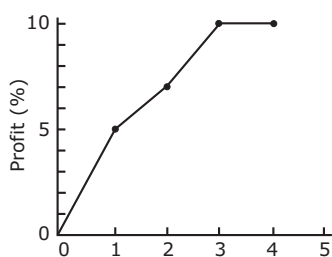


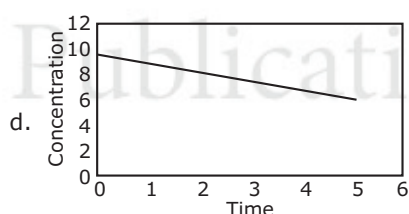
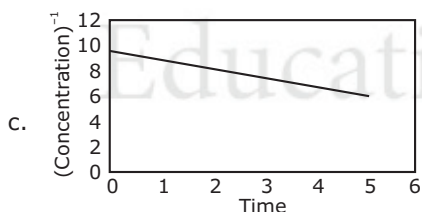
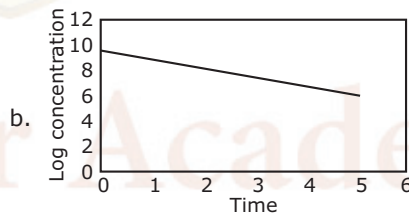
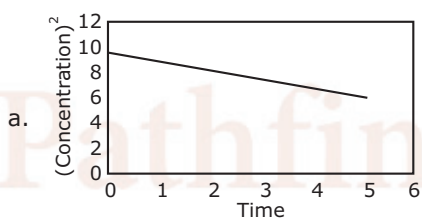
# Life Sciences : June 2011

## Part – A

001. The cumulative profits of a company since its inception are shown in the diagram. If the net worth of the company at the end of 4<sup>th</sup> year is 99 crores, the principal it had started with was



- a. 9.9 crores  
b. 91 crores  
c. 90 crores  
d. 9.0 crores
002. Popular use of which of the following fertilizers increases the acidity of soil?  
a. Potassium nitrate  
b. Ammonium sulphate  
c. Urea  
d. Superphosphate of lime
003. Exposing an organism to a certain chemical can change nucleotide bases in a gene, causing mutation. In one such mutated organism if a protein had only 70% of the primary amino acid sequence, which of the following is likely?  
a. Mutation broke the protein.  
b. The organism could not make amino acids.  
c. Mutation created a terminator codon.  
d. The gene was not transcribed.
004. A reference material is required to be prepared with 4 ppm calcium. The amount of  $\text{CaCO}_3$  (molecular weight = 100) required to prepare 1000 g of such a reference material is  
a. 10  $\mu\text{g}$   
b. 4  $\mu\text{g}$   
c. 4 mg  
d. 10 mg
005. Identify the figure which depicts a first order reaction.



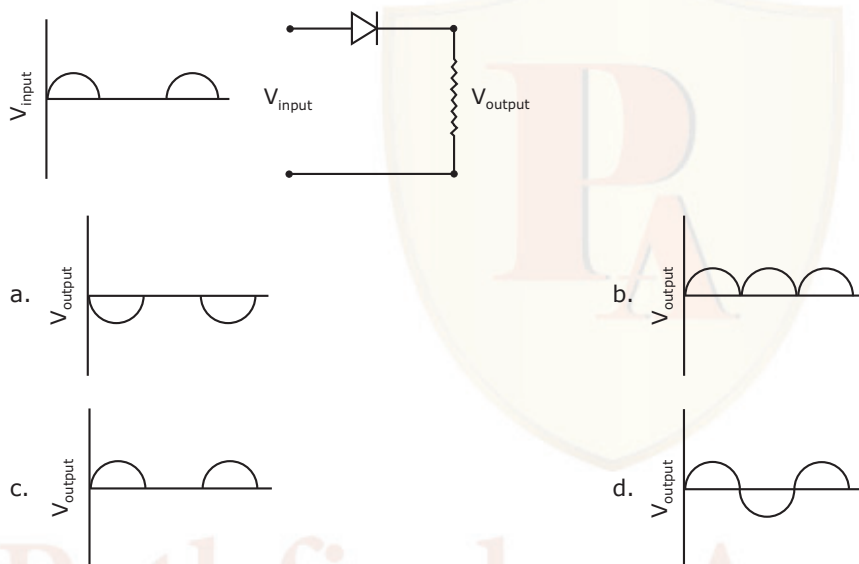
006. If the atmospheric concentration of carbon dioxide is doubled and there are favourable conditions of water, nutrients, light and temperature, what would happen to water requirement of plants?  
a. It decreases initially for a short time and then returns to the original value.  
b. It increases.  
c. It decreases.  
d. It increases initially for a short time and then returns to the original value.

007. The speed of a car increases every minute as shown in the following table. The speed at the end of the 19<sup>th</sup> minute would be

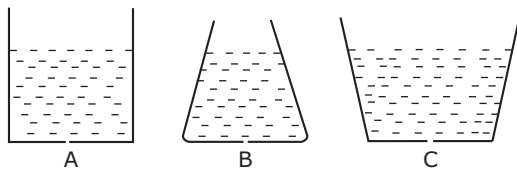
Time (minutes)	Speed (m/sec)
1	1.5
2	3.0
3	4.5
.	.
.	.
24	36.0
25	37.5

- a. 26.5  
b. 28.0  
c. 27.0  
d. 28.5

008. If  $V_{\text{input}}$  is applied to the circuit shown, the output would be

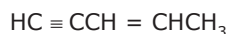


009. A physiological disorder X always leads to the disorder Y. However, disorder Y may occur by itself. A population shows 4% incidence of disorder Y. Which of the following inferences is valid?
- a. 4% of the population suffers from both X and Y.  
b. Less than 4% of the population suffers from X.  
c. At least 4% of the population suffers from X.  
d. There is no incidence of X in the given population.
010. Water is dripping out of a tiny hole at the bottom of three flasks whose base diameter is the same, and are initially filled to the same height, as shown. Which is the *correct* comparison of the rate of fall of the volume of water in the three flasks?



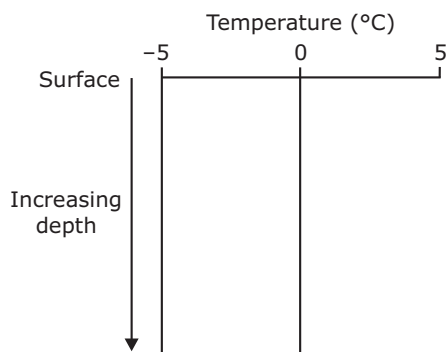
- a. A fastest, B slowest  
b. B fastest, A slowest  
c. B fastest, C slowest  
d. C fastest, B slowest

011. How many  $\sigma$  bonds are present in the following molecule?



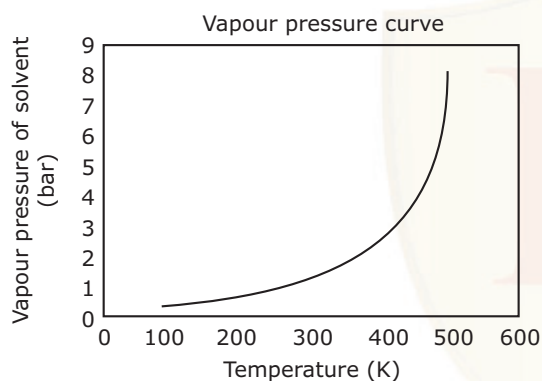
- a. 4  
b. 10  
c. 6  
d. 13

012. The graph represents the depth profile of temperature in the open ocean; in which region this is likely to be prevalent?



- Tropical region
- Equatorial region
- Polar region
- Sub-tropical region

013. The normal boiling point of a solvent (whose vapour pressure curve is shown in the figure) on a planet whose normal atmospheric pressure is 3 bar, is about



- 400 K
- 273 K
- 100 K
- 500 K

014. Diabetic patients are advised a low glycaemic index diet. The reason for this is

- they require less carbohydrate than healthy individuals.
- they cannot assimilate ordinary carbohydrates.
- they need to have slow, but sustained release of glucose in their blood stream.
- they tolerate lower, but not higher than normal blood sugar levels.

015. Glucose molecules diffuse across a cell of diameter  $d$  in time  $\tau$ . If the cell diameter is tripled, the diffusion time would

- increase to  $9\tau$
- decrease to  $\tau/3$
- increase to  $3\tau$
- decrease to  $\tau/9$

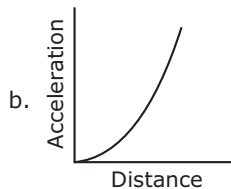
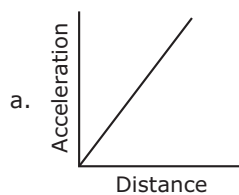
016. The reason for the hardness of diamond is

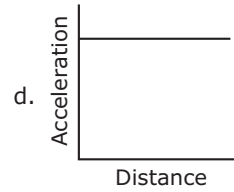
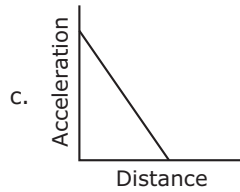
- extended covalent bonding
- layered structure
- formation of cage structures
- formation of tubular structures

017. Which of the following particles has the largest range in a given medium if their initial energies are the same?

- Alpha
- Gamma
- Positron
- Electron

018. A ball is dropped from a height  $h$  above the surface of the earth. Ignoring air drag, the curve that best represents its variation of acceleration is





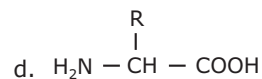
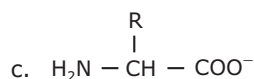
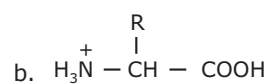
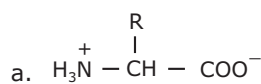
019. Standing on a polished stone floor one feels colder than on a rough floor of the same stone. This is because
- thermal conductivity of the stone depends on the surface smoothness.
  - specific heat of the stone changes by polishing it.
  - the temperature of the polished floor is lower than that of the rough floor.
  - there is greater heat loss from the soles of the feet when in contact with the polished floor than with the rough floor.
020. The acidity of normal rainwater is due to
- SO<sub>2</sub>
  - CO<sub>2</sub>
  - NO<sub>2</sub>
  - NO

