All India Aakash Test Series for NEET - 2024

TEST - 7 (Code-E)

Click Here for Code-F Sol.

Test Date : 31/03/2024

ANSWERS

1. (1)	41. (4)	81. (3)	121. (3)	161. (1)
2. (4)	42. (3)	82. (1)	122. (4)	162. (3)
3. (4)	43. (3)	83. (4)	123. (1)	163. (4)
4. (3)	44. (4)	84. (2)	124. (3)	164. (1)
5. (2)	45. (2)	85. (2)	125. (3)	165. (3)
6. (2)	46. (3)	86. (3)	126. (4)	166. (2)
7. (1)	47. (1)	87. (3)	127. (2)	167. (3)
8. (3)	48. (3)	88. (3)	128. (4)	168. (3)
9. (3)	49. (2)	89. (4)	129. (3)	169. (2)
10. (3)	50. (1)	90. (3)	130. (4)	170. (1)
11. (4)	51. (4)	91. (3)	131. (1)	171. (3)
12. (4)	52. (2)	92. (1)	132. (1)	172. (2)
13. (2)	53. (1)	93. (2)	133. (4)	173. (2)
14. (1)	54. (1)	94. (3)	134. (3)	174. (3)
15. (1)	55. (1)	95. (3)	135. (1)	175. (1)
16. (4)	56. (1)	96. (4)	136. (3)	176. (3)
17. (3)	57. (3)	97. (3)	137. (4)	177. (4)
18. (2)	58. (2)	98. (4)	138. (4)	178. (4)
19. (1)	59. (4)	99. (2)	139. (2)	179. (4)
20. (2)	60. (4)	100. (4)	140. (1)	180. (1)
21. (3)	61. (2)	101. (4)	141. (1)	181. (2)
22. (4)	62. (3)	102. (3)	142. (3)	182. (2)
23. (4)	63. (2)	103. (3)	143. (2)	183. (2)
24. (1)	64. (3)	104. (4)	144. (1)	184. (3)
25. (1)	65. (1)	105. (3)	145. (4)	185. (1)
26. (2)	66. (4)	106. (1)	146. (3)	186. (4)
27. (3)	67. (1)	107. (1)	147. (1)	187. (4)
28. (4)	68. (4)	108. (1)	148. (2)	188. (4)
29. (1)	69. (1)	109. (3)	149. (4)	189. (2)
30. (1)	70. (3)	110. (1)	150. (3)	190. (4)
31. (2)	71. (4)	111. (2)	151. (1)	191. (4)
32. (3)	72. (3)	112. (4)	152. (1)	192. (2)
33. (4)	73. (1)	113. (4)	153. (3)	193. (3)
34. (1)	74. (2)	114. (2)	154. (4)	194. (2)
35. (1)	75. (4)	115. (3)	155. (4)	195. (4)
36. (3)	76. (2)	116. (4)	156. (2)	196. (3)
37. (2)	77. (1)	117. (3)	157. (3)	197. (1)
38. (2)	78. (3)	118. (1)	158. (1)	198. (3)
39. (3)	79. (4)	119. (3)	159. (1)	199. (1)
40. (1)	80. (3)	120. (4)	160. (4)	200. (4)

HINTS & SOLUTIONS

[PHYSICS]

SECTION-A

1. Answer (1)

Hint: Use logic expression.

Sol.: $\overline{A+B}=C$

$\overline{C\cdot\overline{C}}=Y$

$\overline{C}+C=Y$

$\Rightarrow Y=1$

2. Answer (4)

Hint: KE = $q\,\Delta V$

Sol.: KE = $25000\times1.6\times10^{-19}$

$=40\times10^{-16}$

$=4\times10^{-15}$ J

3. Answer (4)

Hint: Using Malus law $I = I_0\cos^2\phi$

Sol.: After passing through 1st polarizer intensity

$I=\frac{I_0}{2}$

After 2nd : $I' = I\cos^2\theta$

$=\frac{I_0}{2}\times\frac{3}{4}$

After 3rd : $I''=\left(\frac{I_0}{2}\times\frac{3}{4}\right)\frac{3}{4}=\frac{9I_0}{32}$

4. Answer (3)

Hint: Location of n^{th} maxima from central bright

$X_n=\frac{n\lambda D}{d}$

Sol.: $\frac{3\lambda D}{d}=x$

$\frac{\lambda D}{d}=\frac{x}{3}$

$\frac{5\lambda D}{d}=\frac{5x}{3}$

5. Answer (2)

Hint & Sol.: Numbers of $t_{1/2}=\frac{12}{2}=6$

If initial amount of substance is N_0 then remaining amount:

$N=\frac{N_0}{64}$

Decay substance = $N_0-\frac{N_0}{64}=\frac{63N_0}{64}$

Percentage of substance decayed

$=\frac{63N_0}{64N_0}\times100\approx98\%$

6. Answer (2)

Hint: Use $E=-13.6\left[\frac{1}{n^2}-\frac{1}{m^2}\right]$

Sol.: $E=-13.6\left[\frac{1}{2^2}-\frac{1}{3^2}\right]$

$h\nu=-13.6\left[\frac{5}{36}\right]$

$h'=-13.6\left[\frac{1}{1^2}-\frac{1}{2^2}\right]$

$h\nu'=-13.6\left[\frac{3}{4}\right]$

$\frac{\nu}{\nu'}=\frac{\frac{5}{36}}{\frac{3}{4}}$

$\frac{\nu}{\nu'}=\frac{5}{27}$

$\nu'=\frac{27\nu}{5}$

7. Answer (1)

Hint: Position of dark fringe $y_n=(2n-1)\frac{\lambda D}{2d}$

Sol.: Location of fifth dark $=\frac{4\lambda D}{d}+\frac{\lambda D}{2d}=\frac{9\lambda D}{2d}$

8. Answer (3)

Hint: Use $v=\frac{Z}{n}v_0$

Sol.: $v\propto\frac{1}{n}$

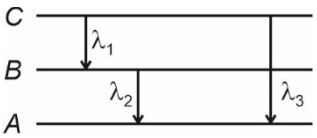
$\frac{v_1}{v_2}=\frac{n_2}{n_1}=\frac{4}{1}$

Therefore, option (3) is correct.

9. Answer (3)

Hint: Energy of emitted radiation $E = \frac{hc}{\lambda}$

Sol.:



$E_3 = E_1 + E_2 \Rightarrow \frac{hc}{\lambda_3} = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_2}$

$\Rightarrow \lambda_3 = \frac{\lambda_1\lambda_2}{\lambda_1 + \lambda_2}$

10. Answer (3)

Hint: Use $\frac{1}{\lambda} = R\left[\frac{1}{n^2} - \frac{1}{m^2}\right]$

Sol.: $\frac{1}{\lambda} = R\left[\frac{1}{3^2} - \frac{1}{\infty^2}\right]$

$\frac{1}{\lambda'} = R\left[1 - \frac{1}{2^2}\right]$

$\frac{\lambda'}{\lambda} = \frac{\frac{1}{9}}{\frac{3}{4}} = \frac{4}{27}$

$\boxed{\lambda' = \frac{4\lambda}{27}}$

11. Answer (4)

Hint: $K_{max} = h\nu - \phi$

Sol.: $(K.E.)_{max1} = 2h\nu_0 - h\nu_0$

$(K.E.)_{max1} = h\nu_0$

$(K.E.)_{max2} = 3h\nu_0 - h\nu_0 = 2h\nu_0$

$(\Delta K.E.) = 2h\nu_0 - h\nu_0 = h\nu_0$

% change = 100%

12. Answer (4)

Hint: $K_{max} = h\nu - \phi$

Sol.: $(KE)_{max} = h\nu - h\nu_0$, $K_{max} = eV_s$

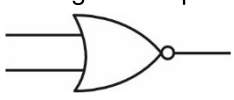
All the options are correct.

13. Answer (2)

Hint & Sol.: Photodiode is used to detect the optical signal.

14. Answer (1)

Hint & Sol.: NOR gate is represented by



15. Answer (1)

Hint: Use $\mu = \frac{c}{v}$

Sol.: $\mu = \frac{c}{v}$

$v = \frac{c}{\mu} = \frac{3\times10^8}{4} = 0.75\times10^8$

$v = 7.5 \times 10^7$ m/s

16. Answer (4)

Hint: Use lens maker formula

Sol.: $\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$\frac{1}{30} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$-\frac{1}{60} = \left(\frac{\mu}{2} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$-\frac{60}{30} = \frac{2(\mu - 1)}{\mu - 2}$

$-(\mu - 2) = \mu - 1$

$\Rightarrow -\mu + 2 = \mu - 1$

$2\mu = 3$

$\mu = \frac{3}{2} = 1.5$

17. Answer (3)

Hint: $\theta_c = \sin^{-1}\left(\frac{1}{\mu}\right)$

Sol.: $v = \frac{x}{t}$

$\mu = \frac{c}{v} = \frac{c}{\frac{x}{t}} = \frac{ct}{x}$

Then $\theta_c = \sin^{-1}\left(\frac{1}{\mu}\right)$

$\theta_c = \sin^{-1}\left(\frac{x}{ct}\right)$

18. Answer (2)

Hint: Frequency of light depends only on source.

Sol.: Frequency of light does not change when light travel from one medium to another medium.

19. Answer (1)

Hint: Reverse biased diode act as open circuit.

Sol.: $R_{eq} = 5 + 5 = 10\ \Omega$

20. Answer (2)

Hint: In reverse biased diode act as open circuit.

Sol.: For any half cycle, at least one diode will be open circuit therefore

$i_R = 0$; $V_{out} = 0$

21. Answer (3)

Hint & Sol.: de Broglie wavelength, $\lambda = \frac{h}{P}$

Since momentum of the given particles are same, therefore $\lambda_\alpha = \lambda_p = \lambda_e$

22. Answer (4)

Hint: Use principle of momentum conservation.

Sol.: Apply momentum conservation

$0 = m_1v_1 + m_2v_2$

$$\Rightarrow \quad \frac{v_1}{v_2} = \frac{m_2}{m_1} = \frac{64}{27}$$

$$\Rightarrow \quad \left(\frac{r_2}{r_1}\right)^3 = \frac{64}{27} \quad \Rightarrow \quad \frac{r_2}{r_1} = \frac{4}{3}$$

23. Answer (4)

Hint & Sol.: $\lambda = \frac{h}{P}$; $KE = \frac{P^2}{2m}$; $KE = qV$

$P^2 = 2m\,(KE) = 2mqV$

$P = \sqrt{2mqV}$

$$\lambda = \frac{h}{\sqrt{2mqV}}$$

$$\frac{\lambda_P}{\lambda_\alpha} = \frac{\sqrt{2\times 4m_0 \times 2q_0V}}{\sqrt{2m_0 \times q_0V}}$$

$$\Rightarrow \quad \frac{\lambda_P}{\lambda} = 2\sqrt{2}$$

$$\lambda_p = 2\sqrt{2}\,\lambda$$

24. Answer (1)

Hint & Sol.: Huygens' theory was based on wave nature of light.

25. Answer (1)

Hint: $d_{\text{eff}} = \frac{d}{\mu}$

Sol.: $d_{\text{eff}} = \frac{h}{2} + \frac{1}{2\mu}\frac{h}{2} + \frac{1}{\mu}\frac{h}{2}$

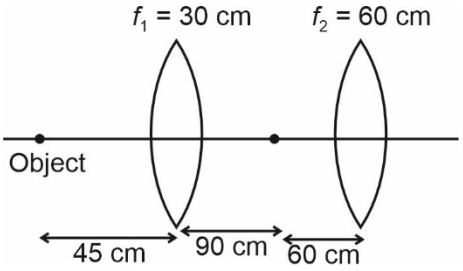
$$= \frac{h}{2} + \frac{h}{4\mu} + \frac{h}{2\mu}$$

$$= h\left[\frac{2\mu + 3}{4\mu}\right]$$

26. Answer (2)

Hint: For the given condition, image of 1st lens is formed on the 1st focus of second lens

Sol.:



$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} + \frac{1}{45} = \frac{1}{30}$$

$$\frac{1}{v} = \frac{1}{30} - \frac{1}{45}$$

$v = 90$ cm

Image of first lens should form on the focus of 2nd, therefore distance between the two lenses = 150 cm

27. Answer (3)

Hint & Sol.: 1 amu = 1.66×10^{-27} kg

28. Answer (4)

Hint: Use mass-energy equivalence relation

Sol.: $E = mc^2$

$= 5 \times (3 \times 10^8)^2$

$= 5 \times 9 \times 10^{16}$

$= 45 \times 10^{16}$ J

$= 4.5 \times 10^{17}$ J

29. Answer (1)

Hint: In *P*-*N* junction diode, *P*-side should be at higher potential in forward biased condition.

Sol.: Diode in diagram (A) is forward biased.

30. Answer (1)

Hint: Maximum magnifying power is obtained when image is formed at near point.

Sol.: $|M_{\max}| = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right)$

$$= \frac{100}{5}\left(1 + \frac{5}{25}\right)$$

$$= 20\left(1 + \frac{1}{5}\right)$$

$$= 20 \times \frac{6}{5}$$

$= 24$

31. Answer (2)

Hint: Use $\Delta\phi = k\Delta x$

Sol.: $2I_0 = 4I_0\cos^2\left(\frac{\phi}{2}\right)$

$\frac{1}{\sqrt{2}} = \cos\left(\frac{\phi}{2}\right)$

$\phi = \frac{\pi}{2}$

$\frac{2\pi}{\lambda}\Delta x = \frac{\pi}{2} \Rightarrow \Delta x = \frac{\lambda}{4}$

32. Answer (3)

Hint: KE = –TE

Sol.: Kinetic energy of electron in 3rd orbit = $\frac{E}{9}$

Then total energy = $-\frac{E}{9}$

33. Answer (4)

Hint: Uncharged particle does not show deflection.

Sol.: γ ray is E.M. wave and hence does not have charge, therefore γ ray does not deflect in electric or magnetic field.

34. Answer (1)

Hint & Sol.: Density of any nucleus remains constant.

35. Answer (1)

Hint: $I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$

and $I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2$

Sol.: $\frac{I_{max}}{I_{min}} = \frac{\left(\sqrt{I_1} + \sqrt{I_2}\right)^2}{\left(\sqrt{I_1} - \sqrt{I_2}\right)^2} = \frac{\left(\sqrt{25I} + \sqrt{9I}\right)^2}{\left(\sqrt{25I} - \sqrt{9I}\right)^2}$

$= \frac{(8)^2 I}{(2)^2 I} = \frac{64}{4} = 16$

SECTION-B

36. Answer (3)

Hint: When light is falling normally on plane surface then it retraces its path.

Sol.: $\mu_1 \sin i = \mu_2 \sin r$

$\sin 45^\circ = \mu \sin 30^\circ$

$\mu = \frac{\sin 45^\circ}{\sin 30^\circ} = \frac{\frac{1}{\sqrt{2}}}{\frac{1}{2}} = \sqrt{2}$

$\mu = \sqrt{2}$

37. Answer (2)

Hint & Sol.: Angular momentum of electron = $\frac{h}{2\pi}$

38. Answer (2)

Hint & Sol.: In depletion layer, charge carriers are absent.

39. Answer (3)

Hint: $\lambda = \frac{hc}{E}$

Sol.: $\lambda = \frac{hc}{E} = \frac{6.63\times10^{-34}\times3\times10^{8}}{5\times1.6\times10^{-19}}$

$= 2.48 \times 10^{-7}$ m

$= 2.48 \times 10^{-5}$ cm

40. Answer (1)

Hint: $eV = h\nu - \phi$

Sol.: $eV = h\nu - h\nu_0$ ...(i)

$eV' = 3h\nu - hV_0$ ...(ii)

$\therefore \quad V' > 3V$

41. Answer (4)

Hint & Sol.: • Concave lens in denser medium → Converging lens

• Convex lens in denser medium → Diverging lens

• Concave mirror and convex mirror act as converging and diverging mirrors respectively, irrespective of the medium.

