KVPY-SX 2019(BIOLOGY)

PART-I

1. Ethanol is used to treat methanol toxicity because ethanol

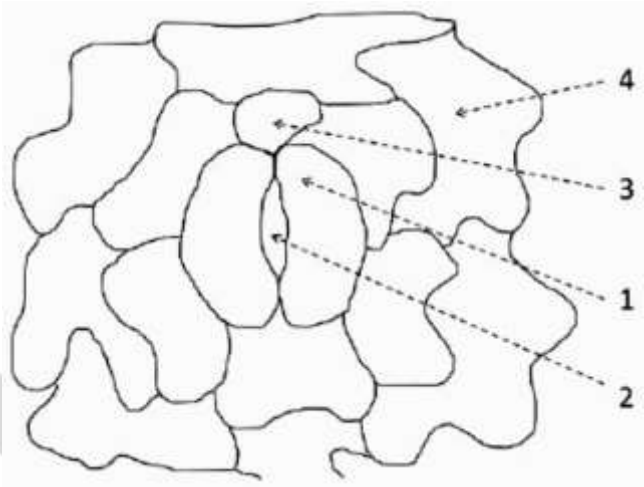
(a) Is a competitive inhibitor of alcohol dehydrogenase

(b) Is a non-competitive inhibitor of alcohol dehydrogenase

(c) Activates enzymes involved in methanol metabolism

(d) Inhibits methanol uptake by cells

2. Given below is a diagram of stomatal apparatus. Match the labels with the corresponding names of the components.



Choose the CORRECT combination.

(a) 1 – Stomatal pore; 2 – Guard cell; 3 – Epidermal cell; 4 – Subsidiary cell

(b) 1 – Guard cell; 2 – Stomatal pore; 3 – Subsidiary cell; 4 – Epidermal cell

(c) 1 – Subsidiary cell; 2 – Guard cell; 3 – Stomatal pore; 4 – Epidermal cell

(d) 1 – Guard cell; 2 – Stomatal pore; 3 – Epidermal cell; 4 – Subsidiary cell

3. Which one of following pairs was excluded from Whittaker's five kingdom classifications?

(a) Viruses and lichens

(b) Algae and euglena

(c) Lichens and algae

(d) Euglena and viruses

4. A plant species when grown in shade tends to produce thinner leaves with more surface area, and when grown under abundant sunlight starts producing thicker leaves with reduced surface area. This phenomenon is an example of

(a) Character displacement (b) phenotypic plasticity

(c) Natural selection (d) genotypic variation

5. Sacred groves found in several regions in India are an example of

(a) In situ conservation (b) ex situ conservation

(c) Reintroduction (d) restoration

6. Which one of the following immune processes is most effectively controlled by anti-histamines?

(a) Cell-mediated autoimmunity

(b) IgE-mediated exaggerated immune response

(c) IgG-mediated humoral immune response

(d) IgM-mediated humoral immune response

7. Which one of the following is explained by the endosymbiotic theory?

(a) The interaction between bacteria and viruses

(b) The symbiosis between plants and animals

(c) The origin of mitochondria and chloroplast

(d) The evolution of multicellular organisms from unicellular ones

8. According to the logistic population growth model, the growth rate is independent of

(a) per capita birth rate (b) per capita death rate

(c) Resource availability (d) environmental fluctuations

9. A violent volcanic eruption wiped out most of the life forms in an island. Over time, different forms of simple organisms colonised this region, followed by the emergence of other organisms such as shrubs, woody plants, invertebrates and mammals. This ecological process is referred to as

(a) Generation (b) replacement (c) succession (d) turnover

10. Which one of the following microbial product is called "clot buster"?

(a) Cyclosporin A (b) Paracetamol (c) Statins (d) Streptokinase

11. Which one of the following elements is NOT directly involved in transcription?

(a) Promoter (b) Terminator (c) Enhancer (d) OriC

12. Which one of the following phyla is a pseudocoelomate?

(a) Cnidaria (b) Nematoda (c) Mollusca (d) Chordate

13. Which one of the following glands does NOT secrete saliva?

(a) Submaxillary gland (b) Lacrimal gland
(c) Parotid gland (d) Sublingual gland

14. Which one of the following options correctly represents the tissue arrangement in roots?

(a) Cortex, pericycle, casparian strip, vascular bundle
(b) Pericycle, cortex, casparian strip, vascular bundle
(c) Cortex, casparian strip, pericycle, vascular bundle
(d) Casparian strip, pericycle, cortex, vascular bundle