### Unit 1 | Part – B

021. The area of allowed regions in the Ramachandran map will be least for
- Gly
  - L-Ala
  - L-Pro
  - α-methyl L-valine
022. Small RNAs with internally complementary sequences that form hairpin-like structure, synthesized as precursor RNAs and cleaved by endonucleases to form short duplexes are called
- snRNA
  - mRNA
  - tRNA
  - miRNA
023. The free energy ΔG of a dissolved solute
- increases with solute concentration
  - decreases with solute concentration
  - is independent of solute concentration
  - depends only on temperature

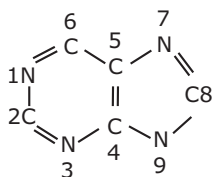
### Unit 1 | Part – C

024. A protein in 100 mM KCl solution was heated and the observed T<sub>m</sub> (midpoint of unfolding) was 60°C. When the same protein solution in 500 mM KCl was heated, the observed T<sub>m</sub> was 65°C. What is the most probable reason for this increase in T<sub>m</sub>?
- Hydrogen-bonding is increased.
  - Hydrophobic interaction is decreased and electrostatic repulsion is increased.
  - Hydrophobic interaction is increased and electrostatic repulsion is decreased.
  - van der Waals interaction is increased.
025. An amino acid contains no ionizable group in its side chain (R). It is titrated from pH 0 to 14. Which of the following ionizable state is *not* observed during the entire titration in the pH range 0–14?



026. An  $\alpha$ -helix in a peptide or protein is characterized by hydrogen bonds and characteristic dihedral angles. Choose the right combination.
- Hydrogen bonding between the amide CO of residue  $i$  and amide NH of residue  $i + 4$ . Dihedral angles in the region  $\phi \sim -50^\circ$ ,  $\psi \sim -60^\circ$ .
  - Hydrogen bonding between the amide NH of residue  $i$  and amide CO of residue  $i + 4$ . Dihedral angles in the region of  $\phi \sim -50^\circ$ ,  $\psi \sim -60^\circ$ .
  - Hydrogen bonding between the amide CO of residue  $i$  and amide NH of residue  $i + 4$ . Dihedral angles in the region of  $\phi \sim -50^\circ$ ,  $\psi \sim +60^\circ$ .
  - Hydrogen bonding between the amide CO of residue  $i$  and amide NH of residue  $i + 3$ . Dihedral angles in the region of  $\phi \sim -50^\circ$ ,  $\psi \sim -60^\circ$ .

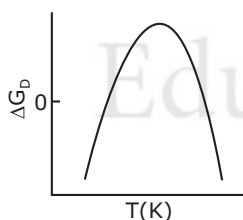
027. Precursors of the atoms in the purine skeleton are



- N1, Asp; C2 and C8, formate; N3 and N9, guanidine of Arg; C4, C5 and N7, Gly; C6, CO<sub>2</sub>.
  - N1, Asp; C2 and C8, citrate; N3 and N9, amide nitrogen of Gln; C4, C5 and N7; Gly; C6, CO<sub>2</sub>.
  - N1, Asp; C2 and C8, formate; N3 and N9, amide nitrogen of Gln, C4, C5 and N7, Gly; C6, CO<sub>2</sub>.
  - N1, Glu; C and C8, acetate; N3 and N9, amide nitrogen of Asn; C4, C5 and N7, Gly; C6, CO<sub>2</sub>.
028. Values of  $T_m$  (midpoint of denaturation),  $\Delta H_m$  (enthalpy change at  $T_m$ ) and  $\Delta C_p$  (constant-pressure heat capacity change) of a protein are measured in a differential scanning calorimeter.  $\Delta G_D(T)$ , the Gibbs free energy change at any temperature  $T(K)$  can be estimated using the following form of the Gibbs-Helmholtz equation with the values obtained from these measurements:

$$\Delta G_D(T) = \Delta H_m \left( \frac{T_m - T}{T_m} \right) - \Delta C_p [T_m - T + T \ln(T / T_m)]$$

The stability curve for the protein simulated using the observed thermodynamic values is given below. The shape of the stability curve is due to



- hydrogen-bonding and electrostatic interactions only
- van der Waals and electrostatic interactions only
- only electrostatic interactions
- only hydrophobic interaction

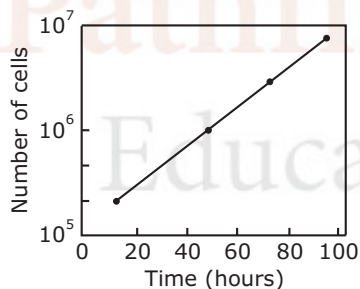
## Unit 2 | Part – B

029. Transport of water across aquaporins is regulated by the presence of which of the following sequence of three highly conserved amino acids?
- Ala-Asn-Pro
  - Pro-Asn-Ala
  - Asn-Pro-Ala
  - Pro-Ala-Asn
030. Polar bears maintain their body temperature because they have more of
- transducin protein
  - uncoupling protein
  - myoglobin protein
  - F<sub>0</sub>F<sub>1</sub> ATPase

031. Which of the cyclins have/has essential functions in S-phase of cell cycle?
- A-type
  - B-type
  - D-type
  - Both B- and D-type
032.  $\text{Na}^+ - \text{K}^+$  ATPase is a tetramer of  $2\alpha$  and  $2\beta$  subunits. On which of the following subunits are the  $\text{Na}^+$  and  $\text{K}^+$  binding sites present?
- Both on  $\alpha$
  - Both on  $\beta$
  - $\text{Na}^+$  on  $\alpha$  and  $\text{K}^+$  on  $\beta$
  - $\text{Na}^+$  on  $\beta$  and  $\text{K}^+$  on  $\alpha$
033. Both halophytes and glycophytes compartmentalize cytotoxic ions into the intracellular compartment or actively pump them out of the cell to the apoplasts with the help of membrane transport proteins. Among these, the  $\text{Na}^+ - \text{H}^+$  antiporter, NHX1, is localized in the
- plasma membrane
  - chloroplast (inner envelope)
  - mitochondria (outer membrane)
  - tonoplast

### Unit 2 | Part – C

034. Budding yeast cells that are deficient for Mad2, a component of the spindle-attachment-check point, are killed by treatment with benomyl, which causes microtubules to depolymerise. In the absence of benomyl, however, the cells are perfectly viable. Which explanation out of the following is able to justify this observation?
- In the absence of benomyl, the majority of spindles form normally and the spindle-attachment checkpoint (Mad2) plays no role.
  - In the presence of benomyl, the majority of spindles form normally and Mad2 plays critical role in cell survival.
  - Other than the role in cell survival, microtubule depolymerization affects oxidative phosphorylation in the absence of Mad2.
  - Benomyl also affects protein synthesis in the absence of Mad2.
035. The overall length of the cell cycle can be measured from the doubling time of a population of exponentially proliferating cells. The doubling time of a population of mouse L cells was determined by counting the number of cells in samples of culture at various times. What is the overall length of the cell cycle in mouse L cells?



- 30 h
  - 20 h
  - 10 h
  - 40 h
036. During receptor-mediated endocytosis, apolipo-protein B on the surface of a LDL particle binds to the LDL-receptor present in coated pits containing clathrin. The receptor-LDL complex is internalized by endocytosis, trafficked to lysosomes and the LDL-receptor is finally recycled. A patient reports with familial hypercholesterolemia. This could be due to
- mutation in the LDL molecule.
  - defect in LDL-receptor recycling.
  - mutation in the LDL-receptor.
  - defect in cholesterol binding with its receptor.
037. Eukaryotic genomes are organized into chromosomes and can be visualized at mitosis by staining with specific dyes. Heat denaturation followed by staining with Giemsa produced alternate dark and light bands. The dark bands obtained by this process are mainly
- AT-rich and gene rich regions.
  - AT-rich and gene desert regions.
  - GC-rich and gene rich regions.
  - GC-rich and gene desert regions.

038. In eukaryotic chromatin, 30 nm fiber (solenoid) can open up to give rise to two kinds of chromatin. In one type (A), the promoter of a gene within the open chromatin is occupied by a nucleosome whereas in the other (B), the promoter is occupied by histone H1.

The following possibilities are suggested.

- P. The gene in (A) is repressed  
 Q. The gene in (B) is repressed  
 R. The gene in (A) is active  
 S. The gene in (B) is active

Which of the following sets is *correct*?

- a. P and S  
 b. P and Q  
 c. Q and S  
 d. R and S

### Unit 3 | Part – B

039. The 5' cap of RNA is required for the  
 a. stability of RNA only  
 b. stability and transport of RNA  
 c. transport of RNA only  
 d. methylation of RNA
040. A culture of an *E. coli* strain that is lysogenic for phage lambda is grown at 32°C. Induction of the prophage from the host chromosome will occur when the culture is exposed to  
 a. 40°C  
 b. ultraviolet radiation  
 c. infrared radiation  
 d. wild type *E. coli* culture
041. The fidelity of replicative base selection can be reduced by a factor of  $10^2$  when the repair of DNA synthesis involves  
 a. AP endonuclease  
 b. ABC excinuclease  
 c. DNA photolyase  
 d. TLS DNA polymerase
042. What is the minimum number of NTPs required for the formation of one peptide bond during protein synthesis?  
 a. One  
 b. Two  
 c. Four  
 d. Six

### Unit 3 | Part – C

043. Lac repressor inhibits expression of genes in *lac*-operon whereas purine biosynthesis is repressed by the Pur repressor. The two proteins have 31% identical sequences and have similar three-dimensional structures. The gene regulatory properties of these proteins differ in relation to  
 P. binding of small molecules to the repressor.  
 Q. presence of recognition sites on the genome.  
 R. oligomeric nature of the repressor.  
 S. DNA binding property.
- The *correct* statements are  
 a. P and Q  
 b. P, Q and R  
 c. P and R  
 d. Q, R and S
044. Two *E. coli* cultures A and B are taken. Culture A was earlier grown in the presence of optimum concentration of gratuitous inducer IPTG. Both the cultures are now used to inoculate fresh medium containing sub-optimal concentration of gratuitous inducer. It was observed that culture B was unable to utilize lactose, whereas culture A did so efficiently. The reason behind this is  
 a. pretreatment with IPTG has resulted in a mutation as a result of which *lac* operon is constitutively expressed.  
 b. IPTG has made the cell membrane more porous to small molecules and so lactose is taken up more efficiently by A as compared to B.  
 c. in culture A, lactose permease was induced to a high level, during pretreatment with IPTG, which allowed the preferential uptake of lactose.  
 d. in culture A, IPTG activated a receptor which bound lactose more efficiently, thereby triggering a signal.





