# Life Sciences : December 2011

Part − A

001. Magnesium powder, placed in an air-tight glass container at 1.0 bar, is burnt by focusing sunlight. Part of the magnesium burns off, and some is left behind. The pressure of the air in the container after it has returned to room temperature is approximately

    a. 1.0 bar
    b. 0.2 bar
    c. 1.2 bar
    d. 0.8 bar

002. Living beings get energy from food through the process of aerobic respiration. One of the reactants is

    a. carbon dioxide
    b. water vapour
    c. oxygen
    d. phosphorus

003. In $\triangle ABC$, angle A is larger than angle C and smaller than angle B by the same amount. If angle B is 67°, angle C is

    a. 67°
    b. 53°
    c. 60°
    d. 57°

004. Which of the following statements about the concentration of CO_2 in the Earth's atmosphere is *true*?

    a. It was the highest in the very early atmosphere of the Earth.
    b. It has steadily decreased since the formation of the Earth's atmosphere.
    c. It has steadily increased since the formation of the Earth's atmosphere.
    d. Its levels today are the highest in the Earth's history.

005. See the following mathematical manipulations.

    1. Let x = 5
    2. then $x^2 - 25 = x - 5$
    3. (x − 5) (x + 5) = x − 5
    4. x + 5 = 1 [cancelling (x − 5) from both sides]
    5. 10 = 1 [Putting x = 5]

    Which of the above is the *wrong* step?

    a. 1 to 2
    b. 2 to 3
    c. 3 to 4
    d. 4 to 5

006. The number of craters observed due to meteoritic impacts during the early stages of formation, is less on the Earth than that on the Moon because,

    a. formation of craters on the Earth was difficult due to the presence of hard rocks.
    b. impacting bodies on the Earth were smaller in size.
    c. craters on the earth are now covered by ocean water.
    d. earlier craters are not preserved due to continuous modification of Earth's surface by geological processes.

007. What is the angle θ in the quadrant of a circle shown below?
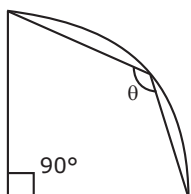
    a. 135°
    b. 90°
    c. 120°
   d. may have any value between 90° and 120°

008. During a total solar eclipse occurring at noon, it becomes dark enough for a few minutes for stars to become visible. The stars that are seen are those which will be seen from the same location
   a. on the following night only
   b. on the night one month later
   c. on the night three months later
   d. on the night six months later

009. A cupboard is filled with a large number of balls of 6 different colours. You already have one ball of each colour. If you are blind-folded, how many balls do you need to draw to be sure of having 3 colour matched pairs of balls?
   a. 3
   b. 4
   c. 5
   d. 6

010. The variation of solubilities of two compounds X and Y in water with temperature is depicted below. Which of the following statements is *true*?
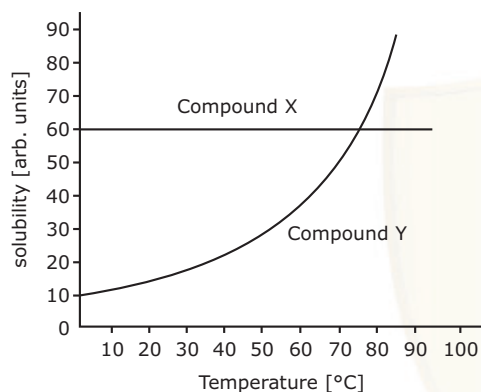

   a. Solubility of Y is less than that of X.
   b. Solubility of X varies with temperature.
   c. Solubilities of X and Y are the same at 75°C.
   d. Solubilities of X and Y are independent of temperature.

011. Restriction endonuclease cleaves DNA molecules at specific 'recognition sites'. One such enzyme has four recognition sites on a circular DNA molecule. After complete digestion how many fragments would be produced upon reaction with the enzyme?
   a. 4
   b. 5
   c. 3
   d. 6

012. A solid cube of side L floats on water with 20% of its volume under water. Cubes identical to it are piled one-by-one on it. Assume that the cubes do not slip or topple, and the contact between their surfaces is perfect. How many cubes are required to submerge one cube completely?
   a. 4
   b. 5
   c. 6
   d. Infinite

013. Inner planets of the solar system are rocky, whereas outer planets are gaseous. One of the reasons for this is that
   a. solar heat drove away the gases to the outer region of the solar system.
   b. gravitational pull of the sun pulled all rocky material to the inner solar system.
   c. outer planets are larger than the inner planets.
   d. comets delivered the gaseous materials to the outer planets.