15. During fermentation of glucose to ethanol, glucose is

(a) First reduced and then oxidised
(b) Only oxidised
(c) Neither oxidised nor reduced
(d) Only reduced

16. Which of the following is/are the product (s) of cyclic photophosphorylation?

(a) Both NADPH and H^+ (b) NADPH

(c) ATP (d) Both ATP and NADPH

17. Which one of the following amino acids is least likely to be in the core of a protein?

(a) Phenylalanine (b) Valine (c) Isoleucine (d) Arginine

18. Which one of following statements is a general feature of global species diversity?

(a) It increases from high to low latitudes

(b) It increases from low to high latitudes

(c) It changes over time but not spatially

(d) It changes randomly across space and time

19. Which one of the following conditions is NOT responsible for the presence of deoxygenated blood in the arteries of a newborn?

(a) Pneumonia

(b) Atrial septal defect

(c) Shunt between pulmonary artery and aorta

(d) Phenylketonuria

20. Rhizobium forms symbiotic association with roots in legumes and fixes atmospheric nitrogen. Which one of the following statement is CORRECT about this process?

(a) Activity of nitrogenase is sensitive to oxygen

(b) Activity of nitogenase is insensitive to oxygen

(c) Anaerobic conditions allow ATP independent conversion of nitrogen to ammonia

(d) Under aerobic conditions, atmospheric nitrogen can be converted to nitrates by Rhizobium

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PART-II

21. In a population, N_{AA} and N_{aa} are the numbers of homozygous individuals of allele 'A' and 'a', respectively, and N_{Aa} is the number of heterozygous individuals. Which one of the following options is the allele frequency of 'A' and 'a' in a population with $N_{AA} = 90$, $N_{Aa} = 40$ and $N_{aa} = 70$?

(a) A = 0.55 and a = 0.45 (b) A = 0.40 and a = 0.60
(c) A = 0.35 and a = 0.65 (d) A = 0.25 and a = 0.75

22. A newly discovered organism possesses a genetic material with a new base composition consisting of the sugar and phosphate backbone as found in existing natural DNA. The five novel bases in this genetic material – namely, P, Q, R, S, T – are heterocyclic structures with 1, 1, 2, 2, and 3 rings, respectively. Assuming the new DNA forms a double helix of uniform width, which one of the following would be the most appropriate base pairing.

(a) P with Q; R with T; S with T (b) P with T; R with S; Q with T
(c) P with S; Q with R; S with T (d) P with Q; R with S; S with T

23. Amino acid analysis of two globular protein samples yielded identical composition per mole. Which one of the following characteristics is necessarily identical for the two proteins?

(a) Disulphide bonds (b) Primary structure
(c) Molecular mass (d) Three-dimensional structure

24. Which of the following conversions in glycolysis is an example of substrate level phosphorylation?

(a) Glyceraldehyde-3-phosphate to 1,3-bisphosphoglycerate
(b) 1,3-bisphosphoglycerate to 3-phosphoglycerate
(c) Fructose 6-phosphate to fructose-1,6-bisphosphate
(d) Glucose-6-phosphate to fructose-6-phosphate

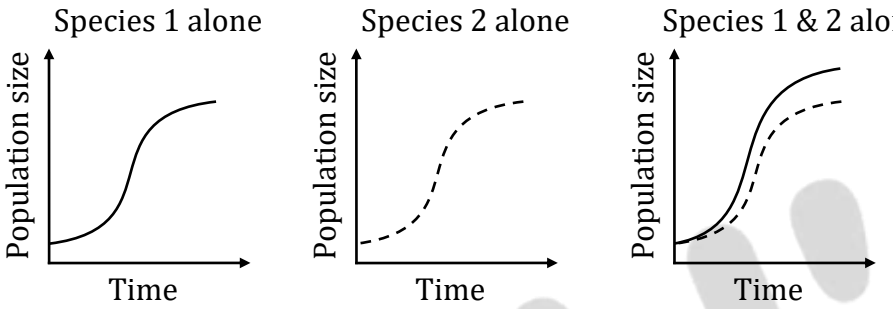
25. A plant heterozygous for height and flower colour (TtRr) are selfed and 1600 of the resulting seeds are planted. If the distance between the loci controlling height and flower colour is 1 centimorgan, then how many offspring are expected to be short with white flower (ttrr)?