051.  $T_H2$  response is generated and maintained mainly by which of the following pair of cytokines?
- IL - 4 and IL - 10
  - IL - 12 and IFN -  $\gamma$
  - IFN -  $\gamma$  and TNF -  $\alpha$
  - IL - 2 and IL - 12
052. Which of the following molecules is involved in  $Ca^{2+}$ -dependent cell-cell adhesion?
- Calmodulin
  - Cadherin
  - N-CAM
  - Calpain
053. With which protein of *Yersinia* would integrin proteins of mammalian cells interact for internalization?
- Pilin
  - Fimbrin
  - Invasin
  - Adherin

#### Unit 4 | Part – C

054. Mouse bone marrow cells were fractionated to derive stem cell antigen-1<sup>+</sup> (Sca-1<sup>+</sup>) cells. These cells were cultured with interleukin-3, or granulocyte-macrophage colony stimulating factor, or macrophage-colony stimulating factor, or granulocyte colony stimulating factor. Most numerous and varied colonies were obtained in the culture stimulated with
- interleukin-3.
  - granulocyte-macrophage colony stimulating factor.
  - macrophage-colony stimulating factor.
  - granulocyte-colony stimulating factor.
055. Cancer causing genes can be functionally classified into mainly three types:
- genes that induce cellular proliferation
  - tumor suppressor genes
  - genes that regulate apoptotic pathway
- Epstein-Barr virus that causes cancer by modulating apoptotic pathway, contains a gene having sequence homology with which of the following genes?
- Bax
  - Bcl-2
  - p53
  - Caspase-3
056. Toll-like receptor 4 is associated with responsiveness to LPS, an endotoxin that causes lethal endotoxic shock. The mice deficient in Toll-like receptor 4 and BALB/c mice were injected with *Escherichia coli*. In addition, some BALB/b mice were also injected with the same bacteria alone or with anti-interleukin-10 (IL-10) antibody. The mice resistant to the lethal effect of the bacteria were
- BALB/b mice receiving the bacteria.
  - BALB/b mice receiving the bacteria and the anti-IL-10 antibody.
  - mice deficient in Toll-like receptor.
  - BALB/c mice receiving the bacteria.
057. Glucose is mobilized in muscle when epinephrine activates  $GS\alpha$ . In an experiment in which muscle cells were stimulated with epinephrine, glucose mobilization was observed even after withdrawal of epinephrine. This could be
- due to the presence of a cAMP phosphodiesterase inhibitor.
  - very low rates of cyclic AMP formation.
  - due to the presence of a cAMP phosphodiesterase activator.
  - due to the absence of protein kinase A.
058. Intracellular pathogens like *Mycobacteria*, *Salmonella*, *Leishmania* and *Listeria* survive in macrophages by modulating host cellular machinery. In order to study the fate of these intracellular pathogens in macrophages, cells were labelled with lysotracker Red and infected with GFP-labelled organisms. After 2 hours at 37°C, cells were fixed, stained with anti-transferrin receptor antibody and probed with secondary antibody conjugated-blue dyes. Cells were viewed under confocal microscope.

Observation: GFP-labelled *Mycobacteria*, *Salmonella* and *Listeria* were localized in the same compartment labelled with blue dyes, whereas GFP-*Leishmania* colocalize with red labelled compartment. Which of the following statement is *true* based on these observations?

- Mycobacteria*, *Salmonella* and *Listeria* reside in the lysosomes.
  - Leishmania* reside in lysosome like compartment.
  - Leishmania* reside in a compartment which bears characteristics of early endocytic compartment.
  - Mycobacteria*, *Salmonella* and *Listeria* lyse the phagosomal membrane and reside in cytosol.
059. Macrophages were collected from BALB/c mice, CD40-deficient mice, CD86-deficient mice and ICAM-1-deficient mice. These macrophages were co-cultured with LCMV peptide-specific T cells in presence of the LCMV peptide for three days. The cells were recovered and co-cultured with BALB/c-derived macrophages in presence of the peptide. During the last twelve hour of the co-culture,  $^3\text{H}$ -thymidine was added to the cultures. The cells were harvested and  $^3\text{H}$ -thymidine incorporation was assessed. The highest incorporation was observed in
- BALB/c macrophage-T cell co-culture.
  - CD40-deficient macrophage-T cell co-culture.
  - CD86-deficient macrophage-T cell co-culture.
  - ICAM-1-deficient macrophage-T cell co-culture.
060. A patient undergoes liver transplantation and during the course of post-operative treatment, becomes susceptible to infection. The patient can be treated in two different modes and can have alternative outcomes. Which of the following statement is *correct*?
- Treatment with immunostimulatory drugs reducing the infection but rejecting the transplant.
  - Treatment with immunostimulatory drugs reducing the infection and retaining the transplant.
  - Treatment with antibiotics reducing the infection but retaining the transplant.
  - Treatment with antibiotics reducing the infection but rejecting the transplant.
061. Based on the structural regions of a nuclear receptor shown in the diagram, the following predictions were made.



- Region F is responsible for binding to ligands and contains two zinc-finger-like binding motifs.
- Receptors with A/B domains generally associate with chaperones and do not bind to DNA.
- Region E indicate that receptors associate with chaperones which protect the nuclear hormone receptors.
- Region C contains the P-box and the D-box required for dimerization of the receptor and creates contact with DNA phosphate backbone.

Which one of the following is *true*?

- P and Q
  - Q and R
  - Q and S
  - R and S
062. Monoclonal antibodies (mAb) can be potentially used as therapeutic agents. The major advantage is that they can specifically target aberrant cells. However, there is a practical difficulty. Monoclonals are raised in mouse and therefore it is expected that an immune reaction will develop if these are injected into humans. It is therefore necessary to *humanize* monoclonal antibody by
- expressing the genes for the mAb in cultured human cells and isolating the mAb from these cells.
  - replacing the Fv region of a mAb with one derived from a human IgG.
  - replacing  $C_L$  and  $C_H$  regions of the mAb with that obtained from a human IgG.
  - taking a human IgG and replacing the CDRs by those derived from the mouse mAb.

**Unit 5 | Part – B**

063. Cytoplasmic determinants coding for anterior structure of *Drosophila* embryo, if injected elsewhere in the recipient embryo, would lead to
- normal development
  - formation of additional ectopic head
  - degeneration
  - a phenotype with two heads and two tails
064. In amphibian oocyte, the germplasm which gets segregated during cleavage to give rise to primordial germ cells (PGCs) is normally
- distributed evenly throughout the oocyte
  - localized at animal pole
  - localized at vegetal pole
  - aggregated in central part of oocyte
065. In mature *Arabidopsis* embryo, root apical meristem consists of cells derived from
- embryo and apical suspensor cell
  - embryo only
  - suspensor only
  - hypophysis only

**Unit 5 | Part – C**

066. cAMP signaling plays a very important role in the development and differentiation of *Dictyostelium discoideum*. This morphogen is synthesized by different adenylyl cyclases expressed at different stages of its life cycle. The following statements (P-S) refer to the effect of mutations in different adenylyl cyclase genes:
- P. *aca* deficient cells can be allowed to aggregate by exposing them to pulses of cAMP.
- Q. *acb* deficient cells would form normal fruiting bodies and the spores can germinate when exposed to favourable conditions.
- R. *acg* deficient cells develop normally and the spores germinate in the spore head itself.
- S. spores formed from the *acg* deficient cells will germinate irrespective of the osmotic conditions.
- Which of the above statements are *correct*?
- P and S
  - P only
  - P and Q
  - R and S
067. During early cleavage of *Caenorhabditis elegans* embryos, each asymmetrical division produces one founder cell which produces differentiated descendants and one stem cell. The very first cell division produces one anterior founder cell, namely AB and one posterior stem cell, namely P1. When these blastomeres are experimentally separated and allowed to proceed further with development, one could get the following possible outcomes:
- P1 cell would develop autonomously while the AB would show conditional development.
  - P1 cells would show conditional development while AB would show autonomous development.
  - both would show autonomous specification and result in mosaic development.
  - both would show conditional specification and result in regulative development.
068. Injection of *noggin* mRNA into a 1-cell, UV-irradiated embryos of frog completely rescues dorsal development and allows the formation of a complete embryo. Some of the following statements (P-S) could possibly explain this observation.
- P. Noggin is a secreted protein which induces dorsal ectoderm to form neural tissue and it dorsalizes the mesoderm cells which would otherwise contribute to ventral mesoderm.
- Q. Noggin binds directly to BMP4 and BMP2 thus preventing complex formation with their receptors.
- R. Noggin along with other molecules prevent BMP from binding to and inducing ectoderm and mesoderm cells near the organizer.
- S. Noggin is a secreted protein which induces the dorsal ectoderm to form the epidermis and it ventralizes the mesoderm cells which would otherwise contribute to dorsal mesoderm.

Which of the above statements are *correct*?