014. On exposure to desiccation, which of the following bacteria are least likely to experience rapid water loss?
   a. Isolated rods
   b. Rods in chain
   c. Cocci in chain
   d. Cocci in clusters

015. A bell is rung before giving food to a dog. After doing this continuously for 10 days, which of the following is most likely to happen?
   a. The dog learns to ignore the bell.
   b. The dog salivates on hearing the bell.
   c. The dog ignores food and runs towards the bell.
   d. The dog will not eat food without hearing the bell.

016. When a magnet is made to fall free in air, it falls with an acceleration of 9.8 ms^{-2}. But when it is made to fall through a long aluminium cylinder, its acceleration decreases, because
    a. a part of the gravitational potential energy is lost in heating the magnet.
    b. a part of the gravitational potential energy is lost in heating the cylinder.
    c. the said experiment was done in the magnetic northern hemisphere.
    d. the cylinder shields the gravitational force.

017. For an elastic material, strain is proportional to stress. A constant stress is applied at time t_1. Which of the following plots characterizes the strain in that material?
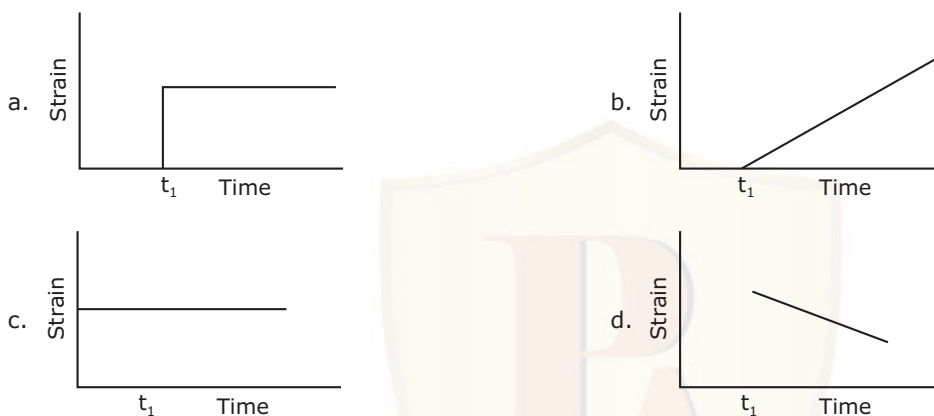

018. The conductance of a potassium chloride solution is measured using the arrangement depicted below. The specific conductivity of the solution in Sm^{-1}, when there is no deflection in the galvanometer, is
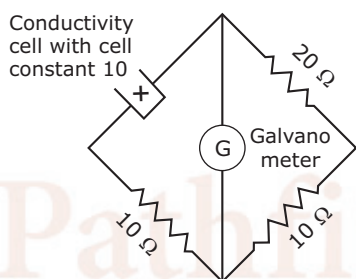
    a. 1.0
    b. 0.5
    c. 2.0
    d. 1.5

019. An overweight person runs 4 km everyday as an exercise. After losing 20% of his body weight, if he has to run the same distance in the same time, the energy expenditure would be
    a. 20% more   b. the same as earlier
    c. 20% less   d. 40% less

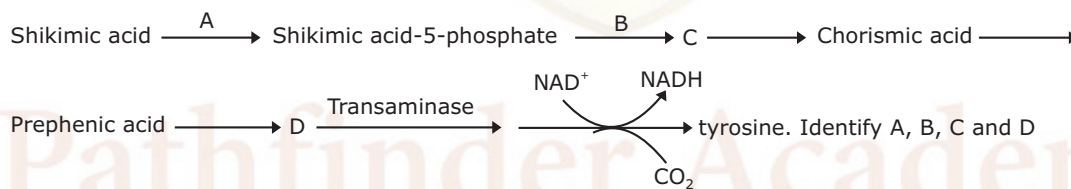020. What is the half-life of the radioisotope whose activity profile is shown below?
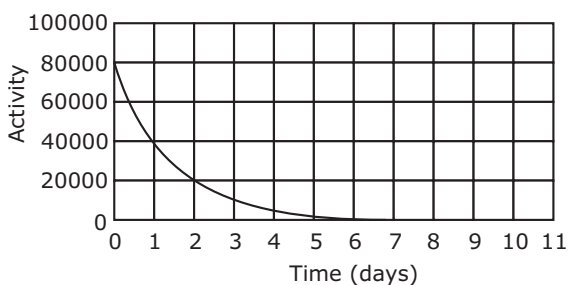
    a. 1 day   b. 3 days
    c. 2 days   d. 4 days

Unit 1 | Part − B

021. In which form of DNA, the number of base pairs per helical turn is 10.5?

   a. A
   b. B
   c. X
   d. Z

022. On the molar scale which of the following interactions in a nonpolar environment provides highest contribution to the biomolecule?

   a. van der Waals interaction
   b. Hydrogen bonding
   c. Salt bridge
   d. Hydrophobic interaction

023. Michaelis and Menten derived their equation using which of the following assumption?

   a. Rate limiting step in the reaction is the breakdown of ES complex to product and free enzyme.
   b. Rate limiting step in the reaction is the formation of ES complex.
   c. Concentration of the substrate can be ignored.
   d. Non-enzymatic degradation of the substrate is the major step.