42. Answer (3)

Hint: Use Einstein's equation.

Sol.: As per the graph

$V_3 > V_2$

and $(\text{current})_3 = (\text{current})_1$

$f_3 > f_2$ and $I_3 = I_1$

43. Answer (3)

Hint: $K_{max} = h\nu - \phi$ $\quad h \rightarrow$ slope of curve

Sol.: Slope will be same for all the curves.

44. Answer (4)

Hint: At polarising angle, reflected and refracted light are perpendicular to each other.

Sol.: $\tan\theta_P = \mu$

$\Rightarrow \tan 60^\circ = \mu$

$\Rightarrow \mu = 1.73$

45. Answer (2)

Hint: $\frac{1}{F_{eq}} = \frac{1}{f_1} + \frac{1}{f_2}$

Sol.: Combination will behave like a glass slab therefore, $f = \infty$

46. Answer (3)

Hint: $\overline{A \cdot B} = \overline{A} + \overline{B}$

Sol.:

A	B	$\overline{A \cdot B}$
0	0	1
0	1	1
1	0	1
1	1	0

47. Answer (1)

Hint & Sol.: Change in atomic number

$= -3(2) + 5(1)$

$= -1$

48. Answer (3)

Hint: Nucleus with greater binding energy per nucleons are more stable.

Sol.: $9E_A > 10E_B$

Stability of a nuclei is determined by binding energy per nucleon.

49. Answer (2)

Hint: In nuclear reactions reactant and product have same net A and Z value.

Sol.: For X

$A = 8$

$Z = 17$

Therefore, it is oxygen of mass 17.

50. Answer (1)

Hint: Isotones have same number of neutrons.

Sol.: Atoms having same number of neutrons but different number of protons are called isotones.

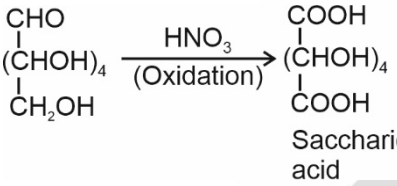
[CHEMISTRY]

SECTION-A

51. Answer (4)

Hint: Glucose is a reducing sugar.

Sol.:

- Glucose is a reducing sugar hence reduces Tollens' reagent
- 

Saccharic acid

52. Answer (2)

Hint: Histidine is an essential amino acid.

Sol.: Histidine and methionine are essential amino acids.

53. Answer (1)

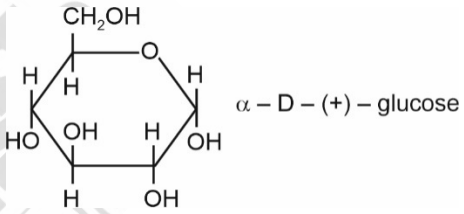
Hint: Negative electron gain enthalpy of oxygen is low because the added electron suffers electronic repulsion due to small size of oxygen atom.

Sol.:

Element	**$\Delta_{eg}H$(kJ mol^{-1})**
O	–141
S	–200
Se	–195
Te	–190
Po	–174

54. Answer (1)

Hint:



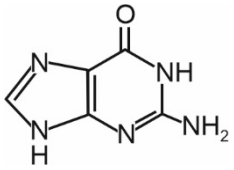
α – D – (+) – glucose

Sol.: α – D – (+) – glucose contains five chiral centres.

55. Answer (1)

Hint: Purine bases are bicyclic compounds

Sol.: •



Guanine is a purine base.

- Cytosine, Thymine and Uracil are pyrimidine bases.

56. Answer (1)

Hint & Sol : Thyroxine is produced in the thyroid gland and it is an iodinated derivative of amino acid tyrosine.

57. Answer (3)

Hint: Leat nitrate on decomposition gives NO_2 as one of the products

Sol.: $2Pb(NO_3)_2 \xrightarrow{673\ K} 4NO_2 + 2PbO + O_2$

58. Answer (2)

Hint: Platinum gauge is used as catalyst in Ostwald's process.

Sol.:

Process		Catalyst
Contact process	→	V_2O_5
Deacon's process	→	$CuCl_2$
Haber's process	→	Iron oxide
Ostwald's process	→	Pt

59. Answer (4)

Hint: Chlorine is acting as an oxidising agent.

Sol.: $I_2 + 6H_2O + 5Cl_2 \longrightarrow 2HIO_3 + 10HCl$

60. Answer (4)

Hint: XeO_3 is pyramidal in shape

Sol.: $XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$

61. Answer (2)

Hint: $Fe_2O_3.xH_2O(s)$ is a brown solid.

Sol.:

Species	Colour
$[Ag(NH_3)_2]Cl$ (aq)	Colourless
$[Cu(NH_3)_4]^{2+}$ (aq)	Deep blue
$Fe_2O_3 \cdot xH_2O$ (s)	Brown solid
$Zn(OH)_2$ (s)	White solid

62. Answer (3)

Hint: d-and f-electrons have low screening effect

Sol.: The observed discontinuity in the ionisation enthalpy values between Al and Ga and between In and Tl are due to inability of d-and f-electrons, which have low screening effect, to compensate the increase in nuclear charge.

Element	IE (kJ mol^{-1})
Al	577
Ga	579
In	558
Tl	589

63. Answer (2)

Hint: When glucose reacts with Br_2 water, aldehydic group oxidises to carboxylic group.

Sol.:

Gluconic acid

64. Answer (3)

Hint: Equal number of amino and carboxyl groups makes the amino acid neutral.

Sol.: Lysine is a basic amino acid having two amino groups and one carboxyl groups.

65. Answer (1)

Hint: α-D-(+)-Glucopyranose and β-D-(+)-Glucopyranose differ only in the configuration at C1.

Sol.: α-form and β-form are anomers.

66. Answer (4)

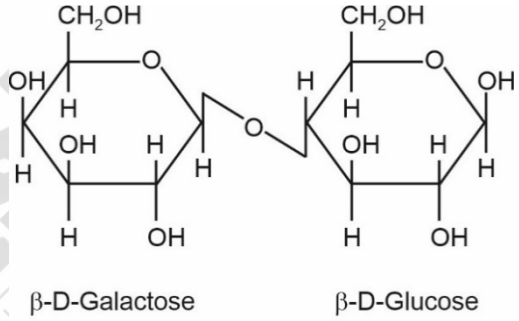
Hint: 1° structure remains unaltered during denaturation of proteins.

Sol.: Proteins loses its biological activity after denaturation.

67. Answer (1)

Hint: Lactose is composed of 2 different monosaccharides.

Sol.:



β-D-Galactose β-D-Glucose

Lactose

68. Answer (4)

Hint & Sol: CO is a colourless, odourless and almost water insoluble gas.

69. Answer (1)

Hint: In sucrose reducing groups of glucose and fructose are involved in glycosidic bond formation.

Sol.: Since the reducing groups of glucose and fructose are involved in glycosidic bond formation, sucrose is a non-reducing sugar.

70. Answer (3)

Hint.: B group vitamins are soluble in water.

Sol.:

- Vitamin B_1, pyridoxine (vitamin B_6), Vitamin C, riboflavin (vitamin B_2) are water soluble.
- Vitamin A, D, E and K are fat soluble vitamin.

71. Answer (4)

Hint: The amino acid which does not contain chrial centre is optically inactive.

Sol.: Glycine is optically inactive amino acid.

72. Answer (3)

Hint & Sol: $4Zn + 10HNO_3(\text{dilute}) \rightarrow 4Zn(NO_3)_2 + 5H_2O + N_2O$

73. Answer (1)

Hint: $P_4 + 3NaOH + 3H_2O \rightarrow PH_3 + 3NaH_2PO_2$

Sol.: The solution of PH_3 in water decomposes in presence of light giving red phosphorus and H_2 gas.

74. Answer (2)

Hint: Brown ring test depends on the ability of Fe^{2+} to reduce nitrates to nitric oxide

Sol.: $NO_3^- + 3Fe^{2+} + 4H^+ \longrightarrow NO + 3Fe^{3+} + 2H_2O$

$\left[Fe(H_2O)_6\right]^{2+} + NO \longrightarrow \underset{\text{Brown}}{[Fe(H_2O)_5(NO)]^{2+}} + H_2O$

75. Answer (4)

Hint: $PCl_5(s)$ exists as $[PCl_4]^+[PCl_6]^-$

Sol.: $[PCl_6]^-$ is octahedral in shape having sp^3d^2 hybridisation.

76. Answer (2)

Hint: In Ostwald's process, NO formed combines with O_2 to give NO_2 which is dissolved in water to give HNO_3.

Sol.: $4NH_3(g) + 5O_2(g) \xrightarrow[500\,K,\ 9\,bar]{\text{Pt/Rh gauge catalyst}} 4NO(g) + 6H_2O(g)$

$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

$3NO_2(g) + H_2O(\ell) \longrightarrow 2HNO_3(aq) + NO(g)$

77. Answer (1)

Hint: Oxidation state of phosphorus remains same before and after hydrolysis.

Sol.: $PCl_3 + 3H_2O \longrightarrow H_3PO_3 + 3HCl$

78. Answer (3)

Hint: The basic structural unit of silicates is SiO_4^{4-}.

Sol.: ZSM-5, used to convert alcohols directly in gasoline.

79. Answer (4)

Hint: In graphite, electrons are delocalised over the whole sheet.

Sol.: Each carbon atom in graphite undergoes sp^2 hybridisation and makes three sigma bonds with three neighbouring C atoms and 4th electron forms a π bond.

80. Answer (3)

Hint: Higher oxidation states for the group 14 elements are less stable for the higher members of the group due to inert pair effect.

Sol.: Pb^{4+} compounds are stronger oxidising agents than Sn^{4+} compounds as Pb^{4+} undergoes reduction to Pb^{2+} more easily.

81. Answer (3)

Hint: Orthophosphorous acid on heating gives orthophosphoric acid as one of the products.

Sol.: $4H_3PO_3 \rightarrow 3H_3PO_4 + PH_3$

82. Answer (1)

Hint: Bleaching action of chlorine is due to oxidation.

Sol.: $Cl_2 + H_2O \longrightarrow 2HCl + O$

Coloured substance + O $\rightarrow$ Colourless substance

83. Answer (4)

Hint: Amphoteric oxides are those which show characteristics of both acid as well as base

Sol.: Al_2O_3 is an amphoteric oxide and SO_2, Cl_2O_7 and N_2O_5 are acidic oxides.

84. Answer (2)

Hint: Hot concentrated sulphuric acid is a moderately strong oxidising agent.

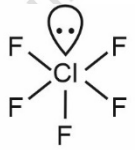
Sol.:

$$\overset{0}{C} + 2H_2\overset{+6}{S}O_4(\text{conc.}) \longrightarrow \overset{+4}{C}O_2 + 2\overset{+4}{S}O_2 + 2H_2O$$

85. Answer (2)

Hint: ClF_5 has 5σ bonds and one lone pair

Sol.:



Square pyramidal

SECTION - B

86. Answer (3)

Hint: Amylopectin is insoluble in water and constitutes about 80-85% of starch

Sol.: Amylopectin is a branched chain polymer of α-D-glucose units in which chain is formed by C1-C4 glycosidic linkage whereas branching occurs at C1-C6 glycosidic linkage.

87. Answer (3)

Hint: Myosin is an example of fibrous protein

Sol.:

- Keratin and myosin are fibrous proteins
- Insulin and albumin are globular proteins

88. Answer (3)

Hint: In DNA, Cytosine forms hydrogen bonds with guanine.

Sol.: In DNA, adenine forms hydrogen bonds with thymine.

89. Answer (4)

Hint: XeF_4 undergoes disproportionation reaction on hydrolysis

Sol.: $6XeF_4 + 12H_2O \rightarrow$

$$4Xe + 2XeO_3 + 24HF + 3O_2$$

90. Answer (3)

Hint: N_2O is laughing gas

Sol.:

Formula	Name
$COCl_2$	Phosgene
CCl_3NO_2	Tear gas
$ClCH_2CH_2SCH_2CH_2Cl$	Mustard gas
N_2O	Laughing gas

91. Answer (3)

Hint: Aqua regia on reaction with Pt gives $[PtCl_6]^{2-}$ species

Sol.: $3Pt + 16H^+ + 4NO_3^- + 18Cl^- \rightarrow$

$$3PtCl_6^{2-} + 4NO + 8H_2O$$

92. Answer (1)

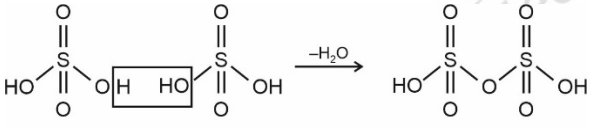
Hint: On going down the group electronegativity of central atom decreases.

Sol.:

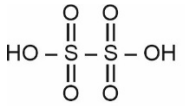
Hydrides of group 15	HEH angle (°)
NH_3	107.8
PH_3	93.6
AsH_3	91.8
SbH_3	91.3

93. Answer (2)

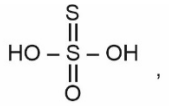
Hint:



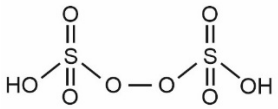
Sol.:



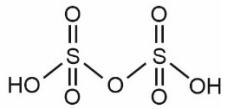
$(H_2S_2O_6)$



$(H_2S_2O_3)$



$(H_2S_2O_8)$



$(H_2S_2O_7)$

94. Answer (3)

Hint: Urea on reaction with water gives ammonia.

Sol.: $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + 4H_2O + Cr_2O_3$

95. Answer (3)

Hint & Sol: When nucleoside is linked to phosphoric acid at 5′ – position of sugar moiety we get a nucleotide.

96. Answer (4)

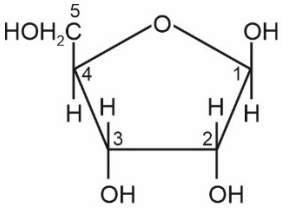
Hint: $[B_4O_5(OH)_4]^{2-}$ is the tetranuclear unit of borax ($Na_2B_4O_7 \cdot 10H_2O$)

Sol.: Because of the large size of chloride ions, Si^{4+} can not accommodate six chloride ions.

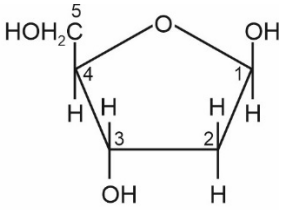
97. Answer (3)

Hint: In DNA molecule, the sugar moiety is β-D-2-deoxyribose whereas in RNA, it is β-D-ribose.

Sol.:



β-D-ribose



β-D-2-deoxyribose

The two molecules differ at C-2 position.

98. Answer (4)

Hint: Pernicious anaemia is RBC deficiency in haemoglobin.

Sol.: Deficiency of vitamin B_{12} causes pernicious anaemia.

99. Answer (2)

Hint: Because of larger size of iodine, bond dissociation enthalpy of I_2 is minimum.

Sol.:

Halogens	Bond dissociation enthalpy ($kJ\ mol^{-1}$)
F_2	158.8
Cl_2	242.6
Br_2	192.8
I_2	151.1

100. Answer (4)

Hint: PbS is called galena

Sol.:

Ore	Formula
Cryolite	Na_3AlF_6
Gypsum	$CaSO_4 \cdot 2H_2O$
Epsom Salt	$MgSO_4 \cdot 7H_2O$

[BOTANY]

SECTION-A

101. Answer (4)

Hint: Population attributes are features of a group of individuals.

Sol.: Natality, mortality and sex ratio are population attributes while birth is an attribute of an organism.

102. Answer (3)

Hint: Natality is the number of births during a period in the population that are added to the initial density.