- a. P, Q and R  
 b. P and Q  
 c. Q and R  
 d. P and S

069. In case of sea urchin, which of the following is the *correct* sequence of events taking place during the interaction of sperm and egg?
- Chemoattraction of sperm to the egg by soluble molecules secreted by the egg → exocytosis of the sperm acrosomal vesicle to release its enzymes → binding of the sperm to the extracellular matrix of the egg → passage of sperm through this extracellular matrix → fusion of egg and sperm cell membranes.
  - Chemoattraction of sperm to the egg by soluble molecules secreted by the egg → binding of the sperm to the extracellular matrix of the egg → exocytosis of the sperm acrosomal vesicle to release its enzymes → passage of sperm through this extracellular matrix → fusion of egg and sperm cell membranes.
  - Chemoattraction of sperm to the egg by soluble molecules secreted by the egg → binding of the sperm to the extracellular matrix of the egg → passage of sperm through this extracellular matrix → exocytosis of the sperm acrosomal vesicle to release its enzymes → fusion of egg and sperm cell membranes.
  - Chemoattraction of sperm to the egg by soluble molecules secreted by the egg → passage of sperm through this extracellular matrix → binding of the sperm to the extracellular matrix of the egg → exocytosis of the sperm acrosomal vesicle to release its enzymes → fusion of egg and sperm cell membranes.
070. When a wrist blastema from a recently cut *Axolotl* forelimb is placed on a host hind limb cut at the mid thigh level, it will generate only a wrist. The host (whose own hind limb was removed) will fill the gap and regenerate the limb up to the wrist. However, if the donor blastema is treated with retinoic acid on grafting, the wrist blastema will regenerate a complete limb and will not allow the host to fill the gap. This happens because retinoic acid
- helps in the proximalization of the blastema and activates the Hox genes differentially across the blastema.
  - helps in the distalization of the blastema and activates the Hox genes differentially across the blastema.
  - helps block the receptors of FGF essential for limb development.
  - helps vigorous proliferation of the cells at the cut surface.

### Unit 6 | Part – B

071. The transition to flowering in plants requires
- growth of plants under long-day conditions.
  - growth of plants under short-day conditions.
  - reprogramming of the shoot apical meristem.
  - synthesis of the flowering hormone florigen.
072. The dwarf pea mutant (*le*) used by Mendel was defective in which of the following enzyme involved in gibberellin biosynthesis?
- ent-Kaurene synthase
  - GA 3 $\beta$ -hydroxylase
  - GA 20-oxidase
  - ent-Kaurenoic acid hydroxylase
073. Which of the following statements with respect to alternate oxidase activity in cyanide-resistant respiration in plants, is *not* correct?
- Alternate oxidase accepts electrons directly from cytochrome C.
  - Some plants exhibit thermogenesis during inflorescence development.
  - Transcription of alternate oxidase gene is often induced by various abiotic stresses.
  - When electrons pass to alternate oxidase, two sites of protein pumping are bypassed.

### Unit 6 | Part – C

074. Fill in the blanks (a, b, c and d) in the following statements with a proper combination of m, n o and p.

Wherein m represents - longer  
 n represents - shorter  
 o represents - prevents  
 p represents - induces

Short day (SD) plants flower when night lengths are a than a critical dark period. Interruption of the dark period by a brief light treatment b flowering in SD plants. Long day (LD) plants flower when night length is c than a critical period. Shortening of the night with a brief light treatment d flowering in LD plants.

- a. a-m, b-o, c-n, d-p  
 b. a-n, b-p, c-m, d-o  
 c. a-n, b-o, c-m, d-p  
 d. a-m, b-p, c-n, d-o

075. Mutations in Constans (CO) of *Arabidopsis thaliana* results in the flowering phenotype. Transcript levels of CO were determined in long day and short day seedlings. Which of the following would likely represent the transcript profile of CO?

	Long-day seedlings	Short-day seedlings
a.	—	—
b.	—	—
c.	—	—
d.	—	—

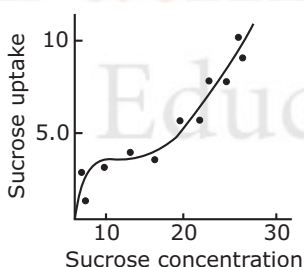
076. Following are some statements for synthesis of secondary metabolites in plants:

- P. terpenes are synthesized by shikimic acid pathway and mevalonic acid pathway.  
 Q. alkaloids are nitrogen containing compounds and are synthesized by shikimic acid pathway.  
 R. phenolic compounds are synthesized by shikimic acid pathway and mevalonic acid pathway.  
 S. both alkaloids and terpenes are synthesized by mevalonic acid pathway and MEP pathway.

Which one of the following combinations of the above statement is *true*?

- a. P and S  
 b. P and R  
 c. Q and R  
 d. Q and S

077. The dependence of the rate of sucrose uptake with respect to sucrose concentration in plant cell was studied and data is shown in the following graph.



From the above data it can be inferred that

- a. the sucrose uptake is energy independent and no special carrier is involved.  
 b. the sucrose uptake is energy dependent and a special carrier is involved.  
 c. at lower concentration of sucrose the uptake of sucrose is energy dependent and carrier mediated.  
 d. at higher concentration of sucrose the uptake is energy dependent and carrier mediated.

078. During episodes of anoxia in plants, pyruvate produced in glycolysis is initially fermented to lactate. During later stage, there is an increase in the fermentation to ethanol and decrease in the fermentation to lactate, a phenomena which helps plants survive anoxia. Which of the following statements is *correct* about this change of fermentation flux from lactate towards ethanol?

- a. The cytosolic pH increases, thus activating both lactate dehydrogenase and pyruvate decarboxylase activity.

- b. The cytosolic pH increases, thus inhibiting lactate dehydrogenase activity and activating pyruvate decarboxylase activity.
- c. The cytosolic pH decreases, thus activating both lactate dehydrogenase and pyruvate decarboxylase activity.
- d. The cytosolic pH decreases, thus inhibiting lactate dehydrogenase and activating pyruvate decarboxylase activity.

079. Atmospheric CO<sub>2</sub> contains the naturally occurring stable carbon isotopes <sup>12</sup>C and <sup>13</sup>C in the proportion of 98.9% and 1.1%, respectively. Following are some of the statements regarding CO<sub>2</sub> assimilation:

- P. Both C<sub>3</sub> and C<sub>4</sub> plants assimilate less <sup>13</sup>CO<sub>2</sub> than <sup>12</sup>CO<sub>2</sub>.
- Q. Both C<sub>3</sub> and C<sub>4</sub> plants assimilate less <sup>12</sup>CO<sub>2</sub> than <sup>13</sup>CO<sub>2</sub>.
- R. C<sub>3</sub> plants assimilate lesser <sup>13</sup>CO<sub>2</sub> than <sup>12</sup>CO<sub>2</sub> as compared to C<sub>4</sub> plants.
- S. C<sub>4</sub> plants assimilate lesser <sup>13</sup>CO<sub>2</sub> than <sup>12</sup>CO<sub>2</sub> as compared to C<sub>3</sub> plants.

Which one of the following combinations of above statements is *true*?

- a. P and Q
- b. P and R
- c. R and S
- d. P and S

### Unit 7 | Part – B

- 080. During urine formation, the filtration of blood at the glomerulus is
  - a. an active process
  - b. an osmotic process
  - c. a pressure-dependent physical process
  - d. a non energy-mediated transport process
- 081. If the core body temperature of a human rises above normal, which of the following processes would be initiated sequentially for thermo-regulation?
  - a. Peripheral vasodilation, increased rate of respiration, tachycardia.
  - b. Peripheral vasoconstriction, increased rate of respiration, bradycardia.
  - c. Peripheral vasodilation, decreased rate of respiration, tachycardia.
  - d. Peripheral vasodilation, decreased rate of respiration, bradycardia.
- 082. Graves disease is associated with
  - a. insufficiency of thyroid hormones
  - b. excess of thyroid hormones
  - c. insufficiency of corticosteroids
  - d. excess of growth hormones

### Unit 7 | Part – C

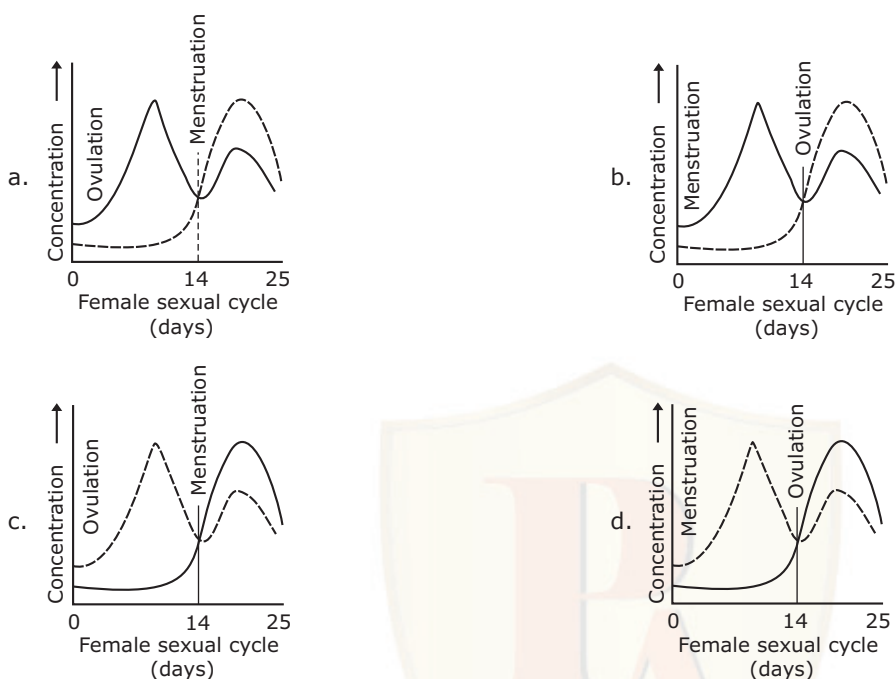
- 083. The time taken for atrial systole and diastole in a normal heart are t<sub>as</sub> and t<sub>ad</sub> seconds, respectively. If ventricular systole takes t<sub>vs</sub> seconds, calculate the ventricular diastolic time (seconds).
  - a. (t<sub>as</sub> + t<sub>ad</sub>) – t<sub>vs</sub>
  - b. (t<sub>as</sub> – t<sub>ad</sub>) + t<sub>vs</sub>
  - c. (t<sub>ad</sub> – t<sub>as</sub>) – t<sub>vs</sub>
  - d. (t<sub>as</sub> + t<sub>ad</sub>) × t<sub>vs</sub>
- 084. Spinal cord of an animal was transected at C1/C2 level. The respiration of the animal stopped and it needed artificial respiration. However, the heart continued to beat although at a slower rate. Some of the explanations given were:
  - P. respiration regulatory centre is located in the medulla.
  - Q. respiration regulatory centre is located above the C1/C2 cut.
  - R. heart regulatory centre is above the C1/C2 cut.
  - S. heart has autoregulation.