Unit 1 | Part − C

024. Equilibrium constant (K) of noncovalent interaction between two non-bonded atoms of two different groups was measured at 27°C. It was observed that $K = 100 \ M^{-1}$. The strength of this noncovalent interaction in terms of Gibbs free energy change is:

   a. 2746 kcal/mole
   b. −2746 kcal/mole
   c. 247 kcal/mole
   d. −247 kcal/mole

025. Biosynthesis of tyrosine is detailed below:

Shikimic acid $\xrightarrow{\text{A}}$ Shikimic acid-5-phosphate $\xrightarrow{\text{B}}$ C $\longrightarrow$ Chorismic acid $\longrightarrow$

Prephenic acid $\longrightarrow$ D $\xrightarrow{\text{Transaminase}}$ $\longrightarrow$ tyrosine. Identify A, B, C and D (NAD^+ $\rightarrow$ NADH, CO_2)

   a. ATP, phosphoenolpyruvic acid, 3-enolpyruyl shikimic acid-5-phosphate, p-hydroxyphenylpyruvic acid.
   b. GTP, pyridoxal phosphate, 3-enolpyruvyl shikimic acid-5-phosphate, phenylpyruvic acid.
   c. NADP, 3–phosphohydroxypyruvic acid, 3-enolpyruvyl shikimic acid–5–phosphate, p-hydroxyphenylpyruvic acid.
   d. ATP, 3-phosphohydroxypyruvic acid, 3-enolpyruvyl shikimic acid-5-phosphate, pyridoxylphosphate.

026. Denaturation profiles of DNA are shown below. The differences in the profiles arise because
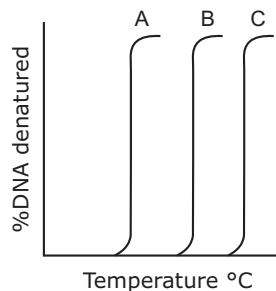
   a. the DNA is single stranded but of different sizes.
   b. A + T content of A > B > C and the DNA are from complex genomes.
   c. G + C content of C > B > A in DNA of comparable sizes isolated from simple genomes.
   d. G + C content is identical but A + T content in A > B > C in DNA of comparable sizes isolated from simple genomes.

027. If van der Waals interaction is described by the following relation,

$$\Delta G_{van} = \frac{A}{r^{12}} - \frac{B}{r^6} + \frac{q_1 q_2}{r}$$

Where ΔG_{van} is the free energy of the van der Waals interaction, A and B are constants, r is the distance between two non-bonded atoms 1 and 2, and q_1 and q_2 are partial charges on the dipoles 1 and 2. In this relation, the parameter A describes

a. electron shell attraction
b. electron shell repulsion
c. dipole-dipole attraction
d. dipole-dipole repulsion

028. The pH of blood of a healthy person is maintained at 7.40 ± 0.05. Assuming that this pH is maintained entirely by the bicarbonate buffer (pKa_1 and pKa_2 of carbonic acid are 6.1 and 10.3, respectively), the molar ratio of [bicarbonate]/[carbonic acid] in the blood is

a. 0.05
b. 1
c. 10
d. 20

029. The hydrolysis of pyrophosphate to orthophosphate is important for several biosynthetic reactions. In *E. coli*, the molecular mass of the enzyme pyrophosphatase is 120 kDa, and it consists of six identical subunits. The enzyme activity is defined as the amount of enzyme that hydrolyzes 10 μmol of pyrophosphate in 15 minutes at 37°C under standard assay condition. The purified enzyme has a V_{max} of 2800 units per milligram of the enzyme.

How many moles of the substrate are hydrolysed per second per milligram of the enzyme when the substrate concentration is much greater than K_m?

a. 0.05 μmol
b. 62 μmol
c. 31.1 μmol
d. 1 μmol

Unit 2 | Part − B

030. In contrast with plant cells, the most distinctive feature of cell division in animal cells is

a. control of cell cycle transitions by protein kinases.
b. enzymes responsible for DNA replication.
c. ubiquitin-dependent pathway for protein degradation.
d. pattern of chromosome movement.