Sol.: The population density of a given habitat during a given period fluctuates due to changes in four basic processes. Natality and immigration contribute to an increase and mortality and emigration contribute to a decrease in population density.

103. Answer (3)

Hint: In the polar seas, aquatic mammals like seals have a thick layer of fat (blubber) below their skin that acts as an insulator and reduces loss of body heat.

Sol.: Desert plants like *Opuntia,* have no leaves, they are reduced to spines.

- Desert lizards lack the physiological ability, thus manage to keep their body temperature fairly constant by behavioural means.
- Kangaroo rat has the ability to concentrate its urine so that minimal volume of water is used to remove the excretory products.

104. Answer (4)

Hint: Man-made or anthropogenic ecosystems are created and maintained by human beings.

Sol.: Forest, grassland and desert are natural ecosystems while crop fields are man-made or anthropogenic ecosystems.

105. Answer (3)

Hint: Humus is highly resistant to microbial action, its degradation by some microbes is mineralisation.

Sol.: Humification leads to accumulation of a dark coloured amorphous substance called humus.

106. Answer (1)

Hint: All successions whether taking place in water or on land, proceed to a similar community – the mesic.

Sol.:

- The species that invade a bare area are called pioneer species.

107. Answer (1)

Hint: India has 1000 varieties of mango.

Sol.: India has more than 50,000 genetically different strains of rice.

108. Answer (1)

Hint: The direct economic benefits from nature are categorised under narrowly utilitarian ecosystem services.

Sol.: Fibre, food and firewood are direct economic benefits from nature while oxygen and pollination are broadly utilitarian ecosystem services.

109. Answer (3)

Hint: Keystone species drive major ecosystem functions.

Sol.: Endemic species are the species confined to a particular region and not found anywhere else.

Endangered species are those which are facing the threat of extinction in near future.

110. Answer (1)

Hint: International Union for Conservation of Nature and Natural Resources (IUCN) is now called World Conservation Union (WCU).

Sol.: The Red Data Book or Red List is maintained by World Conservation Union (WCU)

- UNEP is United Nations Environment Programme.
- MAB is Man and Biosphere Programme.
- WWF is World Wide Fund for Nature.

111. Answer (2)

Hint: Total number of hotspots of biodiversity in the world till date is 34.

Sol.: Initially, 25 hotspots of biodiversity have been identified throughout the world.

India has three of these hotspots.

112. Answer (4)

Hint: Mutualism – species A species B

(+) (+)

In mutualism, both species get benefited from each other.

Sol.: Red billed Ox-pecker and yellow billed Ox-pecker sit on the back of black rhinoceros and feed on the ticks.

The birds also warn the rhinoceros of approaching danger. Both the partners are benefitted and both can live separately. Lichens represent an intimate mutualistic relationship between algae and fungi.

113. Answer (4)

Hint: Population size measurement can also be carried out indirectly without actually counting the organisms, this is called indirect count e.g., tiger census is based on pug marks and faecal pellets.

Sol.: Population age at any given time is composed of individuals of different ages. Urn shaped age pyramid has smaller number of pre-reproductive individuals followed by a large number of reproductive individuals. As there are fewer individuals in pre-reproductive group, the population size will decline with time. Such population shows negative growth.

114. Answer (2)

Hint: Under normal conditions, births and deaths are two important factors influencing population density.

Sol.: If a new habitat is just being colonised, immigration may contribute more significantly to population growth than birth rates.

115. Answer (3)

Hint: Prey species have evolved various defenses to minimise or challenge the impact of predation.

Sol.: Monarch butterfly is highly distasteful and therefore avoided by its predator. Endoparasites live inside the host body at different sites and their life cycle is more complex.

116. Answer (4)

Hint: Logistic growth describes a situation in which resource and space are limited.

Sol.: In logistic growth curve influence of environmental resistance over biotic potential is denoted by $\left(\frac{K-N}{K}\right)$. The integral form of exponential growth equation in $N_t = N_0 e^{rt}$.

117. Answer (3)

Hint: In brood parasitism, parasitic bird lays its eggs in the nest of its host and let the host incubates them.

Sol.: Cuckoo laying its eggs in the nest of crow is an example of brood parasitism.

Lice on humans, ticks on dogs and *Cuscuta* growing on hedge plants are examples of ectoparasitism.

118. Answer (1)

Hint: Logistic growth of a population is described by equation $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$ and is represented by S-shaped curve.

Sol.: Exponential growth of a population occurs when resources are unlimited.

It is described by the equation $\frac{dN}{dt} = rN$ and represented by a J-shaped curve.

119. Answer (3)

Hint: Expanding population is young or growing population.

Sol.: In expanding population, pre-reproductive individuals are more than reproductive individuals and post-reproductive individuals are proportionately fewer than reproductive individuals.

Such a population shows positive growth.

It is represented by an upright triangular age pyramid.

120. Answer (4)

Hint: Terms euryhaline and stenohaline are used with reference to tolerance of organisms towards salinities.

Sol.: A few organisms can tolerate and thrive in a wide range of temperatures, they are called eurythermal. But a vast majority of them are restricted to a narrow range of temperatures, they are called stenothermal.

121. Answer (3)

Hint: Hibernation is shown by bears to escape in time during winter and some snails and fish go into aestivation to avoid summer-related problems.

Sol.: Under unfavourable conditions, many zooplankton species in lakes and ponds are known to enter diapause, a stage of suspended development.

122. Answer (4)

Hint: Primary productivity depends on a variety of environmental factors, such as availability of nutrients and photosynthetic capacity of plants.

Sol.: Primary productivity is rate of biomass production by plants. It depends on the plant species inhabiting a particular area but does not depend on the animals inhabiting that area.

123. Answer (1)

Hint: Despite occupying about 70 percent of the surface, the productivity of the oceans is only 55 billion tons.

Sol.: The annual net primary productivity of the whole biosphere is approximately 170 billion tons (dry weight) of organic matter.

124. Answer (3)

Hint & Sol.: Of the incident solar radiation less than 50 percent of it is photosynthetically active radiation (PAR).

Plants capture only 2-10 percent of the PAR.

125. Answer (3)

Hint: Secondary productivity is defined as the rate of formation of new organic matter by consumers

Sol.: Each trophic level has a certain mass of living material at a particular time is called standing crop.

Standing state or quality is the amount of all the inorganic substances present in an ecosystem.

126. Answer (4)

Hint: Sparrow can feed on seeds as well as insects.

Sol.: Sparrow can occupy a primary consumer level (when feeds on seeds) or secondary consumer level (when feeds on insects) in food chain.

127. Answer (2)

Hint: Out of the total quantity of global carbon, we find 71 percent carbon is found dissolved in the oceans.

Sol.: Carbon constitutes 49 percent of the dry weight of organisms in the body of living organisms.

128. Answer (4)

Hint: Western ghat regions of Karnataka and Maharashtra, and Aravalli hills of Rajasthan are sacred groves of India.

Sol.: Sarguja, Chanda and Bastar areas of Madhya Pradesh and Khasi and Jaintia hills in Meghalaya are examples of sacred groves.

129. Answer (3)

Hint: The Earth Summit was the historic convention on biological diversity.

Sol.: India now has 14 biosphere reserves, 90 national parks and 448 wildlife sanctuaries.

Western ghats and Sri Lanka, Indo-Burma and Himalayas are the three hotspots of India.

130. Answer (4)

Hint: Anthropogenic ecosystem is created and maintained by human beings.

Sol.: Anthropogenic ecosystem have little diversity and possess simple food chain.

131. Answer (1)

Hint: Producers are autotrophs, they convert solar energy into chemical energy.

Sol.: Primary consumers are key industry animals because they convert plant matter into animal matter.

132. Answer (1)

Hint: Decomposition is the breakdown of complex organic matter to inorganic raw materials.

Sol.: Temperature and soil moisture are the most important climatic factors that regulate decomposition through their effects on the activities of soil microbes.

133. Answer (4)

Hint: Succession that occurs on rock is called lithosere. Xerosere/Xerarch succession takes place in dry areas.

Sol.: Succession in water is called hydrosere/hydrarch. Succession in saline conditions is called halosere.

134. Answer (3)

Hint: Species diversity increases during the process of ecological succession.

Sol.: During ecological succession, niche of an organism becomes specialised and there is increase in humus content of soil.

135. Answer (1)

Hint: Decline in plant productivity is the result of loss of biodiversity.

Sol.: Loss of biodiversity in a region may lead to reduced resistance to environmental perturbations and increase in variability of ecosystem processes.

SECTION-B

136. Answer (3)

Hint: In commensalism and amensalism at least one partner species remains unaffected.

Sol.: In amensalism one species is harmed (–) and other remains unaffected (0).

- Competition → Species A(–) and species B (–)
- Commensalism → Species A(+) and species B (0)
- Mutualism → Species A(+) and species B (+)

137. Answer (4)

Hint: Commensalism is the interaction in which one species is benefitted and the other is neither harmed nor benefitted.

Sol.: In the interaction between sea anemone and hermit crab both the species are benefitted, (+, +). It is protocooperation.

An orchid growing on a mango branch, barnacles growing on the back of a whale and the cattle egret and grazing cattle, exemplify commensalism.

138. Answer (4)

Hint: Parasitic mode of nutrition ensures free lodging and meals.

Sol.: Parasites have high reproductive capacity.

They show loss of unnecessary sense organs, presence of adhesive organs and loss of digestive system.

139. Answer (2)

Hint: Identification and enumeration of plant and animal species of an ecosystem gives its species composition.

Sol.: Vertical distribution of different species occupying different levels is called stratification.

Food chain is a sequence of living organisms which involves transfer of food energy from producers, through a series of organisms with repeated eating and being eaten.

Natural interconnection of food chains makes it a food web.

140. Answer (1)

Hint: Decomposition is largely an oxygen-requiring process.

Sol.: The rate of decomposition is controlled by chemical composition of detritus and climatic factors.

Decomposition rate is slower if detritus is rich in lignin and chitin, and quicker, if detritus is rich in nitrogen and water-soluble substances like sugars.

Warm and moist environment favour decomposition whereas low temperature and anaerobiosis inhibit decomposition.

141. Answer (1)

Hint: Pyramid of energy is always upright in all ecosystems.

Sol.: Pyramid of energy in a sea is always upright. Pyramid of number in a tree ecosystem can be inverted or spindle-shaped but never upright because the number of producer is represented by one tree supporting more than one consumer.

142. Answer (3)

Hint: Phosphorus cycle is a sedimentary cycle.

Atmospheric inputs of phosphorus through rainfall are much smaller than carbon inputs.

Sol.: Gaseous exchanges of phosphorus between organism and environment are negligible.

Unlike carbon cycle, there is no respiratory release of phosphorus into atmosphere.

143. Answer (2)

Hint: It is a diversity shown by a single species at the genetic level over its distributional range.

Sol.: Genetic diversity is exemplified by the medicinal plant *Rauwolfia vomitoria* growing in different Himalayan ranges.

Species diversity is the diversity at the species level.

Ecological diversity is the diversity at the ecosystem level.

144. Answer (1)

Hint: In *ex-situ* conservation, threatened animals and plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care.

Sol.: Wildlife safari parks and seed banks are *ex-situ* conservation methods while biosphere reserves, national parks and sacred groves are *in-situ* conservation methods.

145. Answer (4)

Hint: Alexander von Humboldt gave species-area relationship curve while Paul Ehrlich used Rivet popper hypothesis.

Sol.: Edward Wilson popularised the term biodiversity and David Tilman performed long term ecosystem experiments using outdoor plots.

146. Answer (3)

Hint: Hunting and poaching is not permitted in sanctuary as well as in national park.

Sol.: In wildlife sanctuaries collection of forest products, harvesting of timber, tilling of land are allowed.

147. Answer (1)

Hint: Darwin found that fourteen species of finches co-exist in Galapagos island due to development of different feeding habits.

Sol.: Gause's competitive exclusion states that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eventually eliminated. MacArthur showed that five closely related species of warblers avoid competition by changing foraging pattern. Connell's experiment showed that on the rocky coasts of Scotland, the larger *Balanus* dominates the intertidal area.

148. Answer (2)

Hint: Lichens are the pioneer community in xerarch succession. This accelerates the process of soil formation.

Sol.: The successional series progress from xeric to mesic conditions is

Lichens → Bryophytes → Grasses → Higher plants → Forest

149. Answer (4)

Hint: According to IUCN Red list (2004), 338 vertebrate species got extinct.

Sol.: IUCN red list (2004) documents the extinction of 784 species in last 500 years.

150. Answer (3)

Hint: Nile perch, an alien species killed and eliminated ecologically unique assemblage of over 200 species of cichlid fish that were endemic to fresh water aquatic system.

Sol.: Many species got extinct in the last 500 years (Dodo, Steller's sea cow, passenger pigeon) due to over-exploitation by humans.

[ZOOLOGY]

SECTION-A

151. Answer (1)

Hint: A widely used diagnostic test for AIDS

Sol.: ELISA is based on the principle of antigen-antibody interaction. Infections by pathogen can be detected by the presence of antigens (protein, glycoproteins, *etc.*), or by detecting the antibodies synthesised against the pathogen.

152. Answer (1)

Hint: Exclude the institute where 'Saheli' was developed.

Sol.: The Indian Government has set up organisations such as GEAC (Genetic Engineering Approval Committee), which will make decisions regarding the validity of GM research and the safety of introducing GM-organisms for public services. The European Federation of Biotechnology has given a definition of biotechnology. Central Drug Research Institute prepared 'Saheli', a non-steroidal pill.

US Patent and trademark office gave patent rights on Basmati Rice in 1997.

153. Answer (3)

Hint: Same genus causes typhoid fever

Sol.: The construction of the first rDNA emerged from the possibility of linking a gene encoding antibiotic resistance with a native plasmid of *Salmonella typhimurium*.

Salmonella typhi causes typhoid fever.

Streptococcus pneumoniae and *Haemophilus influenzae* are causative agents of pneumonia.

154. Answer (4)

Hint: Belong to the class nucleases

Sol.: The cutting of DNA at specific locations became possible with the discovery of the so called 'molecular scissors'–restriction enzymes.

Taq polymerase is an example of thermostable DNA polymerase that synthesises a new strand of DNA complementary to an existing DNA template in 5' to 3' direction.

155. Answer (4)

Hint: GM organism

Sol.: There are three basic steps in genetically modifying an organism:

(i) Identification of DNA with desirable genes

(ii) Introduction of the identified DNA into the host

(iii) Maintenance of introduced DNA in the host and transfer of the DNA to its progeny

156. Answer (2)

Hint: *Eco*RI has been isolated from *Escherichia coli*

Sol.: The convention for naming restriction enzymes is that the first letter of the name comes from the genus and the second two letters come from the species of the prokaryotic cell from which they were isolated, *e.g., Eco*RI comes from *Escherichia coli* RY13. In *Eco*RI, the letter 'R' is derived from the name of the strain. Roman numbers following the name indicate the order in which enzymes were isolated from that strain of bacteria.

157. Answer (3)

Hint: Between purines

Sol.: *Eco*RI cuts the DNA between bases G and A only when the sequence 5′GAATTC3′ is present in the DNA.

158. Answer (1)

Hint: Cuts within the DNA

Sol.: Endonucleases make cuts at specific positions within the DNA. Each restriction endonuclease functions by inspecting the length of a DNA sequence. Once it finds its specific recognition sequence, it will bind to the DNA and cut each of the two strands of the double helix at specific points in their sugar-phosphate backbones.

159. Answer (1)

Hint: Involves the use of agarose gel

Sol.: The cutting of DNA by restriction endonucleases results in the fragments of DNA. These fragments can be separated by a technique known as gel electrophoresis. Since DNA fragments are negatively charged molecules, they can be separated by forcing them to move towards the anode under an electric field through a medium/matrix.