Which one of the following is *most* appropriate?

  - a. P only
  - b. Q and R only
  - c. P, Q and S only
  - d. Q, R and S only

085. Which one of the following graphs represents a normal sexual cycle in a normal human female?

— estrogen      - - - - progesterone



086. An organism having heart for circulation, excretes through green glands. It has several ganglia and tactile organs on its body and its larval form is very different than its adult form. This organism is most likely to respire by:

- P. exchanging oxygen and carbon dioxide through an extensive tracheal system.
- Q. gaseous exchange over thinner areas of cuticle or by gills.
- R. an efficient tracheal system that delivers oxygen directly to the tissues.
- S. a double transport system, where the circulating fluid contains a dissolved respiratory pigment.

Choose the *correct* option.

- a. P and R
- b. Only S
- c. Only Q
- d. Q and S

087. In a stressful condition, ACTH secretion was increased and as a result glucocorticoid concentration was elevated in blood. One or a combination of the following changes most likely taking place in this condition:

- P. decreased circulating eosinophils and basophils.
- Q. reduced IL2 release.
- R. potentiated inflammatory response to tissue injury.
- S. increased mitotic activity of lymphocytes in lymph nodes.

The *correct* answer is

- a. Q and R
- b. P and Q
- c. Q and S
- d. R and S

### Unit 8 | Part – B

088. The following is the biochemical pathway for purple pigment production in flowers of sweet pea:

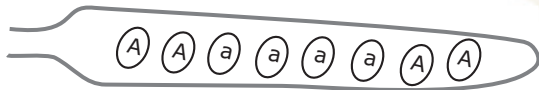


Recessive mutation of either gene A or B leads to the formation of white flowers. A cross is made between two parents with the genotype:  $AaBb \times aabb$ . Considering that the two genes are not linked, the phenotypes of the expected progenies are

- a. 9 purple : 7 white  
b. 3 white : 1 purple  
c. 1 purple : 1 white  
d. 9 purple : 6 light purple : 1 white
089. Aneuploid females with only one X-chromosome is a characteristic of individuals with  
a. *cri du chat* syndrome  
b. Klinefelter syndrome  
c. Down syndrome  
d. Turner syndrome
090. A mechanism that can cause a gene to move from one linkage group to another is  
a. crossing over  
b. inversion  
c. translocation  
d. duplication
091. A mother of blood group O has a group O child. The father could be of blood type  
a. A or B or O  
b. O only  
c. A or B  
d. AB only

### Unit 8 | Part – C

092. The total variance in a phenotypic character can be split into two components-genetic ( $V_G$ ) and environmental ( $V_E$ ). The heritability of a phenotypic trait can be expressed quantitatively as heritability coefficient ( $h^2$ ) which is calculated as  $h^2 =$   
a.  $V_G - V_E$   
b.  $V_E/V_G$   
c.  $\frac{V_G}{(V_G + V_E)}$   
d.  $\frac{V_G}{(V_G - V_E)}$
093. In *Neurospora* a cross between the genotypes 'A' and 'a' results in an ascus with ascospores of genotypes as shown below:



Statements P to S are events that could have occurred during meiosis

P. Crossing over between the centromere and the gene.

Q. Segregation of alleles 'A' and 'a' in meiosis I.

R. Segregation of alleles 'A' and 'a' in meiosis II.

S. Assortment of alleles 'A' and 'a'.

Which of the above events could *correctly* explain the observation shown in the figure?

- a. P followed by R  
b. P followed by Q  
c. R alone  
d. S alone
094. When F1 female *Drosophila* of the genotype  $a^+ a b^+ b c^+ c$  is test crossed, the following progenies were obtained:

Progeny classes*	Number of progenies
$a^+ b^+ c^+$	22
$a^+ b^+ c$	28
$a b c^+$	26
$a b c$	24
$a^+ b c^+$	230
$a^+ b c$	220
$a b^+ c^+$	225
$a b^+ c$	225
Total	1000



\*The progeny has been shown as classes derived from the female gamete.

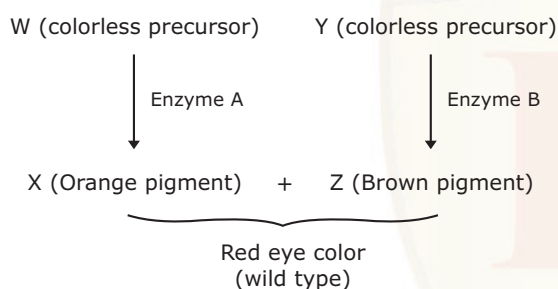
Statements 1 to 6 as given below are conclusions derived from the above result

1. genes a and b are linked in *cis*.
2. genes a and b are linked in *trans*.
3. genes a and b are linked in *cis* while b and c are linked in *trans*.
4. the genotype of the parents are  $a^+a^+b^+b^+$  and  $aabb$ .
5. the genotype of the parents are  $a^+a^+bb$  and  $aab^+b^+$ .
6. genes a and b are 10 cM apart.

Which of the above statements are *correct*?

- |               |               |
|---------------|---------------|
| a. 3 alone    | b. 1, 5 and 6 |
| c. 2, 5 and 6 | d. 1, 4 and 6 |

095. The following is a hypothetical pathway for the development of wild type (red) eye color in an insect:



Enzymes A and B are encoded by the genes  $a^+$  and  $b^+$ , respectively.

The following statements are made regarding inheritance of the genes involved in the development of eye color:

- P. when two heterozygous individuals of the genotype  $a^+ ab^+ b$  are mated, progenies with red, orange, brown and white eye color will be observed irrespective of whether the genes are independently assorting or showing incomplete linkage.
- Q. when two heterozygous individuals of the genotype  $a^+ ab^+ b$  are mated, progenies with red, orange, brown and white eye color will be observed in a ratio of 9:3:3:1, when the genes are independently assorting.
- R. when a heterozygous individuals of the genotype  $a^+ b/a b^+$  is test crossed, progenies with red and white eye color will be more in number.
- S. when a heterozygous individual of the genotype  $a^+ b/a b^+$  is test crossed, progenies with orange and brown eye color will be more in number.

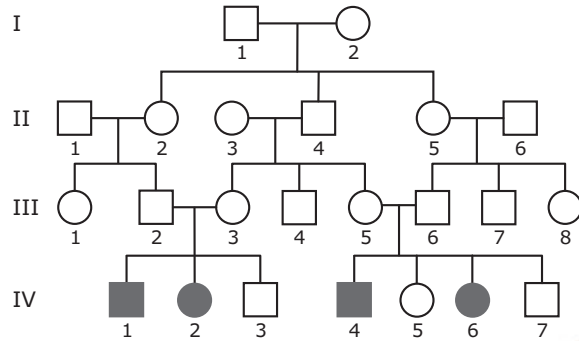
Which of the above statements is *true*?

- |               |               |
|---------------|---------------|
| a. P and R    | b. Q and R    |
| c. P, Q and R | d. P, Q and S |

096. Mendel crossed tall pea plants with dwarf ones. The F<sub>1</sub> plants were all tall. When these F<sub>1</sub> plants were selfed to produce F<sub>2</sub> generation, he got a 3:1 tall to dwarf ratio in the offspring. What is the probability that out of three plants (of F<sub>2</sub> generation) picked up at random two would be dwarf and one would be tall?

- |         |         |
|---------|---------|
| a. 3/4  | b. 3/8  |
| c. 9/64 | d. 9/32 |

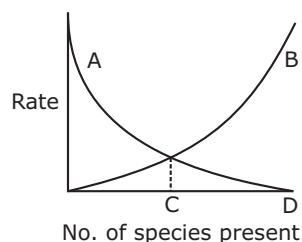
097. Affected individuals from the pedigree given below are suffering from albinism, an autosomal recessive disease. Identify the confirmed carrier individuals in this pedigree assuming that the members coming from outside the family are homozygous for the dominant allele.



- a. III-2, III-3, III-5, III-6, II-1, II-3 and II-6.  
 b. III-2, III-3, III-5, III-6, II-2, II-4, II-5 and I-2.  
 c. III-2, III-3, III-5, III-6, II-2, II-4 and II-5.  
 d. III-1, III-4, III-7, II-2, II-4, and II-5.