031. The membrane lipid molecules assemble spontaneously into bilayers when placed in water and form a closed spherical structure known as

a. lysosome
b. peroxisome
c. liposome
d. endosome

032. Most common type of phospholipid in the cell membrane of nerve cells is

a. phosphatidylcholine
b. phosphatidylinositol
c. phosphatidylserine
d. sphingomyelin

Unit 2 | Part − C

033. The erythrocyte membrane cytoskeleton consists of a meshwork of proteins underlying the membrane. The principal component spectrin has α, β-subunits which assemble to form tetramers. The cytoskeleton is anchored to the membrane through linkages with the transmembrane proteins band 3 and glycophorin C. The cytosolic domain of band 3 also serves as the binding site of glycolytic enzymes such as glyceraldehyde 3-phosphate dehydrogenase. Analysis of the blood sample of a patient with haemolytic anemia shows spherical red blood cells. The patient carries

a. a mutation in glycophorin C.

b. a mutant spectrin with increased tetramerization propensity.

c. mutant β spectrin defective in $\alpha\beta$ dimerization ability.

d. mutant glyceraldehyde 3-phosphate dehydrogenase.

034. Maturation-promoting factor (MPF) controls the initiation of mitosis in eukaryotic cells. MPF kinase activity requires cyclin B. Cyclin B is required for chromosome condensation and breakdown of the nuclear envelope into vesicles. Cyclin B degradation is followed by chromosome decondensation, nuclear envelope reformation and exit from mitosis. This requires ubiquitination of a cyclin destruction box motif in cyclin B. RNase-treated *Xenopus* egg extracts and sperm chromatin were mixed. MPF activity increased with chromosome condensation and nuclear envelope breakdown. However, this was not followed by chromosome decondensation and nuclear envelope reformation because

a. RNase contamination persisted in the system.

b. cyclin B was missing from the system.

c. ubiquitin ligase had been overexpressed.

d. cyclin B lacking the cyclin destruction box had been overexpressed.

035. The bacterial flagellar motor is a multi-protein complex. Rotation of the flagellum requires movement of protons across the membrane facilitated by a multi-protein complex. The flagellar motor proteins combine to create a proton channel that drives mechanical rotation. In a screen for mutants, some non-motile ones were selected. These could have

a. mutations in tubulin and actin proteins.

b. mutations in kinesin proteins.

c. mutated H^+–ATPase.

d. mutations in the charged residues lining the ridge of the FliG subunit.

Unit 3 | Part – B

036. A single-strand nick in the parental DNA helix just ahead of a replication fork causes the replication fork to break. Recovery from this calamity requires

a. DNA ligase

b. DNA primase

c. site-specific recombination

d. homologous recombination

037. α-amanitin inhibits

a. only RNA polymerase I

b. only RNA polymerase II

c. only RNA polymerase III

d. all RNA polymerases

038. Reverse transcriptase has both ribonuclease and polymerase activities. Ribonuclease activity is required for

a. the synthesis of new RNA strand

b. the degradation of RNA strand

c. the synthesis of new DNA strand

d. the degradation of DNA strand

039. In gene regulation, open reading frame (ORF) implies

a. intervening nucleotide sequence in between two genes.

b. a series of triplet codons not interrupted by a stop codon.

c. a series of triplet codons that begins with a start codon and ends with a stop codon.

d. the exonic sequence of a gene that corresponds to the 5'UTR of the mRNA and thus does not code for the protein.

040. While replicating DNA, the rate of misincorporation by DNA polymerase is 1 in 10^5 nucleotides. However, the actual error rate in the replicated DNA is 1 in 10^9 nucleotides incorporated. This is achieved mainly due to

a. spontaneous excision of misincorporated nucleotides.

b. $3' \rightarrow 5'$ proofreading activity of DNA polymerase.

c. termination of DNA polymerase at misincorporated sites.

d. $5' \rightarrow 3'$ proofreading activity.

041. Amino acid selenocysteine (Sec) is incorporated into polypeptide chain during translation by

a. charging of Sec into tRNA^{ser} followed by incorporation through serine codon.

b. charging of serine into tRNA^{ser} followed by modification of serine into selenocysteine and then incorporation through serine codon.

c. charging of Sec into tRNA^{ser} and then incorporation through selenocysteine codon.

d. charging of serine into tRNA^{sec}, modification of serine into selenocysteine and then incorporation through a specially placed stop codon.