(a) 1 (b) 10 (c) 100 (d) 400

26. Which one of the following will be the ratio of heavy, intermediate and light bands in Meselson and Stahl's experiment after two generations if DNA replication were conservative?

(a) 0:2:2 (b) 1:0:3 (c) 2:2:0 (d) 2:0:2

27. Given the graphs below, the interaction between species 1 and 2 can be classified as



(a) amensalism (b) commensalism (c) mutualism (d) competition

28. The additional nuclear ploidy levels found in a diploid angiosperm species in full bloom compared to its vegetative stage are:

(a) 1N & 2N (b) 2N & 3N (c) 3N & 4N (d) 1N & 3N

29. The bill sizes in a bird species of seed crackers from West Africa shows a bimodal distribution. Their most abundant food sources are two types of marsh plants that produce hard and soft seeds, consumed preferentially by the large and small billed birds respectively. This bimodal distribution of bill sizes is a likely consequence of

(a) Directional selection (b) stabilising selection

(c) Disruptive selection (d) sexual selection

30. The containers X and Y have 1 litre of pure water and 1 litre of pure water and 1 litre of 0.1 M sugar solution, respectively. Which one of the following statements would be CORRECT regarding their water potential (Ψ) and osmotic potential (Ψ_S)?

(a) Both Ψ and Ψ_S are zero in X (b) Both Ψ and Ψ_S are zero in Y

(c) Ψ in X is zero and Ψ_S in Ψ is negative (d) Ψ in X is negative and Ψ_S in Y is zero

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ANSWER KEY

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

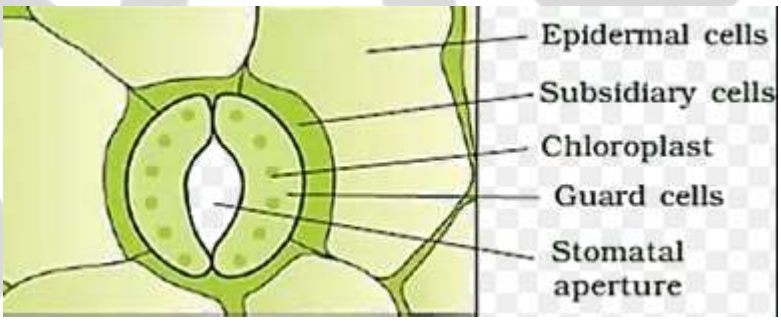
SOLUTIONS

PART-I

1. (a)

The preferred antidote is fomepizole. Fomepizole or ethanol serves as alcohol dehydrogenase inhibitors to stop the conversion of methanol to its toxic metabolite. Ethanol acts as competitive inhibitors of alcohol dehydrogenase. Ethanol has a higher binding affinity to alcohol dehydrogenase compared to methanol resulting in blockade of the formation of toxic compounds.

2. (b)



Label markings are as follows 1 – Guard cell 2 – Stomatal pore 3 – Subsidiary cell 4 – Epidermal cell

3. (a)

The five kingdom classification was proposed by R.H. Whittaker in 1969. The five kingdoms were formed on the basis of characteristics such as cell structure, mode of nutrition, source of nutrition and body organisation. It includes Kingdom Monera, Kingdom Protista, Kingdom Fungi, Kingdom Plantae, and Kingdom Animalia. Some a cellular organisms like viruses as well as lichens are not included in the five kingdom system of classification.

4. (b)

Phenotypic plasticity is the ability of an individual organism to alter its physiology/morphology in response to changes in environmental conditions. This ability is particularly important in plants; whose sessile life-style requires them to deal with ambient conditions OR it plasticity is the ability of an organism to change in response to stimuli or inputs from the environment.

5. (a)

In situ conservation means the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticates or cultivated species, in the surroundings where they have developed their distinctive properties. So, sacred groves are considered in In-situ conservation.

6. (b)

Hypersensitivities include atopic diseases, which are an exaggerated IgE mediated immune responses (i.e., allergic: asthma, rhinitis, conjunctivitis, and dermatitis), and allergic diseases, which are immune responses to foreign allergens (i.e., anaphylaxis, angioedema, food, and drug allergies). When an allergen comes in contact with antibody IgE then IgE binds to the allergen which causes the mast cells to release histamine. Histamine further increases allergic reactions like coughing, sneezing then antihistamines reduce or block histamines, so they stop allergy symptoms.