160. Answer (4)

Hint: Digests DNA

Sol.: Fungal cell wall is made up of chitin, thus chitinase is used. The RNA can be removed by treatment with ribonuclease whereas proteins can be removed by treatment with protease.

161. Answer (1)

Hint: Transgenic plants have reduced post-harvest losses.

Sol.: GM plants have been useful in many ways. Genetic modification has :

(i) Made crops more tolerant to abiotic stresses (cold, drought, salt, heat)

(ii) Reduced reliance on chemical pesticides (pest-resistance crops)

(iii) Helped to reduce post-harvest losses

(iv) Increased efficiency of mineral usage by plants (this prevents early exhaustion of fertility of soil)

(v) Enhanced nutritional value of food, *e.g.*, golden rice, *i.e.*, Vitamin 'A' enriched rice

162. Answer (3)

Hint: Kills armyworm

Sol.: *Bt* toxin is produced by a bacterium called *Bacillus thuringiensis. Bt* toxin gene has been cloned from the bacteria and been expressed in plants to provide resistance to insects without the need for insecticides; in effect created a bio-pesticide.

163. Answer (4)

Hint: *Agrobacterium*

Sol.: Using *Agrobacterium* vectors, nematode-specific genes were introduced into the host plant. *Agrobacterium tumefaciens*, a pathogen of several dicot plants, is able to deliver a piece of DNA known as T-DNA to transform normal plant cells into tumor cells to produce the chemicals required by the pathogen. Retrovirus possesses RNA genome.

164. Answer (1)

Hint: Less than 30 documented varieties of Basmati rice are grown in India.

Sol.: Rice is an important food grain in India. There are an estimated 200,000 varieties of rice and 27 documented varieties of Basmati are grown in India.

165. Answer (3)

Hint: DNA cannot cross the cell membrane.

Sol.: The genetic material of humans is DNA. DNA is negatively charged as well as hydrophilic molecule. Thus, DNA cannot pass through cell membranes.

166. Answer (2)

Hint: Probe is used in autoradiography.

Sol.: During isolation of genetic material, DNA can be spooled out after the addition of chilled ethanol. DNA can be seen as collection of fine threads in the suspension.

The separated bands of DNA are cut out from the agarose gel and extracted from the gel piece by the process called elution.

167. Answer (3)

Hint: Exclude downstream processing

Sol.: Recombinant DNA technology involves several steps in specific sequence such as isolation of DNA, fragmentation of DNA by restriction endonucleases, isolation of a desired DNA fragment, ligation of the DNA fragment into a vector, transferring the recombinant DNA into the host, culturing the host cells in a medium at large scale and extraction of the desired product.

168. Answer (3)

Hint: *Pvu* I restriction site is present in amp^R gene.

Sol.: If a foreign gene is inserted at the *Pvu* I site of vector pBR322 followed by its insertion in a host cell, then the recombinants will be amp^S and tet^R and non-recombinants will be amp^R and tet^R.

169. Answer (2)

Hint: 2^n

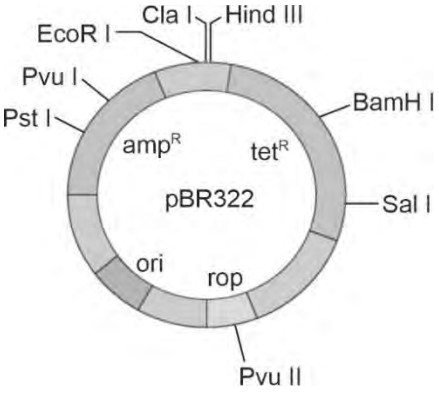
Sol.: 2^n number of fragments are formed after 'n' number of PCR cycles.

$\therefore 2^6 = 64$ DNA fragments

170. Answer (1)

Hint: Gene that controls copy number does not have any restriction site.

Sol.:



171. Answer (3)

Hint: Selectable marker

Sol.: In order to link the alien DNA, the vector needs to have very few, preferably single, recognition site for the commonly used restriction enzymes. Presence of more than one recognition sites within the vector will complicate the gene cloning. *rop* codes for the proteins involved in the replication of plasmid.

172. Answer (2)

Hint: Retrovirus mediated transformation

Sol.: Microinjection – rDNA is directly injected into the nucleus of an animal cell

Gene gun (biolistic) – Suitable for plants

173. Answer (2)

Hint: Exclude immortal cells

Sol.: In some children, ADA deficiency can be cured by bone marrow transplantation; in others it can be treated by enzyme replacement therapy, in which functional ADA is given to the patient by injection. But the problem with both of these approaches are that they are not completely curative. As a first step towards gene therapy, lymphocytes from the blood of the patient are grown in a culture outside the body. A functional ADA cDNA (using a retroviral vector) is then introduced into these lymphocytes, which are subsequently returned to the patient. However, as these cells are not immortal, the patient requires periodic infusion of such genetically engineered lymphocytes. However, if the gene isolated from marrow cells producing ADA is introduced into cells at early embryonic stages, it could be a permanent cure.

174. Answer (3)

Hint: Equal to the number of pairs of cranial nerves in man

Sol.: At present, about 30 recombinant therapeutics have been approved for human use the world over. In India, 12 of these are presently being marketed.

175. Answer (1)

Hint: Insulin isolated from pigs develops allergies.

Sol.: The recombinant DNA technological processes have made an immense impact in the area of healthcare by enabling mass production of safe and more effective therapeutic drugs. Further, the recombinant therapeutics do not induce unwanted immunological responses as is common in case of similar products isolated from non-human sources. At present, about 30 recombinant therapeutics have been approved for human-use the world over. In India, 12 of these are presently being marketed.

176. Answer (3)

Hint: Includes autoimmune disorder

Sol.: Many transgenic animals are designed to increase our understanding of how genes contribute to the development of disease. These are specially made to serve as models for human diseases so that investigation of new treatments for diseases is made possible. Today transgenic models exist for many human diseases such as cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's disease.

177. Answer (4)

Hint: 1997

Sol.: In 1997, the first transgenic cow, Rosie produced human protein-enriched milk (2.4 grams per litre).

The first clinical gene therapy was given to a four year-old girl with ADA deficiency in 1990.

In 1983, Eli Lilly, an American company prepared two DNA sequences corresponding to A and B chains of human insulin and introduced them in plasmids of *E.coli* to produce insulin chains.

178. Answer (4)

Hint: Have genetic material similar to HIV

Sol.: RNAi takes place in all eukaryotic organisms as a method of cellular defense. This method involves silencing of a specific mRNA due to a complementary dsRNA molecule that binds to and prevents translation of the mRNA (silencing). The source of this complementary RNA could be from an infection by viruses having RNA genomes or mobile genetic elements (transposons) that replicate *via* an RNA intermediate.

179. Answer (4)

Hint: Exclude the modern methods of disease diagnosis

Sol.: Using conventional methods of diagnosis (serum and urine analysis, *etc.*) early detection is not possible. Recombinant DNA technology, Polymerase Chain Reaction (PCR) and Enzyme-Linked Immuno-sorbent Assay (ELISA) are some of the techniques that serve the purpose of early diagnosis.

180. Answer (1)

Hint: Exclude the category to which mosquitoes belong to

Sol.: Some strains of *Bacillus thuringiensis* produce proteins that kill certain insects such as lepidopterans (tobacco budworm, armyworm), coleopterans (beetles) and dipterans (flies, mosquitoes)

181. Answer (2)

Hint: DNA is negatively charged

Sol.: DNA fragments are negatively charged molecules and they can be separated by forcing them to move towards the anode under an electric field through a medium/matrix. Nowadays, the most commonly used matrix is agarose which is a natural polymer extracted from sea weeds. The DNA fragments separate (resolve) according to their size through the sieving effect provided by the agarose gel. Hence, the smaller the fragment size, the farther it moves.

182. Answer (2)

Hint: Selectable marker helps to eliminate non-transformants.

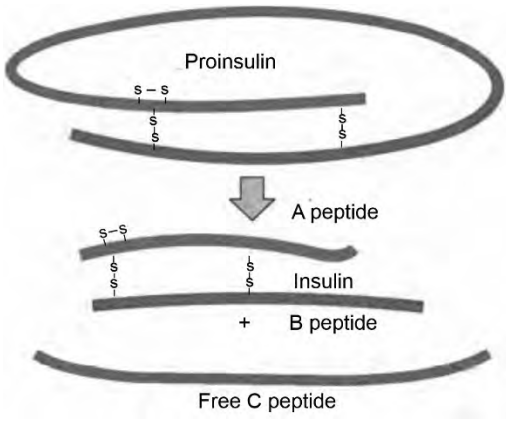
Sol.:

Origin of replication (*ori*)	–	Controls the copy number
Selectable marker	–	Antibiotic-resistance gene
Ti – plasmid	–	*Agrobacterium tumefaciens*
Disarmed Retrovirus	–	Used for animal host

183. Answer (2)

Hint: Proinsulin

Sol.:



184. Answer (3)

Hint: *Bt* toxin kills insects by creating pores into the cell membrane.

Sol.: The *Bt* toxin protein exists as inactive protoxins but once an insect ingests the inactive toxin, it is converted into an active form of toxin due to the alkaline pH of the gut which solubilises the crystals.

The activated toxin binds to the surface of midgut epithelial cells and create pores that cause cell swelling and lysis and eventually cause death of the insect.

185. Answer (1)

Hint: Bioreactors are also known as fermenters.

Sol.: Bioreactors, also known as fermenters are chambers in which microorganisms are cultured in a liquid/ solid medium. To produce the desired product in large quantities, bioreactors were developed where large volumes (100 – 1000L) of culture can be processed.

Bioreactors are vessels in which raw materials are biologically converted into specific products, individual enzymes, *etc.,* using microbial plant, animal or human cells.

SECTION-B

186. Answer (4)

Hint: 95% of all existing transgenic animals are mice.

Sol.: Transgenic mice are being used to test the safety of the polio vaccine.

Transgenic animals are made that carry genes which make them more sensitive to toxic substances than non-transgenic animals.

187. Answer (4)

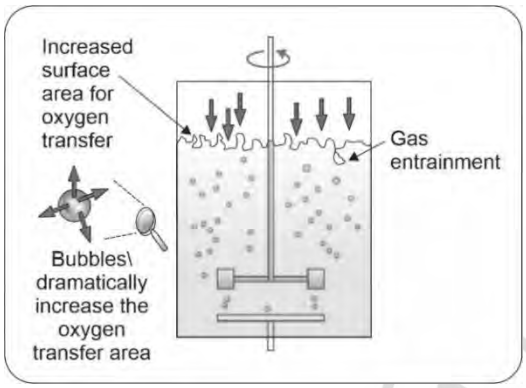
Hint: Physiologically most active phase

Sol.: In continuous culture system, the used medium is drained out from one side while fresh medium is added from the other to maintain the cells in their physiologically most active log/exponential phase. This type of culturing method produces a larger biomass leading to higher yields of desired protein.

188. Answer (4)

Hint: Gas entrainment

Sol.:



189. Answer (2)

Hint: Included under upstream processing

Sol.: After completion of the biosynthetic stage, the product has to be subjected through a series of processes before it is ready for marketing as a finished product. The processes include separation and purification, which are collectively referred to as downstream processing. The product has to be formulated with suitable preservatives. Such formulation has to undergo thorough clinical trials as in case of drugs. Strict quality control testing for each product is also required. The downstream processing and quality control testing vary from product to product.

190. Answer (4)

Hint: Equal to the total number of ear ossicles in man

Sol.: *Hin*d II always cuts DNA molecules at a particular point by recognising a specific sequence of six base pairs. This specific base sequence is known as the recognition sequence for *Hin*d II.

191. Answer (4)

Hint: Temperature less than that required during annealing

Sol.: In order to force bacteria to take up the plasmid, the bacterial cells must first be made 'competent' to take up DNA. This is done by treating them with a specific concentration of a divalent cation, such as Ca^{++}, which increases the efficiency with which DNA enters the bacterium through pores in its cell wall. Recombinant DNA can then be forced into such cells by incubating the cells with recombinant DNA on ice, followed by placing them briefly at 42ºC (heat shock), and then putting them back on ice. This enables the bacteria to take up the recombinant DNA.

192. Answer (2)

Hint: Lepidopteran

Sol.: The proteins encoded by the genes *cryIAc* and *cryIIAb* control cotton bollworms that of *cryIAb* controls corn borer.

193. Answer (3)

Hint: Emphysema

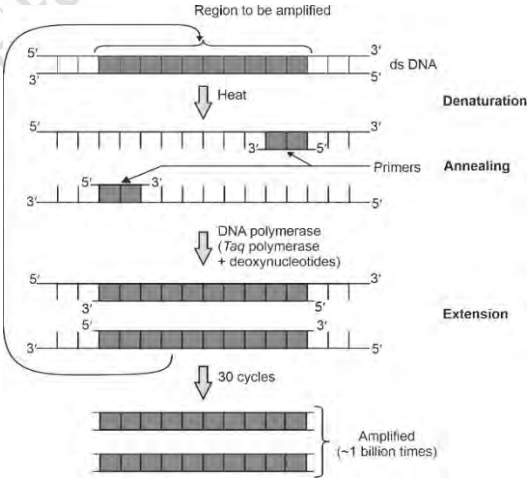
Sol.: Transgenic animals that produce useful biological products can be created by the introduction of the portion of DNA (or genes) which codes for a particular product such as human protein (α-1-antitrypsin) used to treat emphysema.

The milk produced by Rosie, contained the human α-lactalbumin and was nutritionally a more balanced product for human babies than natural cow milk.

194. Answer (2)

Hint: Takes place at temperature of about 50°C – 60°C

Sol.:



195. Answer (4)

Hint: Partly increased due to use of improved varieties.

Sol.: The green revolution succeeded in tripling the food supply but yet it was not enough to feed the growing human population.

Increased yield of crops is mainly due to the use of better management practices and use of agrochemicals.

196. Answer (3)

Hint: β-galactosidase is present within *lac Z* gene

Sol.: If a recombinant DNA is inserted within the coding sequence of an enzyme, β-galactosidase, then this results into inactivation of the gene for synthesis of this enzyme, which is referred to as insertional inactivation. The presence of a chromogenic substrate gives blue coloured colonies if the plasmid in the bacteria does not have an insert. Presence of insert results into insertional inactivation of the β-galactosidase gene and the colonies do not produce any colour. These are identified as recombinant colonies.

197. Answer (1)

Hint: Number of bacteria is less than number of restriction enzymes

Sol.: Besides *Hin*d II, today we know more than 900 restriction enzymes that have been isolated from over 230 strains of bacteria each of which recognize different recognition sequences.

198. Answer (3)

Hint: Does not carry any vital gene necessary for the cell

Sol.: Plasmid is a circular, double-stranded extra-chromosomal DNA. It does not carry any vital gene necessary for the cell. It can replicate independently of the main genome.

199. Answer (1)

Hint: Equal to the number of parietal bones in man

Sol.: The Indian Parliament has recently cleared the second amendment of the Indian Patents Bill, that takes such issues into consideration including the patent terms, emergency provisions and research and development initiative.

200. Answer (4)

Hint: Bioprocess engineering

Sol.: Among many, the two core techniques that enabled birth of modern biotechnology are :

(i) **Genetic engineering** *:* Techniques to alter the chemistry of genetic material (DNA and RNA), to introduce these into host organisms and thus change the phenotype of the host organism.

(ii) **Bioprocess engineering :** Maintenance of sterile (microbial contamination-free) ambience in chemical engineering processes to enable growth of only the desired microbe/eukaryotic cell in large quantities for the manufacture of biotechnological products like antibiotics, vaccines, enzymes, *etc*.

❑ ❑ ❑

All India Aakash Test Series for NEET - 2024

TEST - 7 (Code-F)

Click Here for Code-E Sol.