Unit 3 | Part − C

042. Synthesis of normal hemoglobin requires coordinated synthesis of α-globin and β-globin. Thalassemias are genetic defects perturbed in this coordinated synthesis. Patients suffering from deficiency of β-globin chains (β–thalassemia) could also be due to mutations affecting the biosynthesis of β-globin mRNA.

The following statements describe the genesis of non-functional β-globin leading to β-thalassemia.

P. Mutation in the promoter region of the β-globin gene.

Q. Mutation in the splice junction of the β-globin gene.

R. Mutation in the intron I of the β-globin gene.

S. Mutations towards the 3' end of the β-globin gene that codes for polyadenylation site.

Which of the following combinations is *correct*?

a. P, Q and S   b. P, Q and R

c. Q, R and S   d. R, S and P

043. Bacteriophage λ has two modes in its life cycle, lytic and lysogenic. In the lysogenic mode, the expression of all the phage genes are repressed while the expression of repressor gene switches between on and off position depending on the concentration of repressor. The following statements are made:

P. Repressor may act both as a positive regulator and a negative regulator.

Q. Expression of repressor gene, cI is independent of the expression of cII and cIII genes.

R. Mutation of cI gene will cause it to form clear plaques on both wild type *E. coli* and *E. coli* (λ^+).

S. Mutation at operators, O_L and O_R will allow the phage to act as a virulent phage.

The *correct* statements are

a. P and Q   b. Q and R

c. R and S   d. S and P

044. Pre-mRNAs are rapidly bound by snRNPs which carry out dual steps of RNA splicing, that removes the intron and joins the upstream and downstream exons. The following statements describe some facts related to this event:

P. Almost all introns begin with GU and end with AG sequences and hence all the GU or AG sequences are spliced out of RNA.

Q. U2 RNA recognizes important sequences at the 3' acceptor end of the intron.

R. The spliceosome uses ATP to carry out accurate removal of intron.

S. An unusual linkage with 2' OH group of guanosine within the intron form a 'lariat' structure.

Which of the following combinations is *correct*?

a. P and Q   b. Q and R

c. R and S   d. S and P

045. In human, protein coding genes are mainly organized as *exons* and *introns*. There are intergenic regions that transcribe into various types of non-coding RNA (not translating into protein). Some introns may harbor also transcription units, which are
    a. always other protein coding genes
    b. protein coding gene and RNA coding genes
    c. always RNA coding genes
    d. pseudo genes

046. Insulin and other growth factors stimulate a pathway involving a protein kinase mTOR, which in its turn augments protein synthesis. mTOR essentially modifies protein(s) which in their unmodified form act as inhibitors of protein synthesis. The following proteins are possible candidates:
    P. eEF-1
    Q. eIF-4E-BP1
    R. eIF-4E
    S. PHAS-1
    Which of the following sets is *correct*?
    a. P and Q
    b. Q and S
    c. P and R
    d. Q and R

047. For continuation of protein synthesis in bacteria, ribosomes need to be released from the mRNA as well as to dissociate into subunits. These processes do not occur spontaneously. They need the following possible conditions:
    P. RRF and EF-G aid in this process.
    Q. An intrinsic activity of ribosomes and an uncharged tRNA are required.
    R. IF-1 promotes dissociation of ribosomes.
    S. IF-3 and IF-1 promote dissociation of ribosomes.
    Which of the following sets is *correct*?
    a. P and S
    b. P and Q
    c. P and R
    d. Q and S

Unit 4 | Part − B

048. Graft rejection does not involve
    a. erythrocytes
    b. T-cells
    c. macrophages
    d. polymorphonuclear leukocytes

049. Toxic shock is caused by
    a. toxins produced by some bacteria
    b. excessive stimulation of a large proportion of T-cells by bacterial superantigens
    c. abnormal cytokine production by B-cells
    d. excessive production of immunoglobulins

050. Indirect immunofluorescence involves fluorescently labelled
    a. immunoglobulin-specific antibodies
    b. antigen-specific antibodies
    c. hapten-specific antibodies
    d. carrier-specific antibodies

Unit 4 | Part − C

051. A fixed smear of a bacterial culture is subjected to the following solutions in the order listed below and appeared red.
    P. Carbolfuchsin (heated)
    Q. Acid-alcohol
    R. Methylene blue
    Bacteria stained by this method can be identified as
    a. non-acid fast *E. coli*
    b. acid-fast *Mycobacterium sp.*
    c. Gram-positive *E. coli*
    d. Gram-negative *Mycobacterium sp.*

052. Survival of intracellular pathogens depends on the levels of pro-inflammatory and anti-inflammatory cytokines in macrophages. In an experimental condition, *Mycobacteria* infected macrophages were treated with IL-6 or IL-12 for 4 hours at 37°C. Untreated cells were used as control. Cells were lysed and number of bacteria in each experimental set was counted by measuring colony forming unit (CFU). Which of the following observations is *true*?

a. IL-12 treated cells contain more intracellular bacteria than control.

b. IL-12 treated cells contain less intracellular bacteria than control.

c. IL-6 treated cells contain more intracellular bacteria than control.

d. IL-6 treated cell contain less intracellular bacteria than control.