### Unit 9 and 10 | Part – B

098. *Imperfect fungi* is a group represented by fungal species which have
- simple mycelia
  - unknown mechanisms of sexual reproduction
  - unknown phylogenetic relationship
  - lost its survival mechanism against harsh environments
099. Which of the following is *not* a characteristic of phylum chordata?
- Pharyngeal slits
  - Amniotic egg
  - Postanal tail
  - Notochord
100. The most commonly used method of estimating primary productivity of a pond involves measurement of the amount of
- CO<sub>2</sub> utilized
  - autotroph biomass
  - oxygen released
  - organic carbon
101. A much greater proportion of energy fixed by autotrophs is transferred to the herbivore level in the open ocean ecosystem than in a forest ecosystem because
- aquatic autotrophs are small.
  - aquatic herbivores are more efficient feeders.
  - terrestrial autotrophs are less efficient feeders.
  - terrestrial autotrophs have more indigestible tissues.
102. Following figure shows McArthur and Wilson's equilibrium model of biota on a single island. In this figure, terms A, B, C and D in order are

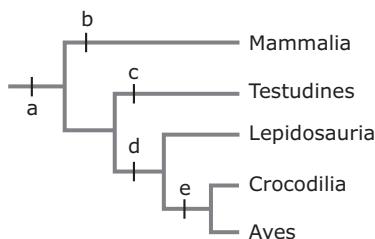


- extinction, immigration, equilibrium number of species, size of species pool.
  - immigration, extinction, equilibrium number of species, size of species pool.
  - extinction, immigration, size of species pool, equilibrium number of species.
  - immigration, extinction, size of species pool, equilibrium number of species.
103. Name the ectothermic animal that can thermoregulate by behavioural means rather than by physiological means.
- Bumble bee in an orchard
  - Tuna fish in the ocean
  - Lizard in a desert
  - Flatworm in a pond

104. Which of the following is a characteristic of an early seral community?
- Narrow niche specialization
  - High species diversity
  - Low community production
  - Open mineral cycling
105. In India, brown antlered deer (sangai) is found only in the floating landmasses of
- Wular lake
  - Sasthamkotta lake
  - Dal lake
  - Lok Tak lake

### Unit 9 and 10 | Part – C

106. Two new plant species, A and B, were described in 1872. Subsequently it was found that the type of species A was never designated and for species B there was one specimen designated as type but missing. As per International Code of Botanical Nomenclature (ICBN), typification should be
- neotype for A only
  - neotype for both A and B
  - neotype for A and lectotype for B
  - lectotype for both A and B
107. Assume a new subspecies *Ficus callosa* subsp. *microcarpa* has been published by Jacobs. The nomenclature of the resulting entities would be
- F. callosa* and *F. callosa* subsp. *microcarpa* Jacobs.
  - F. callosa* subsp. *microcarpa* Jacobs and other yet to be named subspecies of *F. callosa*.
  - F. callosa* subsp. *callosa* Jacobs and *F. callosa* subsp. *microcarpa* Jacobs.
  - F. callosa* subsp. *callosa* and *F. callosa* subsp. *microcarpa* Jacobs.
108. An organism has the following architectural pattern:
- Multicellular with germ layers.
  - A coelom derived from the mesoderm.
  - Primary bilateral symmetry with secondary radial symmetry.
  - Presence of endoskeletal plates.
- Such an organism is most likely to
- have mesohyl as its connective tissue.
  - undergo torsion, whereby the mouth and anus are properly oriented.
  - be devoid of a brain but have calcareous spicules.
  - have comb plates to help in locomotion.
- Which of the following is/are true?
- P and R
  - R only
  - S only
  - Q and R
109. Identify the apomorphic characters marked in the cladogram:

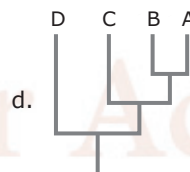
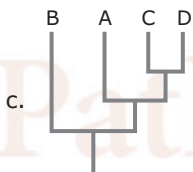
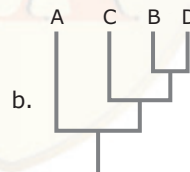
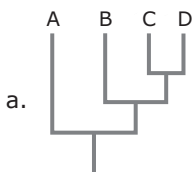


- a-amniotic egg; b-4-chambered heart; c-anapsidan skull; d-diapsidan skull; e-synapsid skull.
- a-amniotic egg; b-synapsidan skull; c-4-chambered heart; d-anapsidan skull; e-diapsidan skull.
- a-4-chambered heart; b-synapsid skull; c-amniotic egg; d-diapsidan skull; e-anapsidan skull.
- a-amniotic egg; b-synapsidan skull; c-anapsidan skull; d-diapsidan skull; e-4-chambered heart.

110. According to MacArthur and Wilson's equilibrium theory, which of the following is *true*?
- Larger islands and islands closer to continent are expected to have more species than smaller and isolated islands.
  - Smaller islands and islands far from the continent are expected to have more species than larger and isolated islands.
  - Smaller islands and islands closer to the continent are expected to have more species than far away smaller and isolated islands.
  - More species are expected on all islands irrespective of their size and distance from the continent.
111. Primary production in aquatic ecosystem is measured using Light-and-Dark-Bottle technique. In this method, as an indirect measure of photosynthetic production, dissolved oxygen concentration of the pond water enclosed in a BOD bottle is measured initially (I) and after a fixed duration of incubation in a light bottle (L) and a dark bottle (D). Then, the gross and net primary production are estimated as
- (L-D) and (L-I), respectively
  - (L-I) and (L-D), respectively
  - (L-I) and (I-D), respectively
  - (L-D) and (I-D), respectively

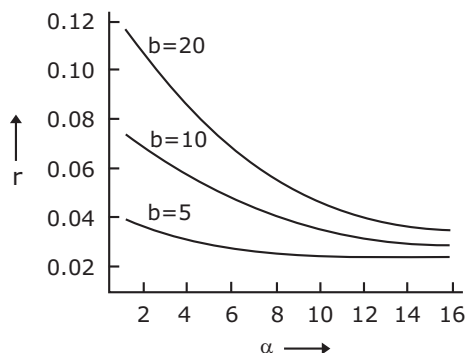
112. Identify the most appropriate cladogram that can be constructed using the data matrix given below, assuming '0's are plesiomorphic and '1's are apomorphic characters.

	1	2	3	4	5
A	0	0	0	0	0
B	0	1	1	0	0
C	0	1	0	0	0
D	0	1	1	0	1



113. Gause's *Competitive exclusion* principle states that two species with identical niches cannot coexist indefinitely. Which of the following statements is the most appropriate regarding the validity of the principle?
- It depends on how one defines niche.
  - There are in nature many instances of continued coexistence of closely related species.
  - The principle is universally true.
  - It does not predict the outcome where both the species are equally strong competitors.

114. The graph below shows the relationships of per capita population growth rate ( $r$ ), fecundity ( $b$ ) and age at first reproduction ( $\alpha$ ) in an animal species.



What is the most important conclusion to be drawn from the graph?

- The later the age of first reproduction, the lower is the population growth rate achieved.
  - The population growth rate decreases as first reproduction is postponed to a later state, regardless of the fecundity.
  - At any  $\alpha$ , the higher the fecundity, the higher is the population growth rate achieved.
  - As the age at first reproduction is postponed further, the benefits of increasing fecundity on the population growth rate become progressively negligible.
115. In a lake ecosystem, bottom-up effects (B) refer to control of a lower trophic level by the higher trophic levels and top-down effects (T) refer to the opposite. In a lake with three trophic levels-Phytoplankton (P), Zooplankton (Z) and primary Carnivore (C),
- P and C are controlled by B, and Z is controlled by T.
  - P, Z and C are all controlled by T.
  - P is controlled by B, Z is controlled by T and C is controlled by B.
  - P is controlled by T, Z is controlled by B and C is controlled by T.

### Unit 11 | Part – B

116. Recent studies on Archaea suggest that life could have originated
- extraterrestrially and seeded through meteorite impacts.
  - in shallow coastal areas.
  - in deep hydrothermal vents.
  - in hot, terrestrial habitats.
117. If the ratio of the number of non-synonymous to synonymous substitutions per site in protein coding gene is greater than one, it is an evidence of selection that is
- positive
  - negative
  - neutral
  - random
118. The frequencies of alleles 'A' and 'a' in a population at Hardy-Weinberg equilibrium are 0.7 and 0.3 respectively. In a random sample of 250 individuals taken from the population, how many are expected to be heterozygous?
- 112
  - 81
  - 105
  - 145
119. In an altruistic act, if a donor sacrifices 'C' offspring which helps the recipient to gain 'B' offspring and the donor is related to the recipient by a coefficient  $\gamma$ , under which condition would kin selection favour this altruistic trait?
- $B > C$
  - $B > \gamma C$
  - $\gamma B - C = 0$
  - $\gamma B - C > 0$
120. The photoreceptor commonly involved in light entrainment of the biological clock in flies, moulds and plants is
- phytochrome
  - rhodopsin
  - carotenoid
  - cryptochrome

### Unit 11 | Part – C

121. Using molecular clock, it was estimated that two species A and B must have diverged from their common ancestor about  $9 \times 10^6$  years ago. If the rate of divergence per base pair is estimated to be 0.0015 per million years, what is the proportion of base pairs that differ between the two species now?
- 0.0270
  - 0.0135
  - 0.00017
  - 0.0035



128. ELISA assay uses
- an enzyme which can react with secondary antibody.
  - an enzyme which can react with the antigen.
  - a substrate which gets converted into a colored product.
  - a radiolabelled secondary antibody.
129. Routinely used glucose biosensor estimates blood glucose level by sensing the concentration of
- glucose
  - oxygen
  - $\delta$ -gluconolactone
  - $H_2O_2$
130. Which of the following methods of plant transformation can be used to introduce a gene into chloroplast genome?
- Agrobacterium*-mediated transformation
  - Particle delivery system
  - Permeabilization
  - Electroporation
131. Yeast artificial chromosome (YAC) vectors contain selectable markers. Loss of which marker at the cloning site distinguishes the re-ligated YACs from the original vector marker?
- TRP1
  - SUP4
  - URA3
  - CEN
132. The  $\mu$  and  $\sigma$  of wing length (a normally distributed parameter) in a population of fruitflies are 4 and 0.2 mm, respectively. In a random sample of 400 fruitflies, how many individuals are expected to have wing lengths greater than 4.4 mm?
- 20
  - 64
  - 10
  - 336

### Unit 12 and 13 | Part – C

133. Industrial products in which bacteria are employed for production are shown in the following table:

*I-List of products*

- P. 2,3-Butanediol  
Q. Dextran  
R. Glutamic acid  
S. Cobalamin

*II-Microorganism*

1. *Leuconostoc*  
2. *Brevibacterium*  
3. *Bacillus polymyxa*  
4. *Propionibacterium*

The correct combination is

- P-3, Q-1, ; R-2, S-4
  - P-1, Q-2, ; R-3, S-4
  - P-3, Q-2, ; R-4, S-1
  - P-2, Q-3, ; R-4, S-1
134. A transposon carrying a promoterless  $\beta$ -galactosidase (*lac Z*) was used to create insertional mutation in the *vir* region of Ti-plasmid of *Agrobacterium tumefaciens*. All the mutants in which *lac Z* fusion was in frame were divided into the following three groups:
- The virulence of the bacteria was completely lost and the *lac Z* was induced by acetosyringone.
  - The virulence of the bacteria was reduced and the *lac Z* was induced by acetosyringone.
  - The virulence of the bacteria was completely lost and *lac Z* was not induced by acetosyringone.
- Which of the following assumptions are valid about these mutants?
- In group A, the insertion could be in *virB*, C, D or G; in group B the insertion could be in *virC* or E; and in group C the insertion could be in *virA* or G.
  - In group A, the insertion could be in *virA*, B, C or D; in group B the insertion could be in either *virC* or D; and in group C the insertion could be in *virG*.