Test Date : 31/03/2024

ANSWERS

1. (1)	41. (2)	81. (3)	121. (3)	161. (1)
2. (4)	42. (4)	82. (4)	122. (2)	162. (3)
3. (4)	43. (3)	83. (3)	123. (4)	163. (2)
4. (3)	44. (3)	84. (1)	124. (4)	164. (2)
5. (2)	45. (4)	85. (2)	125. (2)	165. (3)
6. (2)	46. (1)	86. (4)	126. (1)	166. (1)
7. (1)	47. (3)	87. (2)	127. (3)	167. (2)
8. (3)	48. (2)	88. (4)	128. (4)	168. (3)
9. (3)	49. (2)	89. (3)	129. (1)	169. (3)
10. (3)	50. (3)	90. (4)	130. (1)	170. (2)
11. (1)	51. (4)	91. (3)	131. (4)	171. (3)
12. (1)	52. (2)	92. (3)	132. (3)	172. (1)
13. (4)	53. (1)	93. (2)	133. (4)	173. (4)
14. (4)	54. (1)	94. (1)	134. (2)	174. (3)
15. (3)	55. (1)	95. (3)	135. (4)	175. (1)
16. (2)	56. (1)	96. (3)	136. (3)	176. (1)
17. (1)	57. (3)	97. (4)	137. (4)	177. (3)
18. (2)	58. (2)	98. (3)	138. (2)	178. (2)
19. (3)	59. (4)	99. (3)	139. (1)	179. (2)
20. (4)	60. (4)	100. (3)	140. (3)	180. (2)
21. (1)	61. (4)	101. (4)	141. (4)	181. (1)
22. (1)	62. (2)	102. (3)	142. (1)	182. (4)
23. (2)	63. (1)	103. (3)	143. (2)	183. (4)
24. (4)	64. (3)	104. (4)	144. (3)	184. (4)
25. (4)	65. (4)	105. (3)	145. (1)	185. (3)
26. (1)	66. (3)	106. (1)	146. (1)	186. (4)
27. (1)	67. (1)	107. (1)	147. (2)	187. (1)
28. (4)	68. (4)	108. (1)	148. (4)	188. (3)
29. (3)	69. (1)	109. (3)	149. (4)	189. (1)
30. (2)	70. (4)	110. (1)	150. (3)	190. (3)
31. (1)	71. (1)	111. (3)	151. (1)	191. (4)
32. (1)	72. (3)	112. (3)	152. (1)	192. (2)
33. (4)	73. (2)	113. (1)	153. (3)	193. (3)
34. (3)	74. (3)	114. (4)	154. (4)	194. (2)
35. (2)	75. (2)	115. (3)	155. (4)	195. (4)
36. (1)	76. (2)	116. (4)	156. (2)	196. (4)
37. (2)	77. (2)	117. (3)	157. (3)	197. (2)
38. (3)	78. (4)	118. (1)	158. (1)	198. (4)
39. (1)	79. (1)	119. (3)	159. (1)	199. (4)
40. (3)	80. (3)	120. (4)	160. (4)	200. (4)

HINTS & SOLUTIONS

[PHYSICS]

SECTION-A

1. Answer (1)

Hint: Use logic expression.

Sol.: $\overline{A+B}=C$

$\overline{C\cdot\overline{C}}=Y$

$\overline{C}+C=Y$

$\Rightarrow Y=1$

2. Answer (4)

Hint: KE = $q\,\Delta V$

Sol.: KE = $25000\times1.6\times10^{-19}$

$=40\times10^{-16}$

$=4\times10^{-15}$ J

3. Answer (4)

Hint: Using Malus law $I = I_0\cos^2\phi$

Sol.: After passing through 1st polarizer intensity

$I=\frac{I_0}{2}$

After 2nd : $I' = I\cos^2\theta$

$=\frac{I_0}{2}\times\frac{3}{4}$

After 3rd : $I''=\left(\frac{I_0}{2}\times\frac{3}{4}\right)\frac{3}{4}=\frac{9I_0}{32}$

4. Answer (3)

Hint: Location of n^{th} maxima from central bright

$X_n=\frac{n\lambda D}{d}$

Sol.: $\frac{3\lambda D}{d}=x$

$\frac{\lambda D}{d}=\frac{x}{3}$

$\frac{5\lambda D}{d}=\frac{5x}{3}$

5. Answer (2)

Hint & Sol.: Numbers of $t_{1/2}=\frac{12}{2}=6$

If initial amount of substance is N_0 then remaining amount:

$N=\frac{N_0}{64}$

Decay substance = $N_0-\frac{N_0}{64}=\frac{63N_0}{64}$

Percentage of substance decayed

$=\frac{63N_0}{64N_0}\times100\approx98\%$

6. Answer (2)

Hint: Use $E=-13.6\left[\frac{1}{n^2}-\frac{1}{m^2}\right]$

Sol.: $E=-13.6\left[\frac{1}{2^2}-\frac{1}{3^2}\right]$

$h\nu=-13.6\left[\frac{5}{36}\right]$

$h'=-13.6\left[\frac{1}{1^2}-\frac{1}{2^2}\right]$

$h\nu'=-13.6\left[\frac{3}{4}\right]$

$\frac{\nu}{\nu'}=\frac{\frac{5}{36}}{\frac{3}{4}}$

$\frac{\nu}{\nu'}=\frac{5}{27}$

$\nu'=\frac{27\nu}{5}$

7. Answer (1)

Hint: Position of dark fringe $y_n=(2n-1)\frac{\lambda D}{2d}$

Sol.: Location of fifth dark $=\frac{4\lambda D}{d}+\frac{\lambda D}{2d}=\frac{9\lambda D}{2d}$

8. Answer (3)

Hint: Use $v=\frac{Z}{n}v_0$

Sol.: $v\propto\frac{1}{n}$

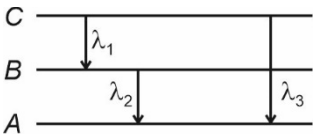
$\frac{v_1}{v_2}=\frac{n_2}{n_1}=\frac{4}{1}$

Therefore, option (3) is correct.

9. Answer (3)

Hint: Energy of emitted radiation $E = \frac{hc}{\lambda}$

Sol.:



$E_3 = E_1 + E_2 \Rightarrow \frac{hc}{\lambda_3} = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_2}$

$\Rightarrow \lambda_3 = \frac{\lambda_1\lambda_2}{\lambda_1 + \lambda_2}$

10. Answer (3)

Hint: Use $\frac{1}{\lambda} = R\left[\frac{1}{n^2} - \frac{1}{m^2}\right]$

Sol.: $\frac{1}{\lambda} = R\left[\frac{1}{3^2} - \frac{1}{\infty^2}\right]$

$\frac{1}{\lambda'} = R\left[1 - \frac{1}{2^2}\right]$

$\frac{\lambda'}{\lambda} = \frac{\frac{1}{9}}{\frac{3}{4}} = \frac{4}{27}$

$\boxed{\lambda' = \frac{4\lambda}{27}}$

11. Answer (1)

Hint: $d_{\text{eff}} = \frac{d}{\mu}$

Sol.: $d_{\text{eff}} = \frac{h}{2} + \frac{1}{2\mu}\frac{h}{2} + \frac{1}{\mu}\frac{h}{2}$

$= \frac{h}{2} + \frac{h}{4\mu} + \frac{h}{2\mu}$

$= h\left[\frac{2\mu + 3}{4\mu}\right]$

12. Answer (1)

Hint & Sol.: Huygens' theory was based on wave nature of light.

13. Answer (4)

Hint & Sol.: $\lambda = \frac{h}{P}$; $KE = \frac{P^2}{2m}$; $KE = qV$

$P^2 = 2m\,(KE) = 2mqV$

$P = \sqrt{2mqV}$

$\lambda = \frac{h}{\sqrt{2mqV}}$

$\frac{\lambda_P}{\lambda_\alpha} = \frac{\sqrt{2 \times 4m_0 \times 2q_0V}}{\sqrt{2m_0 \times q_0V}}$

$\Rightarrow \frac{\lambda_P}{\lambda} = 2\sqrt{2}$

$\lambda_p = 2\sqrt{2}\,\lambda$

14. Answer (4)

Hint: Use principle of momentum conservation.

Sol.: Apply momentum conservation

$0 = m_1v_1 + m_2v_2$

$\Rightarrow \frac{v_1}{v_2} = \frac{m_2}{m_1} = \frac{64}{27}$

$\Rightarrow \left(\frac{r_2}{r_1}\right)^3 = \frac{64}{27} \Rightarrow \frac{r_2}{r_1} = \frac{4}{3}$

15. Answer (3)

Hint & Sol.: de Broglie wavelength, $\lambda = \frac{h}{P}$

Since momentum of the given particles are same, therefore $\lambda_\alpha = \lambda_p = \lambda_e$

16. Answer (2)

Hint: In reverse biased diode act as open circuit.

Sol.: For any half cycle, at least one diode will be open circuit therefore

$i_R = 0$; $V_{\text{out}} = 0$

17. Answer (1)

Hint: Reverse biased diode act as open circuit.

Sol.: $R_{\text{eq}} = 5 + 5 = 10\ \Omega$

18. Answer (2)

Hint: Frequency of light depends only on source.

Sol.: Frequency of light does not change when light travel from one medium to another medium.

19. Answer (3)

Hint: $\theta_c = \sin^{-1}\left(\frac{1}{\mu}\right)$

Sol.: $v = \frac{x}{t}$

$\mu = \frac{c}{v} = \frac{c}{\frac{x}{t}} = \frac{ct}{x}$

Then $\theta_c = \sin^{-1}\left(\frac{1}{\mu}\right)$

$\theta_c = \sin^{-1}\left(\frac{x}{ct}\right)$

20. Answer (4)

Hint: Use lens maker formula

Sol.: $\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$\frac{1}{30} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$-\frac{1}{60} = \left(\frac{\mu}{2} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

$-\frac{60}{30} = \frac{2(\mu - 1)}{\mu - 2}$

$-(\mu - 2) = \mu - 1$

$\Rightarrow \; -\mu + 2 = \mu - 1$

$2\mu = 3$

$\mu = \frac{3}{2} = 1.5$

21. Answer (1)

Hint: Use $\mu = \frac{c}{v}$

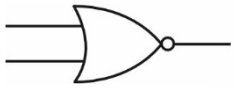
Sol.: $\mu = \frac{c}{v}$

$v = \frac{c}{\mu} = \frac{3 \times 10^8}{4} = 0.75 \times 10^8$

$v = 7.5 \times 10^7$ m/s

22. Answer (1)

Hint & Sol.: NOR gate is represented by



23. Answer (2)

Hint & Sol.: Photodiode is used to detect the optical signal.

24. Answer (4)

Hint: $K_{max} = h\nu - \phi$

Sol.: $(KE)_{max} = h\nu - h\nu_0$, $K_{max} = eV_s$

All the options are correct.

25. Answer (4)

Hint: $K_{max} = h\nu - \phi$

Sol.: $(K.E.)_{max1} = 2h\nu_0 - h\nu_0$

$(K.E.)_{max1} = h\nu_0$

$(K.E.)_{max2} = 3h\nu_0 - h\nu_0 = 2h\nu_0$

$(\Delta K.E.) = 2h\nu_0 - h\nu_0 = h\nu_0$

% change = 100%

26. Answer (1)

Hint: $I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$

and $I_{min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2$

Sol.: $\frac{I_{max}}{I_{min}} = \frac{\left(\sqrt{I_1} + \sqrt{I_2}\right)^2}{\left(\sqrt{I_1} - \sqrt{I_2}\right)^2} = \frac{\left(\sqrt{25I} + \sqrt{9I}\right)^2}{\left(\sqrt{25I} - \sqrt{9I}\right)^2}$

$= \frac{(8)^2 I}{(2)^2 I} = \frac{64}{4} = 16$

27. Answer (1)

Hint & Sol.: Density of any nucleus remains constant.

28. Answer (4)

Hint: Uncharged particle does not show deflection.

Sol.: γ ray is E.M. wave and hence does not have charge, therefore γ ray does not deflect in electric or magnetic field.

29. Answer (3)

Hint: KE = –TE

Sol.: Kinetic energy of electron in 3rd orbit = $\frac{E}{9}$

Then total energy = $-\frac{E}{9}$

30. Answer (2)

Hint: Use $\Delta\phi = k\Delta x$

Sol.: $2I_0 = 4I_0 \cos^2\left(\frac{\phi}{2}\right)$

$\frac{1}{\sqrt{2}} = \cos\left(\frac{\phi}{2}\right)$

$\phi = \frac{\pi}{2}$

$\frac{2\pi}{\lambda}\Delta x = \frac{\pi}{2} \; \Rightarrow \; \Delta x = \frac{\lambda}{4}$

31. Answer (1)

Hint: Maximum magnifying power is obtained when image is formed at near point.

Sol.: $|M_{max}| = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right)$

$= \frac{100}{5}\left(1 + \frac{5}{25}\right)$

$= 20\left(1 + \frac{1}{5}\right)$

$= 20 \times \frac{6}{5}$

= 24

32. Answer (1)

Hint: In *P*-*N* junction diode, *P*-side should be at higher potential in forward biased condition.

Sol.: Diode in diagram (A) is forward biased.

33. Answer (4)

Hint: Use mass-energy equivalence relation

Sol.: $E = mc^2$

$= 5 \times (3 \times 10^8)^2$

$= 5 \times 9 \times 10^{16}$

$= 45 \times 10^{16}$ J

$= 4.5 \times 10^{17}$ J

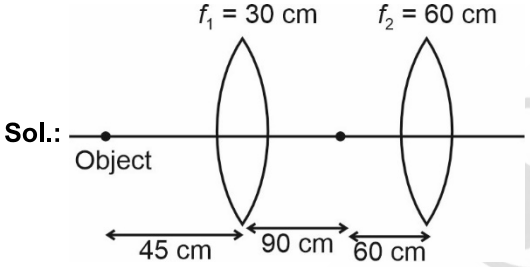
34. Answer (3)

Hint & Sol.: 1 amu = 1.66×10^{-27} kg

35. Answer (2)

Hint: For the given condition, image of 1st lens is formed on the 1st focus of second lens

Sol.:



$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} + \frac{1}{45} = \frac{1}{30}$$

$$\frac{1}{v} = \frac{1}{30} - \frac{1}{45}$$

v = 90 cm

Image of first lens should form on the focus of 2nd, therefore distance between the two lenses = 150 cm

SECTION-B

36. Answer (1)

Hint: Isotones have same number of neutrons.

Sol.: Atoms having same number of neutrons but different number of protons are called isotones.

37. Answer (2)

Hint: In nuclear reactions reactant and product have same net *A* and *Z* value.

Sol.: For *X*

A = 8

Z = 17

Therefore, it is oxygen of mass 17.

38. Answer (3)

Hint: Nucleus with greater binding energy per nucleons are more stable.

Sol.: $9E_A > 10E_B$

Stability of a nuclei is determined by binding energy per nucleon.

39. Answer (1)

Hint & Sol.: Change in atomic number

$= -3(2) + 5(1)$

$= -1$

40. Answer (3)

Hint: $\overline{A \cdot B} = \overline{A} + \overline{B}$

Sol.:

A	B	$\overline{A \cdot B}$
0	0	1
0	1	1
1	0	1
1	1	0

41. Answer (2)

Hint: $\frac{1}{F_{eq}} = \frac{1}{f_1} + \frac{1}{f_2}$

Sol.: Combination will behave like a glass slab therefore, $f = \infty$

42. Answer (4)

Hint: At polarising angle, reflected and refracted light are perpendicular to each other.

Sol.: $\tan\theta_P = \mu$

$\Rightarrow \tan 60^\circ = \mu$

$\Rightarrow \mu = 1.73$

43. Answer (3)

Hint: $K_{max} = h\nu - \phi$ $h \rightarrow$ slope of curve

Sol.: Slope will be same for all the curves.