053. Many cancers carry mutant p53 genes, while some cancers have normal p53 genes. p53 activates p21 (Waf-1) which inhibits G1/S-Cdks and phosphorylation of the retinoblastoma protein (Rb). Cancers with normal p53 genes could

a. express non-phosphorylatable form of Rb.

b. express high levels of p53-deubiquitinases.

c. express inactive forms of G1/S-cdks.

d. express inactive forms of G1/S cyclins.

054. A nerve impulse or action potential is generated from transient changes in the permeability of the axon membrane to Na^+ and K^+ ions. The depolarization of the membrane beyond the threshold level leads to Na^+ flowing into the cell and a change in membrane potential to a positive value. The K^+ channel then opens allowing K^+ to flow outwards ultimately restoring membrane potential to the resting value. The Na^+ and K^+ channels operate in opposite directions because

a. there is an electrochemical gradient growth generated by proton transport.

b. there is a difference in Na^+ and K^+ concentrations on either side of the membrane.

c. Na^+ is a voltage-gated channel, whereas K^+ is ligand gated.

d. Na^+ is dependent on ATP whereas K^+ is not.

055. A bacterial response regulator turns on gene A in its phosphorylated form. The amount of "A" shows a sharp and steep rise at a threshold concentration of the signal sensed by the cognate sensor. This is most likely due to

a. increased phosphatase activity of the sensor at the threshold concentration.

b. decreased phosphorylation of the response regulator by the sensor.

c. cooperativity in binding of the response regulator to the target gene A.

d. negative feedback in gene A expression.

056. You are given a group of four mice. Each mouse is immunized with keyhole limpet hemocyanin or azobenzene arsonate or lipopolysaccharide or dextran. Four weeks later, sera were collected from these mice and antigen-specific IgG1 and IgG2a ELISA were performed. Only one of the mice showed positive response. It was

a. keyhole limpet hemocyanin-primed mouse.

b. azobenzene arsonate-primed mouse.

c. lipopolysaccharide-primed mouse.

d. dextran-primed mouse.

057. T-cell proliferation *in vivo* is to be analyzed. The cells are labelled with CFSE (a fluorescent probe) and injected in CD86-deficient mice and BALB/c mice along with the required antigens. Three days later, the cells are recovered and analyzed by flow cytometry. Which one of the following is logically *correct*?

———— BALB/c   ------ CD86-deficient
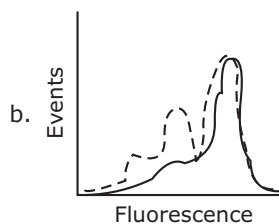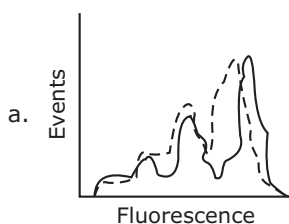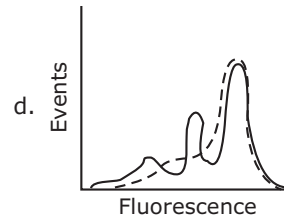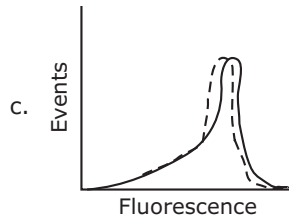
058. Intracellular transport and cytoskeletal organization of a cell is regulated by nucleotide exchange of different small molecular weight GTPases of Ras super family. Overexpression of which of the following GTPase modulates the actin-cytoskeleton of HeLa cells?

    a. Ran is GDP bound form
    b. Ran in GTP bound form
    c. Rho in GTP bound form
    d. Rho in GDP bound form

059. Tumor cells were isolated from a breast cancer patient. These cells were injected into nude mice and they were divided into four groups. Group 1 received EGF receptor-conjugated with methotrexate; Group 2 received transferrin receptor-conjugated with methotrexate; Group 3 received mannose receptor-conjugated with methotrexate; Group 4 received same amount of the free drug. In which of the following cases tumorigenic index would be minimum?