- c. In group A, the insertion could be in *virA*; in group B, the insertion could be in *virB*; and in group C, the insertion could be in *virC*.
- d. In group A, the insertion could be in *virG*; in group B, the insertion could be in *virB*, D and E; in group C, the insertion could be in *virA*.

135. To detect mutation (GAG → GTG) allele specific hybridization method is used. Four members of an affected family are investigated. DNA isolated from blood samples of parents and two offsprings are spotted on a membrane after appropriate processing and probed with either TGACTCCTGAGGAGAAGTC (first probe) or TGACTCCTGTGGAGAAGTC (second probe) after labelling. While probed with first oligonucleotide, signals are obtained for the positions where DNA are spotted from parents and offspring II. When probed with second oligonucleotide, signals are obtained at position where DNA from the parents and offspring I spotted. Results are shown below:

	Father	Mother	Offspring I	Offspring II
First probe	+	+	-	+
Second probe	+	+	+	-

On the basis of the result, which of the following statements is *correct*?

- a. Parents are affected  
b. Offspring I is affected  
c. Offspring II is carrier  
d. Offspring II is affected
136. <sup>32</sup>P-labelled genomic DNA from *Bacillus subtilis* (A) and cold genomic DNA from *Clostridium jejeuni* (B) mixed in various proportions was used to transform *Bacillus subtilis*. The results obtained are tabulated below:

Set no.	Concentration DNA used (µg/ml)		Uptake of <sup>32</sup> P labelled DNA (%)	Transforming efficiency (colony forming unit)
	A	B		
1	1	1	90	30
2	1	10	82	10
3	1	100	15	5
4	1	1000	5	1

The following interpretation (P to S) could be made:

- P. The transformation is dependent on recombination between homologous sequences.  
Q. Cells did not distinguish between homologous or heterologous DNA sequences for uptake of DNA.  
R. DNA uptake is based on specific receptors.  
S. DNA degradation dictates transformation efficiency.

Which of the following interpretations are *correct*?

- a. P and Q  
b. P and R  
c. R and S  
d. P and S
137. You are studying the binding of proteins to the cytoplasmic face of cultured liver cells and have found a method that gives a good yield of inside-out vesicles from the plasma membrane. Unfortunately, your preparations are contaminated with variable amounts of right-side-out vesicles. Nothing you have tried avoids this contamination. Somebody suggests that you pass the vesicles over an affinity column made of lectin coupled to Sepharose beads. What is the rationale of this suggestion?
- a. Right-side-out-vesicles will be lysed by lectin coupled to Sepharose beads.  
b. Right-side-out-vesicles will simply bind to the lectin coupled Sepharose beads.  
c. Lectin will bind to the carbohydrate residues present only on the inside out vesicles.  
d. Lectin will bind to only glycoproteins and glycolipids present on the inside out vesicles.



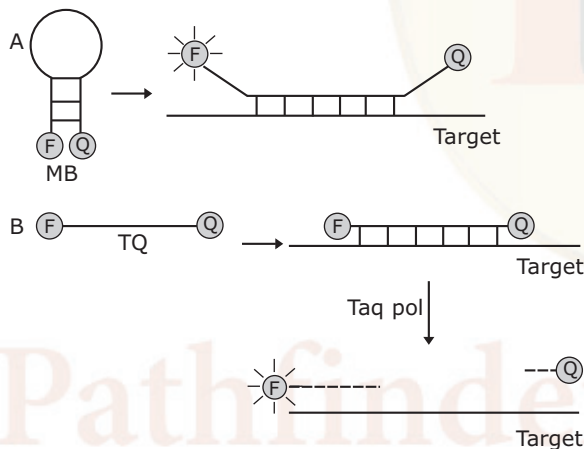


- a. Hfl protease degrades cI, thereby promoting lytic pathway.
- b. Hfl protease degrades cIII and so cIII cannot interact, with cII. The lysogenic pathway is thus preferred.
- c. Hfl protease degrades cII, and therefore cI synthesis cannot be established, thus lytic pathway is preferred.
- d. Hfl protease degrades INT, the protein involved in phage integration and the lytic pathway is initiated.

144. A 30-residue peptide was treated with trypsin and the tryptic peptides were separated by HPLC. Four peaks A, B, C and D were obtained. Peptides corresponding to A, B, C and D were reduced and alkylated selectively at cysteine residues. The sequences obtained from A, B, C and D after reduction and alkylation were: A, AEK; B, C(S-alkyl)EPGYR and WC(S-alkyl)SPPK; C, C(S-alkyl)EHFR and C(S-alkyl)GGK; D, C(S-alkyl)EAFC(S-alkyl)L. The sequence of the 30-residue peptide is

- a. AEKCEPGYRCEHFRWCSPPKCGGKCEAFCL
- b. AEKCEPGYRCEHFRWCSPPKCGGKCEAFCL
- c. AEKCEPGYRCEHFRWCSPPKCGGKCEAFCL
- d. AEKCEPGYRCEHFRWCSPPKCGGKCEAFCL

145. Molecular beacons (MB) and Taqman (TQ) are used as probes in Real time PCR experiments. Both these probes are based on the principle FRET and employ a fluorophore (F) and a quencher (Q). However the mechanisms by which they function are different as illustrated below:



At what stage of the PCR we would be able to detect fluorescence?

- a. Annealing step for both.
- b. Extension step for both.
- c. Annealing for A and extension for B.
- d. Extension for A and annealing for B.

## Answers

### PART – A

001. c	002. b	003. c	004. d	005. b	006. c	007. d
008. c	009. b	010. d	011. b	012. c	013. a	014. c
015. d	016. a	017. b	018. d	019. d	020. b	

### PART – B and C

021. c	022. d	023. b	024. b	025. d	026. a	027. c
028. d	029. c	030. b	031. a	032. a	033. d	034. a
035. b	036. c	037. c	038. a	039. b	040. b	041. d
042. c	043. b	044. c	045. a	046. c	047. c	048. c
049. c	050. d	051. a	052. b	053. c	054. a	055. b
056. b	057. a	058. b	059. a	060. c	061. c	062. d
063. b	064. c	065. a	066. a	067. a	068. b	069. a
070. a	071. c	072. b	073. a	074. a	075. a	076. c
077. c	078. d	079. b	080. c	081. a	082. b	083. a
084. c	085. b	086. c	087. b	088. b	089. d	090. c
091. a	092. c	093. a	094. c	095. d	096. c	097. c
098. b	099. b	100. c	101. d	102. b	103. c	104. d
105. d	106. b	107. b	108. b	109. d	110. a	111. a
112. b	113. a	114. d	115. b	116. c	117. a	118. c
119. d	120. d	121. a	122. b	123. a	124. b	125. b
126. c	127. a	128. c	129. b	130. b	131. b	132. c
133. a	134. a	135. b	136. a	137. b	138. a	139. b
140. b	141. c	142. a	143. c	144. c	145. c	

## Education | Explanations | Publication

001. Given that, net worth = 99 crores and profit = 10%.

Let the principle value be  $y$ , then net worth =  $y + y \times 10\%$

$$99 = (1.1)y.$$

So,  $y = 90$ .

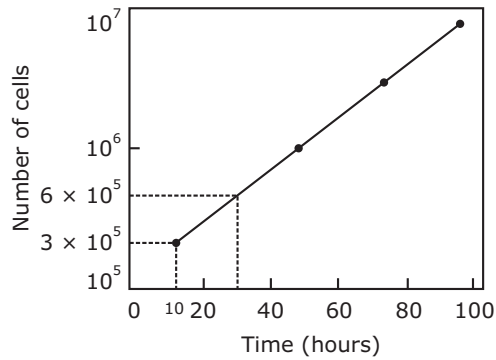
Hence, the principle value is 90.

009. Disorder Y may occur by itself or through disorder X. 4% incidence of disorder Y gives information that there is less than 4% of population which is suffered from X disorder.

010. The amount of water in flask A and B is lesser than in flask C. So, pressure will be maximum at flask C in comparison to A and B flask. So, dripping of water i.e. the rate of the fall of the volume of water in flask C is fastest.

012. As we know that ice is bad conductor of heat. So, in polar region temperature of the ocean surface is approximately equal to  $0^{\circ}\text{C}$  and with increasing depth, its temperature must be equal to  $0^{\circ}\text{C}$ .

035.



To find the length of the cell cycle, select any two points on the graph in the above figure, between which the number of cells has doubled. The time separating those two points is the length of the cell cycle. For example, the first two data points in figure are at  $3 \times 10^5$  cells (10 hours) and  $6 \times 10^5$  cells (30 hours). Since the population of mouse L cells doubled in 20 hours (30 hours – 10 hours), the length of the cell cycle is 20 hours.

047. The siRNA pathway begins with cleavage of long dsRNA by the Dicer enzyme complex into siRNA. These siRNAs are incorporated into Argonaute 2 (AGO2) and the RNAi-induced silencing complex (RISC). If the RNA duplex loaded onto RISC has perfect sequence complementarity, AGO2 cleaves the passenger (sense) strand so that active RISC containing the guide (antisense) strand is produced. The siRNA guide strand recognizes target sites to direct mRNA cleavage by the catalytic domain of AGO2.