44. Answer (3)

Hint: Use Einstein's equation.

Sol.: As per the graph

$V_3 > V_2$

and $(\text{current})_3 = (\text{current})_1$

$f_3 > f_2$ and $I_3 = I_1$

45. Answer (4)

Hint & Sol.: • Concave lens in denser medium $\rightarrow$ Converging lens

• Convex lens in denser medium $\rightarrow$ Diverging lens

• Concave mirror and convex mirror act as converging and diverging mirrors respectively, irrespective of the medium.

46. Answer (1)

Hint: $eV = h\nu - \phi$

Sol.: $eV = h\nu - h\nu_0$ ...(i)

$eV' = 3h\nu - hV_0$ ...(ii)

$\therefore \quad V' > 3V$

47. Answer (3)

Hint: $\lambda = \frac{hc}{E}$

Sol.: $\lambda = \frac{hc}{E} = \frac{6.63\times10^{-34}\times3\times10^{8}}{5\times1.6\times10^{-19}}$

$= 2.48 \times 10^{-7}$ m

$= 2.48 \times 10^{-5}$ cm

48. Answer (2)

Hint & Sol.: In depletion layer, charge carriers are absent.

49. Answer (2)

Hint & Sol.: Angular momentum of electron $= \frac{h}{2\pi}$

50. Answer (3)

Hint: When light is falling normally on plane surface then it retraces its path.

Sol.: $\mu_1 \sin i = \mu_2 \sin r$

$\sin 45^\circ = \mu \sin 30^\circ$

$$\mu = \frac{\sin 45^\circ}{\sin 30^\circ} = \frac{\frac{1}{\sqrt{2}}}{\frac{1}{2}} = \sqrt{2}$$

$\mu = \sqrt{2}$

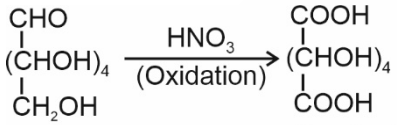
[CHEMISTRY]

SECTION-A

51. Answer (4)

Hint: Glucose is a reducing sugar.

Sol.:

- Glucose is a reducing sugar hence reduces Tollens' reagent
- 

Saccharic acid

52. Answer (2)

Hint: Histidine is an essential amino acid.

Sol.: Histidine and methionine are essential amino acids.

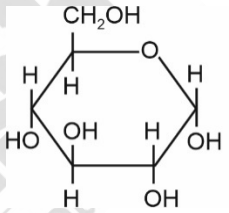
53. Answer (1)

Hint: Negative electron gain enthalpy of oxygen is low because the added electron suffers electronic repulsion due to small size of oxygen atom.

Sol.:

Element	$\Delta_{eg}H$(kJ mol^{-1})
O	–141
S	–200
Se	–195
Te	–190
Po	–174

54. Answer (1)

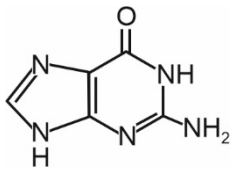
Hint: 

α – D – (+) – glucose

Sol.: α – D – (+) – glucose contains five chiral centres.

55. Answer (1)

Hint: Purine bases are bicyclic compounds

Sol.: •


Guanine is a purine base.

- Cytosine, Thymine and Uracil are pyrimidine bases.

56. Answer (1)

Hint & Sol : Thyroxine is produced in the thyroid gland and it is an iodinated derivative of amino acid tyrosine.

57. Answer (3)

Hint: Leat nitrate on decomposition gives NO_2 as one of the products

Sol.: $2Pb(NO_3)_2 \xrightarrow{673\ K} 4NO_2 + 2PbO + O_2$

58. Answer (2)

Hint: Platinum gauge is used as catalyst in Ostwald's process.

Sol.:

Process		Catalyst
Contact process	$\rightarrow$	V_2O_5
Deacon's process	$\rightarrow$	$CuCl_2$
Haber's process	$\rightarrow$	Iron oxide
Ostwald's process	$\rightarrow$	Pt

59. Answer (4)

Hint: Chlorine is acting as an oxidising agent.

Sol.: $I_2 + 6H_2O + 5Cl_2 \longrightarrow 2HIO_3 + 10HCl$

60. Answer (4)

Hint: XeO_3 is pyramidal in shape

Sol.: $XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$

61. Answer (4)

Hint: $PCl_5(s)$ exists as $[PCl_4]^+[PCl_6]^-$

Sol.: $[PCl_6]^-$ is octahedral in shape having sp^3d^2 hybridisation.

62. Answer (2)

Hint: Brown ring test depends on the ability of Fe^{2+} to reduce nitrates to nitric oxide

Sol.: $NO_3^- + 3Fe^{2+} + 4H^+ \longrightarrow NO + 3Fe^{3+} + 2H_2O$

$$\left[Fe(H_2O)_6\right]^{2+} + NO \longrightarrow \underset{\text{Brown}}{[Fe(H_2O)_5(NO)]^{2+}} + H_2O$$

63. Answer (1)

Hint: $P_4 + 3NaOH + 3H_2O \rightarrow PH_3 + 3NaH_2PO_2$

Sol.: The solution of PH_3 in water decomposes in presence of light giving red phosphorus and H_2 gas.

64. Answer (3)

Hint & Sol: $4Zn + 10HNO_3(\text{dilute}) \rightarrow 4Zn(NO_3)_2 + 5H_2O + N_2O$

65. Answer (4)

Hint: The amino acid which does not contain chrial centre is optically inactive.

Sol.: Glycine is optically inactive amino acid.

66. Answer (3)

Hint.: B group vitamins are soluble in water.

Sol.:

- Vitamin B_1, pyridoxine (vitamin B_6), Vitamin C, riboflavin (vitamin B_2) are water soluble.
- Vitamin A, D, E and K are fat soluble vitamin.

67. Answer (1)

Hint: In sucrose reducing groups of glucose and fructose are involved in glycosidic bond formation.

Sol.: Since the reducing groups of glucose and fructose are involved in glycosidic bond formation, sucrose is a non-reducing sugar.

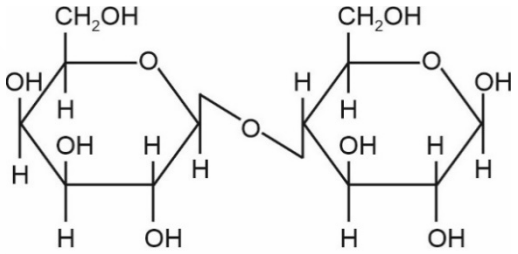
68. Answer (4)

Hint & Sol: CO is a colourless, odourless and almost water insoluble gas.

69. Answer (1)

Hint: Lactose is composed of 2 different monosaccharides.

Sol.:



β-D-Galactose β-D-Glucose

Lactose

70. Answer (4)

Hint: 1° structure remains unaltered during denaturation of proteins.

Sol.: Proteins loses its biological activity after denaturation.

71. Answer (1)

Hint: α-D-(+)-Glucopyranose and β-D-(+)-Glucopyranose differ only in the configuration at C1.

Sol.: α-form and β-form are anomers.

72. Answer (3)

Hint: Equal number of amino and carboxyl groups makes the amino acid neutral.

Sol.: Lysine is a basic amino acid having two amino groups and one carboxyl groups.

73. Answer (2)

Hint: When glucose reacts with Br_2 water, aldehydic group oxidises to carboxylic group.

Sol.:

Gluconic acid

74. Answer (3)

Hint: d-and f-electrons have low screening effect

Sol.: The observed discontinuity in the ionisation enthalpy values between Al and Ga and between In and Tl are due to inability of d-and f-electrons, which have low screening effect, to compensate the increase in nuclear charge.

Element	IE (kJ mol^{-1})
Al	577
Ga	579
In	558
Tl	589

75. Answer (2)

Hint: $Fe_2O_3.xH_2O(s)$ is a brown solid.

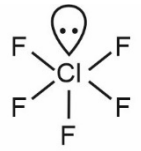
Sol.:

Species	Colour
$[Ag(NH_3)_2]Cl$ (aq)	Colourless
$[Cu(NH_3)_4]^{2+}$ (aq)	Deep blue
$Fe_2O_3 \cdot xH_2O$ (s)	Brown solid
$Zn(OH)_2$ (s)	White solid

76. Answer (2)

Hint: ClF_5 has 5σ bonds and one lone pair

Sol.:



Square pyramidal

77. Answer (2)

Hint: Hot concentrated sulphuric acid is a moderately strong oxidising agent.

Sol.:

$$C + \overset{+6}{2H_2SO_4}(conc.) \longrightarrow CO_2 + \overset{+4}{2SO_2} + 2H_2O$$

78. Answer (4)

Hint: Amphoteric oxides are those which show characteristics of both acid as well as base

Sol.: Al_2O_3 is an amphoteric oxide and SO_2, Cl_2O_7 and N_2O_5 are acidic oxides.

79. Answer (1)

Hint: Bleaching action of chlorine is due to oxidation.

Sol.: $Cl_2 + H_2O \longrightarrow 2HCl + O$

Coloured substance + O $\rightarrow$ Colourless substance

80. Answer (3)

Hint: Orthophosphorous acid on heating gives orthophosphoric acid as one of the products.

Sol.: $4H_3PO_3 \rightarrow 3H_3PO_4 + PH_3$

81. Answer (3)

Hint: Higher oxidation states for the group 14 elements are less stable for the higher members of the group due to inert pair effect.

Sol.: Pb^{4+} compounds are stronger oxidising agents than Sn^{4+} compounds as Pb^{4+} undergoes reduction to Pb^{2+} more easily.

82. Answer (4)

Hint: In graphite, electrons are delocalised over the whole sheet.

Sol.: Each carbon atom in graphite undergoes sp^2 hybridisation and makes three sigma bonds with three neighbouring C atoms and 4th electron forms a π bond.

83. Answer (3)

Hint: The basic structural unit of silicates is SiO_4^{4-}.

Sol.: ZSM-5, used to convert alcohols directly in gasoline.

84. Answer (1)

Hint: Oxidation state of phosphorus remains same before and after hydrolysis.

Sol.: $PCl_3 + 3H_2O \longrightarrow H_3PO_3 + 3HCl$

85. Answer (2)

Hint: In Ostwald's process, NO formed combines with O_2 to give NO_2 which is dissolved in water to give HNO_3.

Sol.: $4NH_3(g) + 5O_2(g) \xrightarrow[500\,K,\ 9\,bar]{Pt/Rh\ gauge\ catalyst} 4NO(g) + 6H_2O(g)$

$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

$3NO_2(g) + H_2O(\ell) \longrightarrow 2HNO_3(aq) + NO(g)$

SECTION - B

86. Answer (4)

Hint: PbS is called galena

Sol.:

Ore	Formula
Cryolite	Na_3AlF_6
Gypsum	$CaSO_4 \cdot 2H_2O$
Epsom Salt	$MgSO_4 \cdot 7H_2O$

87. Answer (2)

Hint: Because of larger size of iodine, bond dissociation enthalpy of I_2 is minimum.

Sol.:

Halogens	Bond dissociation enthalpy (kJ mol^{-1})
F_2	158.8
Cl_2	242.6
Br_2	192.8
I_2	151.1

88. Answer (4)

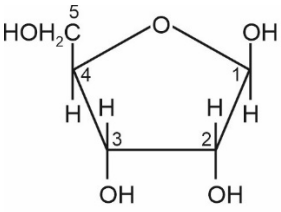
Hint: Pernicious anaemia is RBC deficiency in haemoglobin.

Sol.: Deficiency of vitamin B_{12} causes pernicious anaemia.

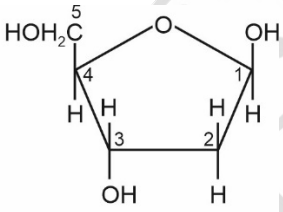
89. Answer (3)

Hint: In DNA molecule, the sugar moiety is β-D-2-deoxyribose whereas in RNA, it is β-D-ribose.

Sol.:



β-D-ribose



β-D-2-deoxyribose

The two molecules differ at C-2 position.

90. Answer (4)

Hint: $[B_4O_5(OH)_4]^{2-}$ is the tetranuclear unit of borax ($Na_2B_4O_7 \cdot 10H_2O$)

Sol.: Because of the large size of chloride ions, Si^{4+} can not accommodate six chloride ions.

91. Answer (3)

Hint & Sol: When nucleoside is linked to phosphoric acid at 5′ – position of sugar moiety we get a nucleotide.

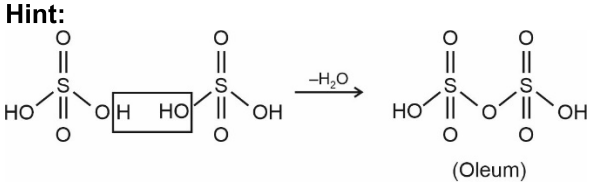
92. Answer (3)

Hint: Urea on reaction with water gives ammonia.

Sol.: $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + 4H_2O + Cr_2O_3$

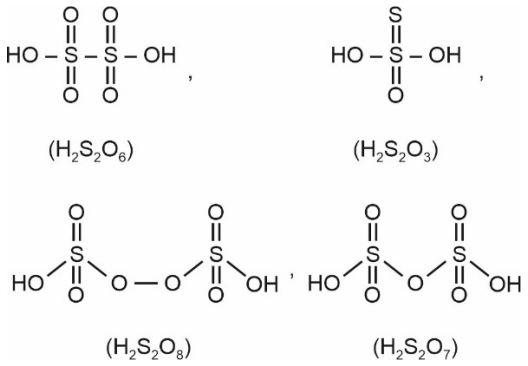
93. Answer (2)

Hint:



(Oleum)

Sol.:



$(H_2S_2O_6)$ $(H_2S_2O_3)$ $(H_2S_2O_8)$ $(H_2S_2O_7)$

94. Answer (1)

Hint: On going down the group electronegativity of central atom decreases.

Sol.:

Hydrides of group 15	HEH angle (°)
NH_3	107.8
PH_3	93.6
AsH_3	91.8
SbH_3	91.3

95. Answer (3)

Hint: Aqua regia on reaction with Pt gives $[PtCl_6]^{2-}$ species

Sol.: $3Pt + 16H^+ + 4NO_3^- + 18Cl^- \rightarrow$

$$3PtCl_6^{2-} + 4NO + 8H_2O$$

96. Answer (3)

Hint: N_2O is laughing gas

Sol.:

Formula	Name
$COCl_2$	Phosgene
CCl_3NO_2	Tear gas
$ClCH_2CH_2SCH_2CH_2Cl$	Mustard gas
N_2O	Laughing gas

97. Answer (4)

Hint: XeF_4 undergoes disproportionation reaction on hydrolysis

Sol.: $6XeF_4 + 12H_2O \rightarrow$

$$4Xe + 2XeO_3 + 24HF + 3O_2$$

98. Answer (3)

Hint: In DNA, Cytosine forms hydrogen bonds with guanine.

Sol.: In DNA, adenine forms hydrogen bonds with thymine.

99. Answer (3)

Hint: Myosin is an example of fibrous protein

Sol.:

- Keratin and myosin are fibrous proteins
- Insulin and albumin are globular proteins

100. Answer (3)

Hint: Amylopectin is insoluble in water and constitutes about 80-85% of starch

Sol.: Amylopectin is a branched chain polymer of α-D-glucose units in which chain is formed by C1-C4 glycosidic linkage whereas branching occurs at C1-C6 glycosidic linkage.

[BOTANY]

SECTION-A

101. Answer (4)

Hint: Population attributes are features of a group of individuals.

Sol.: Natality, mortality and sex ratio are population attributes while birth is an attribute of an organism.