7. (c)

The symbiotic hypothesis states that mitochondria and chloroplasts arose from bacteria entering a eukaryotic cell to form a symbiotic relationship, similarities between bacteria and these semiautonomous organelles show strong evidence that this hypothesis is right.

8. (d)

Logistic growth takes place when a population's per capita growth rate decreases as population size approaches a maximum imposed by limited resources, the carrying capacity (K). It's represented by the equation:

$$dN/dt=rN(K–N)/K$$

So, it is independent of environmental fluctuations.

9. (c)

Ecological succession is the gradual process by which ecosystems change and develop over time. There are two main types of succession, primary and secondary. Primary succession is the series of community changes which occur on an entirely new habitat which has never been colonized before. There are five main elements to ecological succession: primary succession, secondary succession, pioneer and niche species, climax communities and sub-climax communities.

10. (d)

Streptokinase is the product produced by the bacterium Streptococcus. This chemical helps in removing clots from the blood vessels of patients who have undergone myocardial infarction and this microbial product is called "clot buster".

11. (d)

The origin of replication is a particular sequence in a genome at which replication is initiated. Incomplete, erroneous, or untimely DNA replications are not defined at the level of DNA sequence; instead, they appear to be circular and contain a single origin of chromosomal replication (oriC) so it is not involved directly in transcription.

12. (b)

Nematodes are tubular in shape and are considered pseudo coelomates because of they do not possess a true coelom. Nematodes do not have a well-developed excretory system, but do have a complete digestive system. Nematodes possess the ability to shed their exoskeleton in order to grow, a process called ecdysis.

13. (b)

The lacrimal gland is the main contributor to the aqueous layer of the tear film. It secretes proteins, electrolytes and water, which helps to nourish and protect the ocular surface.

14. (c)

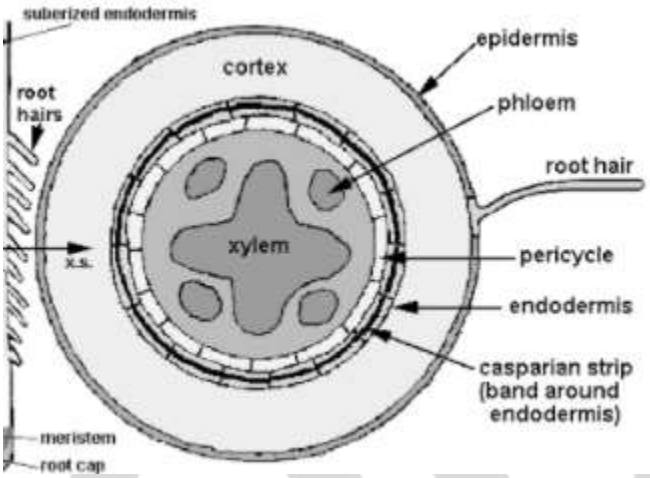


Diagram shows tissue arrangement in plant roots is

Cortex → Casparian strip → Pericycle → Vascular bundle

15. (c)

BONUS

16. (c)

Under certain conditions, the photo excited electrons take an alternative path called cyclic electron flow, which uses photo system I (P700) but not photo system II (P680). This process produces no NADPH and no O_2, but it does make ATP. This is called cyclic photophosphorylation.

17. (d)

Arginine (2-amino-5-guanidinovaleric acid) is one of the 20 amino acids that are coded for as part of ribosomal protein synthesis in humans and arginine is a charged amino acid which is generally found at surface. Phenylalanine, Valine & Isoleucine are found at the core of protein.

18. (a)

Biodiversity varies with a change in altitude or latitude. The diversity increases as we move from high to low altitudes from poles to equator. There is a decrease in species diversity from lower to higher altitudes on a mountain. Drop in temperature and greater seasonal variability at higher altitudes are a major factor that reduces diversity.

19. (d)

Phenylketonuria (PKU) is an inborn error of metabolism that results in decreased metabolism of the amino acid phenylalanine. The affected individual lacks an enzyme that converts the amino acid phenylalanine into tyrosine. Accumulation of phenyl pyruvic acid results in mental retardation. Untreated, PKU can lead to intellectual disability, seizures, behavioural problems, and mental disorders.

20. (a)

Rhizobia are a "group of soil bacteria that infect the roots of legumes to form root nodules". Rhizobia are found in the soil and after infection, produce nodules in the legume where they fix nitrogen gas (N_2) from the atmosphere turning it into a more readily useful form of nitrogen. And these processes of nitrogen fixation carry various biochemical reactions included nitrogenase activity but oxygen inhibits the nitrogenase activity or activity of nitrogenase is sensitive to oxygen.