The miRNA pathway begins with endogenously encoded primary miRNAs that are transcribed by RNA polymerase II and are processed by the Drosha enzyme complex to yield precursor miRNAs (pre-miRNAs). These precursors are then exported to the cytoplasm and subsequently bind to the Dicer enzyme complex, which processes the pre-miRNA for loading onto the Argonaute 2–RISC complex. When the RNA duplex loaded onto RISC has imperfect sequence complementarity, the passenger (sense) strand is unwound leaving a mature miRNA bound to active RISC. The mature miRNA recognizes target sites (typically in the 3'-UTR) in the mRNA, leading to direct translational inhibition. Binding of miRNA to target mRNA may also lead to mRNA target degradation in processing.

Source: Gene and Cell Therapy: *Therapeutic Mechanisms and Strategies (3e)*

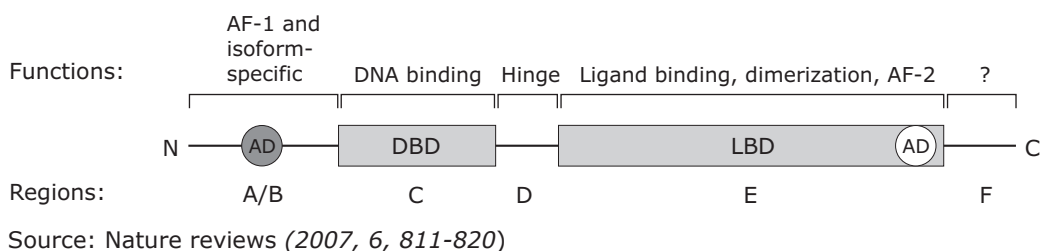
048. TATA-binding protein (TBP) appears to be essential for all transcription in eukaryotic cell nuclei, which suggests that its function was established early in evolution. Archaeobacteria constitute a kingdom of organisms distinct from eukaryotes and eubacteria. Archaeobacterial gene regulatory sequences often map to TATA box-like motifs. Here it is shown that the archaeobacterium *Pyrococcus woesei* expresses a protein with structural and functional similarity to eukaryotic TBP molecules.

Source: Science, (1994, 264:5163, 1326-1329)

Recognition of the TATA box is conferred by the TATA-binding protein (TBP), a small protein of ~30 kD. TBP has the unusual property of binding to DNA in the minor groove. TBP associated with TAFs are responsible for identifying all classes of promoters regardless of their TATA content -  $TF_{II}D$  (for pol II promoters),  $TF_{III}B$  (for pol III promoters) and SL1 (for pol I promoters).

Source: *Gene X* by Benjamin Lewin

061. Nuclear receptors (such as retinoic acid receptors) consist of five to six structural and functional domains denoted A to F. The evolutionarily conserved DNA-binding domains (DBDs) and ligand-binding domains (LBDs) are schematically represented by cylinders. The DBD is composed of two zinc-finger motifs and mediates sequence-specific DNA recognition. Transcriptional regulation is mainly mediated by the multifunctional LBD, which contains a ligand-binding pocket, a dimerization surface and a ligand-dependent transcriptional activation function (AF-2). The divergent regions are represented as thin tubes. The N-terminal A/B region contains a ligand-independent activation function (AF-1), the short D region corresponds to a linker allowing the proper orientation of DBDs and LBDs within DNA-bound dimers and finally the C-terminal F domain, which is present in RARs but not in RXRs and for which no clear function has been assigned. The activation domains (ADs) contain transcriptional activation functions that can activate transcription when fused to a heterologous DBD.



088. Parents genotype: AaBb × aabb  
Gametes: AB, ab, Ab, aB ab

Genotype of progenies	Phenotype
ABab	- Purple
abab	- White
Abab	- White
aBab	- White

096. As we know that,  $P = \frac{n!}{x!(n-x)!} p^x q^{n-x}$

where,  $n$  = total number of events = 3,  $x$  = number of events of dwarf plants = 2

$p$  = probability of dwarf plants = 1/4,  $q$  = probability of tall plants = 3/4

$$\text{Probability that two would be dwarf and one would be tall} = P = \frac{3!}{2!1!} \times \left(\frac{1}{4}\right)^2 \times \left(\frac{3}{4}\right)^{3-2} = \frac{3 \times 2 \times 1}{2 \times 1 \times 1} \times \frac{1}{16} \times \frac{3}{4} = \frac{9}{64}$$

115. Statements and options are not related.

Two models of community organization are common: the bottom-up model and the top-down model. Bottom-up model postulates a unidirectional influence from lower to higher trophic levels. In this case, the presence or absence of mineral nutrients controls plant numbers, which control herbivore numbers, which in turn control predator numbers. In contrast, the top-down model postulates the opposite. Predation mainly controls community organization because predators limit herbivores, herbivores limit plants, and plants limit nutrient levels through their uptake of nutrients during growth and reproduction. The simplified top-down model is also called the *trophic cascade model*.

Source: Biology (8e) by Campbell and Jane B. Reece

118. Frequency of allele A =  $p = 0.7 = 70\%$  and frequency of allele a =  $q = 0.3 = 30\%$   
Total number of individuals ( $p^2 + 2pq + q^2$ ) = 250 and heterozygous genotype ( $2pq$ ) =  $2 \times 0.7 \times 0.3 = 0.42 = 42\%$

$$\text{So, the number of heterozygous genotypes} = \frac{250 \times 42}{100} = 105$$

121. As we know that,  $D = 2 \times r \times t$ ; where,  $D$  = proportion of base pairs that differ between the two sequences.

$r$  = the rate of divergence per base pair per million years.

$t$  = the time in million years since the species common ancestor.

2 = two diverging lineages and  $D = 2 \times 0.0015 \times 9 = 0.0270$ .

122. As we know that, effective population size =  $N_e = \frac{4N_m N_f}{N_m + N_f}$

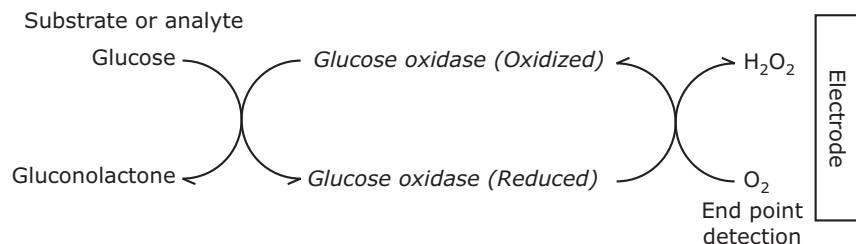
Where,  $N_m$  = Number of breeding males and  $N_f$  = Number of breeding females.

$$N_e = \frac{4 \times 40 \times 200}{40 + 200} = \frac{32000}{240} \cong 133$$

126. Edible vaccines are plant parts which contain an antigen introduced using recombinant DNA technology and therefore stimulate antibody formation in the host. First successful attempt for the development of edible vaccine

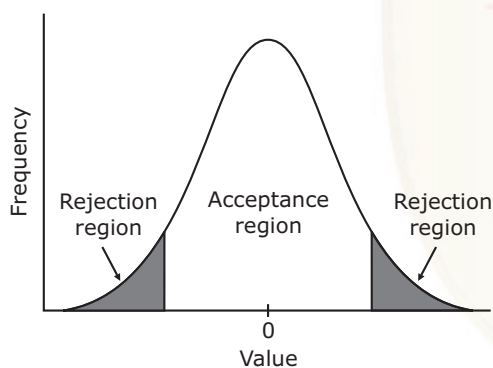
against hepatitis B was made in recombinant potato. Later other plants such as transgenic lupin (*Lupinus luteus* L.) and lettuce (*Lactuca sativa* L.) have also been used to make edible vaccines hepatitis B.

129. The scheme of chemical reactions forming basis of glucose biosensor is depicted below:



The final step of this reaction involves utilization of oxygen and subsequent conversion into hydrogen peroxide. The electrons involved in this reaction produced electronic signal which is ultimately used to calculate glucose concentration therefore routinely used glucose biosensor estimates blood glucose level by sensing the concentration of H<sub>2</sub>O<sub>2</sub>.  $\delta$ -gluconolactone is a reaction intermediate.

- 132.



For rejection of the hypothesis, 
$$L = \mu \pm z^* \times \frac{\sigma}{\sqrt{n}}$$

Where,  $\mu$  = sample mean,  $\sigma$  = standard deviation and  $n$  = size of the sample and  $z^* = 1.96$  (at 95% confidence interval)  
 $L$  = lower estimate of the population and  $U$  = upper estimate of the population.

$$\frac{L}{U} = 4 \pm 1.96 \times \frac{0.2}{\sqrt{400}} = 4 \pm 1.96 \times \frac{0.2}{20} \quad \text{and} \quad \frac{L}{U} = 4 \pm 1.96 \times 0.01 = 4 \pm 0.0196 = 4.0196, 3.9804$$

It means that out of 100 fruitflies of exactly 4 mm length we are confident that 95 of them are derived from fruitflies of lengths between 4.0196 mm and 3.9804 mm. The other 5 are probably outside these limits.

So, total number of fruitflies whose length is beyond the limit of upper and lower estimate =  $0.05 \times 400 = 20$ .

Hence, the number of fruitflies whose length is greater than 4.4 mm =  $20/2 = 10$ .

139. Gene A of this organism contains 1000 bases with 225 G and 215 C. Hence, 225 G = 225 C and 215 C = 215 G  
 Observed value of total GC content = 440 bp and expected value of total GC content = 400 bp

As we know that,  $\chi^2 = \sum \frac{(O - E)^2}{E}$ ; where, O = observed value and E = expected value.

$$\chi^2 = \sum \frac{(440 - 400)^2}{400} = \frac{1600}{400} = 4$$

Gene B contains 800 bases with 160 G and 140 C. Hence, 160 G = 160 C and 140 C = 140 G

Observed value of total GC content = 300 bp and expected value of total GC content = 320 bp

$$\chi^2 = \sum \frac{(300 - 320)^2}{320} = \frac{400}{320} = 1.25$$

Given that,  $\chi^2 = 3.841$  at 0.05 significance level i.e. 95% confidence interval. The gene B lies in the significance level means that gene B is a native.

# CSIR-NET Life Sciences Practice Books Combo Set



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