102. Answer (3)

Hint: Natality is the number of births during a period in the population that are added to the initial density.

Sol.: The population density of a given habitat during a given period fluctuates due to changes in four basic processes. Natality and immigration contribute to an increase and mortality and emigration contribute to a decrease in population density.

103. Answer (3)

Hint: In the polar seas, aquatic mammals like seals have a thick layer of fat (blubber) below their skin that acts as an insulator and reduces loss of body heat.

Sol.: Desert plants like *Opuntia,* have no leaves, they are reduced to spines.

- Desert lizards lack the physiological ability, thus manage to keep their body temperature fairly constant by behavioural means.
- Kangaroo rat has the ability to concentrate its urine so that minimal volume of water is used to remove the excretory products.

104. Answer (4)

Hint: Man-made or anthropogenic ecosystems are created and maintained by human beings.

Sol.: Forest, grassland and desert are natural ecosystems while crop fields are man-made or anthropogenic ecosystems.

105. Answer (3)

Hint: Humus is highly resistant to microbial action, its degradation by some microbes is mineralisation.

Sol.: Humification leads to accumulation of a dark coloured amorphous substance called humus.

106. Answer (1)

Hint: All successions whether taking place in water or on land, proceed to a similar community – the mesic.

Sol.:

- The species that invade a bare area are called pioneer species.

107. Answer (1)

Hint: India has 1000 varieties of mango.

Sol.: India has more than 50,000 genetically different strains of rice.

108. Answer (1)

Hint: The direct economic benefits from nature are categorised under narrowly utilitarian ecosystem services.

Sol.: Fibre, food and firewood are direct economic benefits from nature while oxygen and pollination are broadly utilitarian ecosystem services.

109. Answer (3)

Hint: Keystone species drive major ecosystem functions.

Sol.: Endemic species are the species confined to a particular region and not found anywhere else.

Endangered species are those which are facing the threat of extinction in near future.

110. Answer (1)

Hint: International Union for Conservation of Nature and Natural Resources (IUCN) is now called World Conservation Union (WCU).

Sol.: The Red Data Book or Red List is maintained by World Conservation Union (WCU)

- UNEP is United Nations Environment Programme.
- MAB is Man and Biosphere Programme.
- WWF is World Wide Fund for Nature.

111. Answer (3)

Hint: Secondary productivity is defined as the rate of formation of new organic matter by consumers

Sol.: Each trophic level has a certain mass of living material at a particular time is called standing crop.

Standing state or quality is the amount of all the inorganic substances present in an ecosystem.

112. Answer (3)

Hint & Sol.: Of the incident solar radiation less than 50 percent of it is photosynthetically active radiation (PAR).

Plants capture only 2-10 percent of the PAR.

113. Answer (1)

Hint: Despite occupying about 70 percent of the surface, the productivity of the oceans is only 55 billion tons.

Sol.: The annual net primary productivity of the whole biosphere is approximately 170 billion tons (dry weight) of organic matter.

114. Answer (4)

Hint: Primary productivity depends on a variety of environmental factors, such as availability of nutrients and photosynthetic capacity of plants.

Sol.: Primary productivity is rate of biomass production by plants. It depends on the plant species inhabiting a particular area but does not depend on the animals inhabiting that area.

115. Answer (3)

Hint: Hibernation is shown by bears to escape in time during winter and some snails and fish go into aestivation to avoid summer-related problems.

Sol.: Under unfavourable conditions, many zooplankton species in lakes and ponds are known to enter diapause, a stage of suspended development.

116. Answer (4)

Hint: Terms euryhaline and stenohaline are used with reference to tolerance of organisms towards salinities.

Sol.: A few organisms can tolerate and thrive in a wide range of temperatures, they are called eurythermal. But a vast majority of them are restricted to a narrow range of temperatures, they are called stenothermal.

117. Answer (3)

Hint: Expanding population is young or growing population.

Sol.: In expanding population, pre-reproductive individuals are more than reproductive individuals and post-reproductive individuals are proportionately fewer than reproductive individuals.

Such a population shows positive growth.

It is represented by an upright triangular age pyramid.

118. Answer (1)

Hint: Logistic growth of a population is described by equation $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$ and is represented by S-shaped curve.

Sol.: Exponential growth of a population occurs when resources are unlimited.

It is described by the equation $\frac{dN}{dt} = rN$ and represented by a J-shaped curve.

119. Answer (3)

Hint: In brood parasitism, parasitic bird lays its eggs in the nest of its host and let the host incubates them.

Sol.: Cuckoo laying its eggs in the nest of crow is an example of brood parasitism.

Lice on humans, ticks on dogs and *Cuscuta* growing on hedge plants are examples of ectoparasitism.

120. Answer (4)

Hint: Logistic growth describes a situation in which resource and space are limited.

Sol.: In logistic growth curve influence of environmental resistance over biotic potential is denoted by $\left(\frac{K-N}{K}\right)$. The integral form of exponential growth equation in $N_t = N_0 e^{rt}$.

121. Answer (3)

Hint: Prey species have evolved various defenses to minimise or challenge the impact of predation.

Sol.: Monarch butterfly is highly distasteful and therefore avoided by its predator. Endoparasites live inside the host body at different sites and their life cycle is more complex.

122. Answer (2)

Hint: Under normal conditions, births and deaths are two important factors influencing population density.

Sol.: If a new habitat is just being colonised, immigration may contribute more significantly to population growth than birth rates.

123. Answer (4)

Hint: Population size measurement can also be carried out indirectly without actually counting the organisms, this is called indirect count e.g., tiger census is based on pug marks and faecal pellets.

Sol.: Population age at any given time is composed of individuals of different ages. Urn shaped age pyramid has smaller number of pre-reproductive individuals followed by a large number of reproductive individuals. As there are fewer individuals in pre-reproductive group, the population size will decline with time. Such population shows negative growth.

124. Answer (4)

Hint: Mutualism – species A species B
(+) (+)

In mutualism, both species get benefited from each other.

Sol.: Red billed Ox-pecker and yellow billed Ox-pecker sit on the back of black rhinoceros and feed on the ticks.

The birds also warn the rhinoceros of approaching danger. Both the partners are benefitted and both can live separately. Lichens represent an intimate mutualistic relationship between algae and fungi.

125. Answer (2)

Hint: Total number of hotspots of biodiversity in the world till date is 34.

Sol.: Initially, 25 hotspots of biodiversity have been identified throughout the world.

India has three of these hotspots.

126. Answer (1)

Hint: Decline in plant productivity is the result of loss of biodiversity.

Sol.: Loss of biodiversity in a region may lead to reduced resistance to environmental perturbations and increase in variability of ecosystem processes.

127. Answer (3)

Hint: Species diversity increases during the process of ecological succession.

Sol.: During ecological succession, niche of an organism becomes specialised and there is increase in humus content of soil.

128. Answer (4)

Hint: Succession that occurs on rock is called lithosere. Xerosere/Xerarch succession takes place in dry areas.

Sol.: Succession in water is called hydrosere/hydrarch. Succession in saline conditions is called halosere.

129. Answer (1)

Hint: Decomposition is the breakdown of complex organic matter to inorganic raw materials.

Sol.: Temperature and soil moisture are the most important climatic factors that regulate decomposition through their effects on the activities of soil microbes.

130. Answer (1)

Hint: Producers are autotrophs, they convert solar energy into chemical energy.

Sol.: Primary consumers are key industry animals because they convert plant matter into animal matter.

131. Answer (4)

Hint: Anthropogenic ecosystem is created and maintained by human beings.

Sol.: Anthropogenic ecosystem have little diversity and possess simple food chain.

132. Answer (3)

Hint: The Earth Summit was the historic convention on biological diversity.

Sol.: India now has 14 biosphere reserves, 90 national parks and 448 wildlife sanctuaries.

Western ghats and Sri Lanka, Indo-Burma and Himalayas are the three hotspots of India.

133. Answer (4)

Hint: Western ghat regions of Karnataka and Maharashtra, and Aravalli hills of Rajasthan are sacred groves of India.

Sol.: Sarguja, Chanda and Bastar areas of Madhya Pradesh and Khasi and Jaintia hills in Meghalaya are examples of sacred groves.

134. Answer (2)

Hint: Out of the total quantity of global carbon, we find 71 percent carbon is found dissolved in the oceans.

Sol.: Carbon constitutes 49 percent of the dry weight of organisms in the body of living organisms.

135. Answer (4)

Hint: Sparrow can feed on seeds as well as insects.

Sol.: Sparrow can occupy a primary consumer level (when feeds on seeds) or secondary consumer level (when feeds on insects) in food chain.

SECTION-B

136. Answer (3)

Hint: Nile perch, an alien species killed and eliminated ecologically unique assemblage of over 200 species of cichlid fish that were endemic to fresh water aquatic system.

Sol.: Many species got extinct in the last 500 years (Dodo, Steller's sea cow, passenger pigeon) due to over-exploitation by humans.

137. Answer (4)

Hint: According to IUCN Red list (2004), 338 vertebrate species got extinct.

Sol.: IUCN red list (2004) documents the extinction of 784 species in last 500 years.

138. Answer (2)

Hint: Lichens are the pioneer community in xerarch succession. This accelerates the process of soil formation.

Sol.: The successional series progress from xeric to mesic conditions is

Lichens $\rightarrow$ Bryophytes $\rightarrow$ Grasses $\rightarrow$ Higher plants $\rightarrow$ Forest

139. Answer (1)

Hint: Darwin found that fourteen species of finches co-exist in Galapagos island due to development of different feeding habits.

Sol.: Gause's competitive exclusion states that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eventually eliminated. MacArthur showed that five closely related species of warblers avoid competition by changing foraging pattern. Connell's experiment showed that on the rocky coasts of Scotland, the larger *Balanus* dominates the intertidal area.

140. Answer (3)

Hint: Hunting and poaching is not permitted in sanctuary as well as in national park.

Sol.: In wildlife sanctuaries collection of forest products, harvesting of timber, tilling of land are allowed.

141. Answer (4)

Hint: Alexander von Humboldt gave species-area relationship curve while Paul Ehrlich used Rivet popper hypothesis.

Sol.: Edward Wilson popularised the term biodiversity and David Tilman performed long term ecosystem experiments using outdoor plots.

142. Answer (1)

Hint: In *ex-situ* conservation, threatened animals and plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care.

Sol.: Wildlife safari parks and seed banks are *ex-situ* conservation methods while biosphere reserves, national parks and sacred groves are *in-situ* conservation methods.

143. Answer (2)

Hint: It is a diversity shown by a single species at the genetic level over its distributional range.

Sol.: Genetic diversity is exemplified by the medicinal plant *Rauwolfia vomitoria* growing in different Himalayan ranges.

Species diversity is the diversity at the species level.

Ecological diversity is the diversity at the ecosystem level.

144. Answer (3)

Hint: Phosphorus cycle is a sedimentary cycle.

Atmospheric inputs of phosphorus through rainfall are much smaller than carbon inputs.

Sol.: Gaseous exchanges of phosphorus between organism and environment are negligible.

Unlike carbon cycle, there is no respiratory release of phosphorus into atmosphere.

145. Answer (1)

Hint: Pyramid of energy is always upright in all ecosystems.

Sol.: Pyramid of energy in a sea is always upright. Pyramid of number in a tree ecosystem can be inverted or spindle-shaped but never upright because the number of producer is represented by one tree supporting more than one consumer.

146. Answer (1)

Hint: Decomposition is largely an oxygen-requiring process.

Sol.: The rate of decomposition is controlled by chemical composition of detritus and climatic factors.

Decomposition rate is slower if detritus is rich in lignin and chitin, and quicker, if detritus is rich in nitrogen and water-soluble substances like sugars.

Warm and moist environment favour decomposition whereas low temperature and anaerobiosis inhibit decomposition.

147. Answer (2)

Hint: Identification and enumeration of plant and animal species of an ecosystem gives its species composition.

Sol.: Vertical distribution of different species occupying different levels is called stratification.

Food chain is a sequence of living organisms which involves transfer of food energy from producers, through a series of organisms with repeated eating and being eaten.

Natural interconnection of food chains makes it a food web.

148. Answer (4)

Hint: Parasitic mode of nutrition ensures free lodging and meals.

Sol.: Parasites have high reproductive capacity.

They show loss of unnecessary sense organs, presence of adhesive organs and loss of digestive system.

149. Answer (4)

Hint: Commensalism is the interaction in which one species is benefitted and the other is neither harmed nor benefitted.

Sol.: In the interaction between sea anemone and hermit crab both the species are benefitted, (+, +). It is protocooperation.

An orchid growing on a mango branch, barnacles growing on the back of a whale and the cattle egret and grazing cattle, exemplify commensalism.

150. Answer (3)

Hint: In commensalism and amensalism at least one partner species remains unaffected.

Sol.: In amensalism one species is harmed (–) and other remains unaffected (0).

- Competition → Species A(–) and species B (–)
- Commensalism → Species A(+) and species B (0)
- Mutualism → Species A(+) and species B (+)

[ZOOLOGY]

SECTION-A

151. Answer (1)

Hint: A widely used diagnostic test for AIDS

Sol.: ELISA is based on the principle of antigen-antibody interaction. Infections by pathogen can be detected by the presence of antigens (protein, glycoproteins, *etc.*), or by detecting the antibodies synthesised against the pathogen.

152. Answer (1)

Hint: Exclude the institute where 'Saheli' was developed.

Sol.: The Indian Government has set up organisations such as GEAC (Genetic Engineering Approval Committee), which will make decisions regarding the validity of GM research and the safety of introducing GM-organisms for public services. The European Federation of Biotechnology has given a definition of biotechnology. Central Drug Research Institute prepared 'Saheli', a non-steroidal pill.

US Patent and trademark office gave patent rights on Basmati Rice in 1997.

153. Answer (3)

Hint: Same genus causes typhoid fever

Sol.: The construction of the first rDNA emerged from the possibility of linking a gene encoding antibiotic resistance with a native plasmid of *Salmonella typhimurium*.

Salmonella typhi causes typhoid fever.

Streptococcus pneumoniae and *Haemophilus influenzae* are causative agents of pneumonia.

154. Answer (4)

Hint: Belong to the class nucleases

Sol.: The cutting of DNA at specific locations became possible with the discovery of the so called 'molecular scissors'–restriction enzymes.

Taq polymerase is an example of thermostable DNA polymerase that synthesises a new strand of DNA complementary to an existing DNA template in 5' to 3' direction.

155. Answer (4)

Hint: GM organism

Sol.: There are three basic steps in genetically modifying an organism:

(i) Identification of DNA with desirable genes

(ii) Introduction of the identified DNA into the host

(iii) Maintenance of introduced DNA in the host and transfer of the DNA to its progeny

156. Answer (2)

Hint: *Eco*RI has been isolated from *Escherichia coli*

Sol.: The convention for naming restriction enzymes is that the first letter of the name comes from the genus and the second two letters come from the species of the prokaryotic cell from which they were isolated, *e.g., Eco*RI comes from *Escherichia coli* RY13. In *Eco*RI, the letter 'R' is derived from the name of the strain. Roman numbers following the name indicate the order in which enzymes were isolated from that strain of bacteria.

157. Answer (3)

Hint: Between purines

Sol.: *Eco*RI cuts the DNA between bases G and A only when the sequence 5′GAATTC3′ is present in the DNA.

158. Answer (1)

Hint: Cuts within the DNA

Sol.: Endonucleases make cuts at specific positions within the DNA. Each restriction endonuclease functions by inspecting the length of a DNA sequence. Once it finds its specific recognition sequence, it will bind to the DNA and cut each of the two strands of the double helix at specific points in their sugar-phosphate backbones.

159. Answer (1)

Hint: Involves the use of agarose gel

Sol.: The cutting of DNA by restriction endonucleases results in the fragments of DNA. These fragments can be separated by a technique known as gel electrophoresis. Since DNA fragments are negatively charged molecules, they can be separated by forcing them to move towards the anode under an electric field through a medium/matrix.