    a. Free drug
    b. EGF receptor-conjugated drug
    c. Transferrin receptor-conjugated drug
    d. Mannose receptor-conjugated drug

Unit 5 | Part − B

060. The blastopore region of amphibian embryo that secretes BMP inhibitors and dorsalizes the surrounding tissue is known as

    a. Brachet's cleft
    b. Nieuwkoop center
    c. Spemann's organizer
    d. Hensen's node

061. Which of the floral whorls is affected in *agamous* (*ag*) mutants?

    a. Sepals and petals
    b. Petals and stamens
    c. Stamens and carpels
    d. Sepals and carpels

062. Which of the following maternal effect gene products regulate production of anterior structures in *Drosophila* embryo?

    a. Bicoid and Nanos
    b. Bicoid and Hunchback
    c. Bicoid and Caudal
    d. Nanos and Caudal

Unit 5 | Part − C

063. AP1 (APETALA 1) is one of the floral meristem identifying genes. In wild-type *Arabidopsis thaliana* plants transformed with API :: GUS, β glucuronidase (GUS) activity is seen in floral meristem, only after the commitment to flowering. Ectopic expression of API :: GUS in the *Embryonic flower* (*emf*) mutant background result in GUS activity throughout the shoots in four day old seedlings. These observations suggest that AP1 is

    a. not involved in flowering.
    b. involved in repression of flowering.
    c. involved in promoting flowering.
    d. stimulation of flowering in the *emf* background.

064. When the prospective neurons from an early gastrula of a frog were transplanted into the prospective epidermis region, the donor cells differentiated into epidermis. However, when a similar experiment was done with the late gastrula of frog, the prospective neurons developed into neurons only. These observations could possibly be explained by the following phenomena.

    P. The early gastrula show conditional development whereas the late gastrula shows autonomous development.

    Q. The early gastrula show autonomous development whereas the late gastrula shows conditional development.

    R. The prospective neurons from the early gastrula are only specified whereas those from the late gastrula are determined.

S. The prospective neurons from the early gastrula are determined whereas those from the late gastrula are specified.

Which of the conclusions drawn above are *correct*?

a. P and Q

b. P and R

c. P and S

d. Q and R

065. The figure below represents a late zebrafish gastrula. The following concepts may be proposed during further development of the embryo.
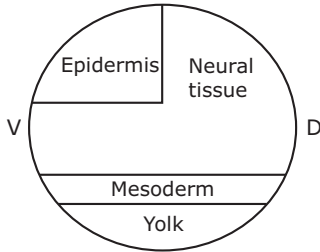
P. The concentration of FGF decreases from the yolk towards the epidermis, along with the increase of BMP activity from the dorsal to the ventral axis.

Q. Increase in FGF activity in the epidermis with concomitant decrease in BMP activity towards the ventral axis.

R. Neural induction in zebrafish is independent of the organizer and depends on activation of BMP signalling.

S. In comparison, both *Xenopus* and chick embryos require activation FGF for neural induction to occur in addition to BMP inhibition.

Which of the above statements are *true*?

a. P and R

b. Q and R

c. P and S

d. R and S

066. In case of morphallactic regeneration:

a. there is repatterning of the existing tissues with little new growth.

b. there is repatterning of the existing tissues after the stem cell division has taken place.

c. there is cell division of the differentiated cells which maintain their differentiated state to finally form a complete organism.

d. there is dedifferentiation of the cells at the cut surface which become undifferentiated. These undifferentiated cells then divide to redifferentiate to form the complete structure.

067. With respect to the extraembryonic structures formed in the mammals, the possible functional attributes have been designated:

P. Allantoin stores urinary waste and helps mediate gas exchange. It is derived from splanchnopleure at the caudal end of the primitive streak.

Q. Amnion is a water sac and protects the embryo and its surrounding amniotic fluid. This epithelium is derived from somatopleure.

R. Chorion is essential for gas exchange in amniote embryos. It is generated from the splanchnopleure.

S. Yolk sac is the last embryonic membrane to form and is derived from somatopleure.

Which of the above statements are *correct*?

