) hence they bond with each other. The total percentage of S (S = 12) and T (T = 16) is equal to the percentage of Q (Q = 28) hence Q binds to both S and T.

25. (c)

Codominance occurs when two versions, or "alleles," of the same gene are present in a living thing, and both are expressed. Instead of one trait being dominant over the other, both traits appear.

So, the possible blood group can be = 7

A → I^AI^A, I^AI^O

B → I^BI^B, I^BI^O

C → I^CI^C, I^CI^O

O → I^OI^O

AB → I^AI^B

AC → I^AI^C

BC → I^BI^C

26. (a)

Initial surface area of leaf = 10 mm^2

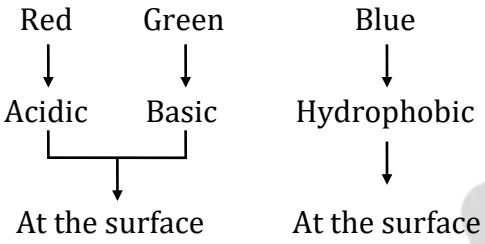
Growth rate = 0.015 mm^2/hr

4 day = 4 × 24 = 96 hrs

Growth in 96 hrs = 0.015 × 96 = 1.44 mm^2

Total surface area = 10 + 1.44 = 11.44 mm^2

27. (b)



28. (a)

Lysosome radius is 0.5 μm = 0.5 × 10^{-6} m

Spherical lysosome volume is $\frac{4}{3}\pi r^3$

$\frac{4}{3}\pi\frac{1}{8}$ × 10^{-18} m^3 or $\frac{4}{3}\pi\frac{1}{8}$ × 10^{-15}L

$[H^+] = 10^{-pH}$ mole/lit

Number of moles of H^+ ions = $\frac{4}{3}\pi\frac{1}{8}$ × 10^{-15} × 10^{-5} mole

Number of H_+ ions = n × NA

n = number of moles

NA = Avogadro number

$[H^+]$ number = $\frac{4}{3}\pi\frac{1}{8}$ × 10^{-20} × 6.023 × 10^{23}

$[H^+]$ number = in between 10^3 to 10^4.

29. (c)

Vitamin B1	-	Thiamine pyrophosphate
Vitamin B2	-	Flavine adenine dinucleotide
Vitamin B6	-	Pyridoxal phosphate
Vitamin B12	-	Methylcobalamin

30. (a)

By the use of O_{18} radioisotope it was confirmed that O_2 exist from H_2O not from CO_2 during light reaction.

By the use of C_{14} radioisotope it was confirmed that C in $C_6H_{12}O_6$ comes from CO_2.