160. Answer (4)

Hint: Digests DNA

Sol.: Fungal cell wall is made up of chitin, thus chitinase is used. The RNA can be removed by treatment with ribonuclease whereas proteins can be removed by treatment with protease.

161. Answer (1)

Hint: Insulin isolated from pigs develops allergies.

Sol.: The recombinant DNA technological processes have made an immense impact in the area of healthcare by enabling mass production of safe and more effective therapeutic drugs. Further, the recombinant therapeutics do not induce unwanted immunological responses as is common in case of similar products isolated from non-human sources. At present, about 30 recombinant therapeutics have been approved for human-use the world over. In India, 12 of these are presently being marketed.

162. Answer (3)

Hint: Equal to the number of pairs of cranial nerves in man

Sol.: At present, about 30 recombinant therapeutics have been approved for human use the world over. In India, 12 of these are presently being marketed.

163. Answer (2)

Hint: Exclude immortal cells

Sol.: In some children, ADA deficiency can be cured by bone marrow transplantation; in others it can be treated by enzyme replacement therapy, in which functional ADA is given to the patient by injection. But the problem with both of these approaches are that they are not completely curative. As a first step towards gene therapy, lymphocytes from the blood of the patient are grown in a culture outside the body. A functional ADA cDNA (using a retroviral vector) is then introduced into these lymphocytes, which are subsequently returned to the patient. However, as these cells are not immortal, the patient requires periodic infusion of such genetically engineered lymphocytes. However, if the gene isolated from marrow cells producing ADA is introduced into cells at early embryonic stages, it could be a permanent cure.

164. Answer (2)

Hint: Retrovirus mediated transformation

Sol.: Microinjection – rDNA is directly injected into the nucleus of an animal cell

Gene gun (biolistic) – Suitable for plants

165. Answer (3)

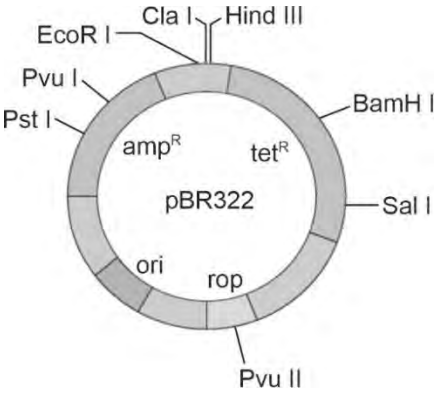
Hint: Selectable marker

Sol.: In order to link the alien DNA, the vector needs to have very few, preferably single, recognition site for the commonly used restriction enzymes. Presence of more than one recognition sites within the vector will complicate the gene cloning. *rop* codes for the proteins involved in the replication of plasmid.

166. Answer (1)

Hint: Gene that controls copy number does not have any restriction site.

Sol.:



167. Answer (2)

Hint: 2^n

Sol.: 2^n number of fragments are formed after 'n' number of PCR cycles.

$\therefore 2^6 = 64$ DNA fragments

168. Answer (3)

Hint: *Pvu* I restriction site is present in amp^R gene.

Sol.: If a foreign gene is inserted at the *Pvu* I site of vector pBR322 followed by its insertion in a host cell, then the recombinants will be amp^S and tet^R and non-recombinants will be amp^R and tet^R.

169. Answer (3)

Hint: Exclude downstream processing

Sol.: Recombinant DNA technology involves several steps in specific sequence such as isolation of DNA, fragmentation of DNA by restriction endonucleases, isolation of a desired DNA fragment, ligation of the DNA fragment into a vector, transferring the recombinant DNA into the host, culturing the host cells in a medium at large scale and extraction of the desired product.

170. Answer (2)

Hint: Probe is used in autoradiography.

Sol.: During isolation of genetic material, DNA can be spooled out after the addition of chilled ethanol. DNA can be seen as collection of fine threads in the suspension.

The separated bands of DNA are cut out from the agarose gel and extracted from the gel piece by the process called elution.

171. Answer (3)

Hint: DNA cannot cross the cell membrane.

Sol.: The genetic material of humans is DNA. DNA is negatively charged as well as hydrophilic molecule. Thus, DNA cannot pass through cell membranes.

172. Answer (1)

Hint: Less than 30 documented varieties of Basmati rice are grown in India.

Sol.: Rice is an important food grain in India. There are an estimated 200,000 varieties of rice and 27 documented varieties of Basmati are grown in India.

173. Answer (4)

Hint: *Agrobacterium*

Sol.: Using *Agrobacterium* vectors, nematode-specific genes were introduced into the host plant. *Agrobacterium tumefaciens*, a pathogen of several dicot plants, is able to deliver a piece of DNA known as T-DNA to transform normal plant cells into tumor cells to produce the chemicals required by the pathogen. Retrovirus possesses RNA genome.

174. Answer (3)

Hint: Kills armyworm

Sol.: *Bt* toxin is produced by a bacterium called *Bacillus thuringiensis. Bt* toxin gene has been cloned from the bacteria and been expressed in plants to provide resistance to insects without the need for insecticides; in effect created a bio-pesticide.

175. Answer (1)

Hint: Transgenic plants have reduced post-harvest losses.

Sol.: GM plants have been useful in many ways. Genetic modification has :

(i) Made crops more tolerant to abiotic stresses (cold, drought, salt, heat)

(ii) Reduced reliance on chemical pesticides (pest-resistance crops)

(iii) Helped to reduce post-harvest losses

(iv) Increased efficiency of mineral usage by plants (this prevents early exhaustion of fertility of soil)

(v) Enhanced nutritional value of food, *e.g.*, golden rice, *i.e.*, Vitamin 'A' enriched rice

176. Answer (1)

Hint: Bioreactors are also known as fermenters.

Sol.: Bioreactors, also known as fermenters are chambers in which microorganisms are cultured in a liquid/ solid medium. To produce the desired product in large quantities, bioreactors were developed where large volumes (100 – 1000L) of culture can be processed.

Bioreactors are vessels in which raw materials are biologically converted into specific products, individual enzymes, *etc.,* using microbial plant, animal or human cells.

177. Answer (3)

Hint: *Bt* toxin kills insects by creating pores into the cell membrane.

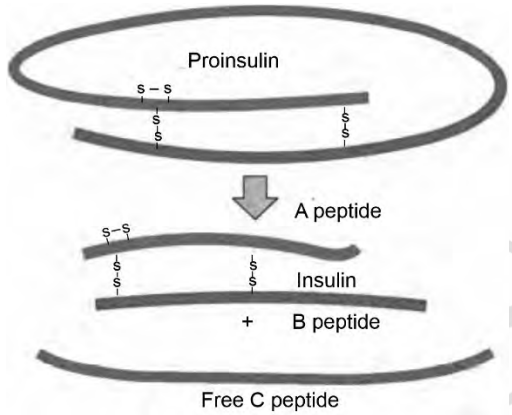
Sol.: The *Bt* toxin protein exists as inactive protoxins but once an insect ingests the inactive toxin, it is converted into an active form of toxin due to the alkaline pH of the gut which solubilises the crystals.

The activated toxin binds to the surface of midgut epithelial cells and create pores that cause cell swelling and lysis and eventually cause death of the insect.

178. Answer (2)

Hint: Proinsulin

Sol.:



179. Answer (2)

Hint: Selectable marker helps to eliminate non-transformants.

Sol.:

Origin of replication (*ori*)	–	Controls the copy number
Selectable marker	–	Antibiotic-resistance gene
Ti – plasmid	–	*Agrobacterium tumefaciens*
Disarmed Retrovirus	–	Used for animal host

180. Answer (2)

Hint: DNA is negatively charged

Sol.: DNA fragments are negatively charged molecules and they can be separated by forcing them to move towards the anode under an electric field through a medium/matrix. Nowadays, the most commonly used matrix is agarose which is a natural polymer extracted from sea weeds. The DNA fragments separate (resolve) according to their size through the sieving effect provided by the agarose gel. Hence, the smaller the fragment size, the farther it moves.

181. Answer (1)

Hint: Exclude the category to which mosquitoes belong to

Sol.: Some strains of *Bacillus thuringiensis* produce proteins that kill certain insects such as lepidopterans (tobacco budworm, armyworm), coleopterans (beetles) and dipterans (flies, mosquitoes)

182. Answer (4)

Hint: Exclude the modern methods of disease diagnosis

Sol.: Using conventional methods of diagnosis (serum and urine analysis, *etc.*) early detection is not possible. Recombinant DNA technology, Polymerase Chain Reaction (PCR) and Enzyme-Linked Immuno-sorbent Assay (ELISA) are some of the techniques that serve the purpose of early diagnosis.

183. Answer (4)

Hint: Have genetic material similar to HIV

Sol.: RNAi takes place in all eukaryotic organisms as a method of cellular defense. This method involves silencing of a specific mRNA due to a complementary dsRNA molecule that binds to and prevents translation of the mRNA (silencing). The source of this complementary RNA could be from an infection by viruses having RNA genomes or mobile genetic elements (transposons) that replicate *via* an RNA intermediate.

184. Answer (4)

Hint: 1997

Sol.: In 1997, the first transgenic cow, Rosie produced human protein-enriched milk (2.4 grams per litre).

The first clinical gene therapy was given to a four year-old girl with ADA deficiency in 1990.

In 1983, Eli Lilly, an American company prepared two DNA sequences corresponding to A and B chains of human insulin and introduced them in plasmids of *E.coli* to produce insulin chains.

185. Answer (3)

Hint: Includes autoimmune disorder

Sol.: Many transgenic animals are designed to increase our understanding of how genes contribute to the development of disease. These are specially made to serve as models for human diseases so that investigation of new treatments for diseases is made possible. Today transgenic models exist for many human diseases such as cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's disease.

SECTION - B

186. Answer (4)

Hint: Bioprocess engineering

Sol.: Among many, the two core techniques that enabled birth of modern biotechnology are :

(i) **Genetic engineering** *:* Techniques to alter the chemistry of genetic material (DNA and RNA), to introduce these into host organisms and thus change the phenotype of the host organism.

(ii) **Bioprocess engineering :** Maintenance of sterile (microbial contamination-free) ambience in chemical engineering processes to enable growth of only the desired microbe/eukaryotic cell in large quantities for the manufacture of biotechnological products like antibiotics, vaccines, enzymes, *etc*.

187. Answer (1)

Hint: Equal to the number of parietal bones in man

Sol.: The Indian Parliament has recently cleared the second amendment of the Indian Patents Bill, that takes such issues into consideration including the patent terms, emergency provisions and research and development initiative.

188. Answer (3)

Hint: Does not carry any vital gene necessary for the cell

Sol.: Plasmid is a circular, double-stranded extra-chromosomal DNA. It does not carry any vital gene necessary for the cell. It can replicate independently of the main genome.

189. Answer (1)

Hint: Number of bacteria is less than number of restriction enzymes

Sol.: Besides *Hin*d II, today we know more than 900 restriction enzymes that have been isolated from over 230 strains of bacteria each of which recognize different recognition sequences.

190. Answer (3)

Hint: β-galactosidase is present within *lac Z* gene

Sol.: If a recombinant DNA is inserted within the coding sequence of an enzyme, β-galactosidase, then this results into inactivation of the gene for synthesis of this enzyme, which is referred to as insertional inactivation. The presence of a chromogenic substrate gives blue coloured colonies if the plasmid in the bacteria does not have an insert. Presence of insert results into insertional inactivation of the β-galactosidase gene and the colonies do not produce any colour. These are identified as recombinant colonies.

191. Answer (4)

Hint: Partly increased due to use of improved varieties.

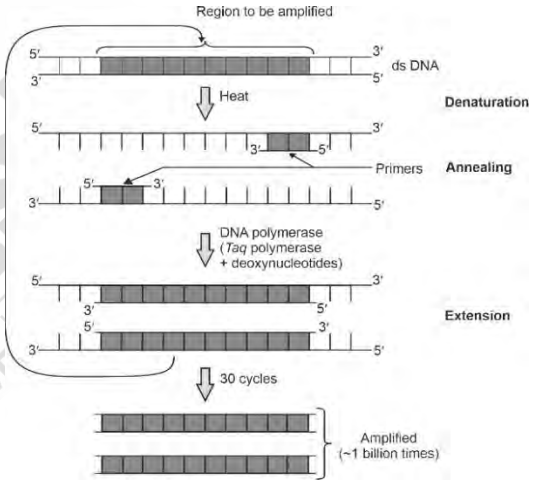
Sol.: The green revolution succeeded in tripling the food supply but yet it was not enough to feed the growing human population.

Increased yield of crops is mainly due to the use of better management practices and use of agrochemicals.

192. Answer (2)

Hint: Takes place at temperature of about 50°C – 60°C

Sol.:



193. Answer (3)

Hint: Emphysema

Sol.: Transgenic animals that produce useful biological products can be created by the introduction of the portion of DNA (or genes) which codes for a particular product such as human protein (α-1-antitrypsin) used to treat emphysema.

The milk produced by Rosie, contained the human α-lactalbumin and was nutritionally a more balanced product for human babies than natural cow milk.

194. Answer (2)

Hint: Lepidopteran

Sol.: The proteins encoded by the genes *crylAc* and *crylIAb* control cotton bollworms that of *crylAb* controls corn borer.

195. Answer (4)

Hint: Temperature less than that required during annealing

Sol.: In order to force bacteria to take up the plasmid, the bacterial cells must first be made 'competent' to take up DNA. This is done by treating them with a specific concentration of a divalent cation, such as Ca^{++}, which increases the efficiency with which DNA enters the bacterium through pores in its cell wall. Recombinant DNA can then be forced into such cells by incubating the cells with recombinant DNA on ice, followed by placing them briefly at 42ºC (heat shock), and then putting them back on ice. This enables the bacteria to take up the recombinant DNA.

196. Answer (4)

Hint: Equal to the total number of ear ossicles in man

Sol.: *Hin*d II always cuts DNA molecules at a particular point by recognising a specific sequence of six base pairs. This specific base sequence is known as the recognition sequence for *Hin*d II.

197. Answer (2)

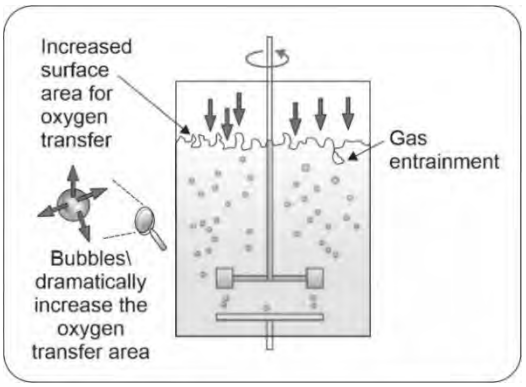
Hint: Included under upstream processing

Sol.: After completion of the biosynthetic stage, the product has to be subjected through a series of processes before it is ready for marketing as a finished product. The processes include separation and purification, which are collectively referred to as downstream processing. The product has to be formulated with suitable preservatives. Such formulation has to undergo thorough clinical trials as in case of drugs. Strict quality control testing for each product is also required. The downstream processing and quality control testing vary from product to product.

198. Answer (4)

Hint: Gas entrainment

Sol.:



199. Answer (4)

Hint: Physiologically most active phase

Sol.: In continuous culture system, the used medium is drained out from one side while fresh medium is added from the other to maintain the cells in their physiologically most active log/exponential phase. This type of culturing method produces a larger biomass leading to higher yields of desired protein.

200. Answer (4)

Hint: 95% of all existing transgenic animals are mice.

Sol.: Transgenic mice are being used to test the safety of the polio vaccine.

Transgenic animals are made that carry genes which make them more sensitive to toxic substances than non-transgenic animals.

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