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PART-II

21. (a)

Allele A frequency $2N_{AA}+Aa/2N$

Total number of individuals in populations = N

N = 90 + 40 + 70 = 200

A = 2 × 90 + 40/2 × 200

= 180 + 40/400

= 220/400 = 0.55

Allele (A) frequency = $2N_{aa}$ + Aa/2N

a = 2×70 + 40/2 × 200

= 140 + 40/400

= 180/400 = 0.45

So, A = 0.55

a = 0.45

22. (b)

P=1 ring

Q=1 ring

R=2 ring

S=3 ring

T=3 ring

P binds with T from four structural ring

Q binds with T from four structural ring

R binds with S from four structural ring

PT = 1 + 3 = 4

RS = 2 + 2 = 4

QT = 1 + 3 = 4.

23. (c)

Amino acid analysis of two globular protein yield identical composition per mole it means molecular weight of 2 proteins is same because molecular weight of a protein can be predicted on the basis of amino acid composition.

24. (b)

The conversion of 1,3-bisphosphoglycerate to 3-phosphoglycerate is the example of substrate level phosphorylation. ATP is produced in this reaction
1,3-bisphosphoglycerate + ADP = kinase—3-phosphoglycerate + ATP
In this reaction high energy phosphate group is transferred from 1,3-bisphosphoglycerate which result in the formation of ATP. This ATP formation is referred as substrate level phosphorylation because the phosphate donor 1,3-bisphosphoglycerate is a substrate.

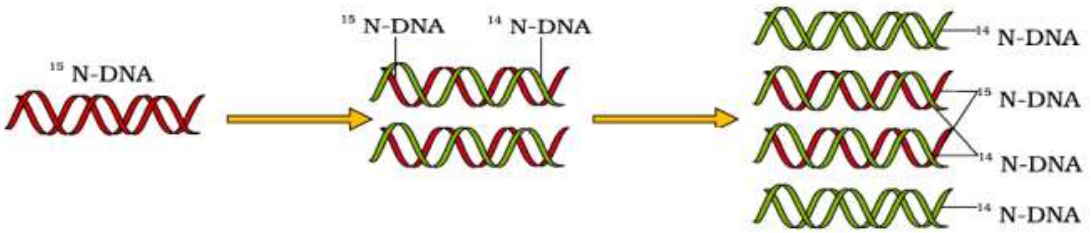
25. (a)

Plant is heterozygous for the following traits:
T = Tall plant
t = Short plant
R = Red colour flower
r = white colour flower
Parental: TTRR × ttrr
↓
F_1 Generation: TrRr
↓ on selfing
F_2 Generation: TtRr × TtRr
Hametes: TR tR Tr tr

	TR	tR	Tr	tr
TR	TTRR	TtRR	TTRr	TrRr
tR	TtRR	ttRR	TtRr	ttRr
Tr	TTRr	TtRr	TTrr	Ttrr
tr	TtRr	ttRr	Ttrr	ttrr

Ratio is 9: 3: 3: 1
Out of 1600 seeds ratio is
900:300:300:100
100 off springs are completely homozygous for trait short and white flower.

26. (b)



This levelled diagram shows radio heavy is one, intermediate is zero, and light stand is three so the ratio is 1:0:3.

27. (b)

The graph shows the example of commensalism is a long-term biological interaction in which members of one species gain benefits while those of the other species neither benefit nor are harmed.

28. (d)

In diploid species ploidy level 2N, while additional ploidy level is 1N and 3N.
1N is found in gametes and 3N is found in endosperm (triploid).

29. (c)

Smaller billed birds feed more efficiently on soft seeds whereas large billed bird feed on hard seed. Birds having intermediate bill size cannot feed on hard and soft seeds efficiently bimordial distribution of bill sizes is a result of disruptive selection which favours larger and smaller bill size individuals over intermediate sized bills.

30. (a)(c)

Water potential and osmotic potential of pure water is zero because water is open to atmosphere hydrostatic pressure of water is same as atmospheric pressure and there are no solutes in water container X does not contain any solute so, Ψ for container X is zero. Container Y contains 0.1M sugar solution so Ψ&Ψ_s would be negative because solutes lower the water potential of a solution

So, Ψs = –ve

$\Psi = \Psi s + \Psi p$, any solute will always lower the water potential of pure water.