a. P and Q

b. P and R

c. Q and R

d. P and S

068. The decision to become either a trophoblast or inner cell mass blastomere is one of the first decisions taken by any mammalian embryo. Below is a diagrammatic representation of the different cells formed during development from the morula with the help of different molecules. Identify the molecules 1-4, sequentially.
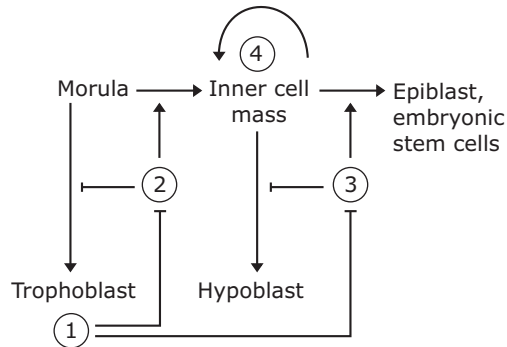
a. cdx 2, Oct 4, Nanog, Stat 3

b. cdx 2, Nanog, Stat 3, Oct 4

c. cdx 2, Nanog, Oct 4, Stat 3

d. cdx 2, Oct 4, Stat 3, Nanog

Unit 6 | Part – B

069. Which of the following is *not* a prosthetic group of nitrate reductase?

a. FAD

b. Heme

c. Mo

d. Pterin

070. Which of the following acts as a branch point for the biosynthesis of sesquiterpenes and triterpenes?

a. Farnesyl pyrophosphate

b. Geranyl pyrophosphate

c. Isopentyl pyrophosphate

d. Hydroxymethylglutaryl–CoA

071. Which of the following set of cell organelles are involved in the biosynthesis of jasmonic acid through octadecanoid signalling pathway?

a. Chloroplast and peroxisomes

b. Chloroplast and mitochondria

c. Mitochondria and peroxisomes

d. Golgi bodies and mitochondria

072. During development of embryos in plants, PIN proteins are involved in

a. establishment of auxin gradients

b. regulation of gene expression

c. induction of programmed cell death

d. induction of cell division

073. Chloroplast distribution in a photosynthesizing cell is governed by blue light sensing phototropin 2 (PHOT2). When the cells are irradiated with high intensity blue light, the chloroplasts

a. move to the side walls

b. aggregate in the middle of the cell

c. are sparsely distributed

d. aggregate in small clusters

074. Ethylene binding to its receptor, *does not* lead to

a. dimerization of the receptor

b. phosphorylation of the receptor

c. activation of CTR Raf kinase

d. endocytosis of ethylene-receptor complex

075. Which of the following features is *not* shown by glyphosate, a broad spectrum herbicide?

a. Little residual soil activity.

b. Ready translocation in phloem.

c. Inhibition of a chloroplast enzyme catalyzing the synthesis of aromatic amino acids.

d. Inhibition of early steps in the biosynthesis of branched chain amino acids.

Unit 6 | Part – C

076. Following are some statements regarding plant growth hormones.

    1. Ethylene regulates abscission.
    2. Gibberellins do not play any role in flowering.
    3. Auxin and cytokinin promote cell division.
    4. Over expression of cytokinin oxidase would promote root growth.
    5. ABA inhibits root growth and promotes shoot growth at low water potential.
    6. ABA promotes leaf senescence independent of ethylene.

    Which one of the following combination of above statements is *correct*?

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

077. Following are some statements about low temperature stress in plants.

    P. Fatty acid composition of mitochondria isolated from chilling resistant and chilling sensitive plants differs significantly.
    Q. Ratio of unsaturated fatty acids to saturated fatty acids is lower in chilling resistant species
    R. The cellular water does not freeze even at –40°C, because of the presence of solutes and other antifreeze proteins.
    S. Heat shock proteins do not play any role during low temperature stress.

    Which one of the following combination of above statement is *correct*?

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

078. Following are some of the statements regarding the effect of CO_2 concentration on photosynthesis in plants.

    P. With elevated CO_2 levels, C_3 plants are much more responsive than C_4 plants under well watered conditions.
    Q. In C_3 plants, increasing intracellular CO_2 partial pressure can stimulate photosynthesis only over a narrow range.
    R. In C_4 plants, CO_2 compensation point is nearly zero.

    Which one of the following combination of above statements is/are *correct*?

    a. P and Q   b. Q and R
    c. P and R   d. R only

079. The quantum yield of photosynthetic carbon fixation in a C_3 plant and C_4 plant is studied as a function of leaf temperature. Following are some statements based on this study:

    P. At lower temperature the quantum yield of C_3 plant is lower than C_4 plant.
    Q. In C_4 plant quantum yield does not show a temperature dependence.
    R. Since the photorespiration is low in C_4 plants because of CO_2 concentrating mechanism, quantum yield is not affected.
    S. At higher temperature the quantum yield of C_3 plant is lower than C_4 plant.

    Which one of the following combination of above statements is *correct*?

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

080. Following are some statements for synthesis of jasmonic acid in plants:

    1. 12-oxo-phytodienoic acid is produced in chloroplast and transported peroxisome.
    2. Action of lipoxygenase, allene oxide synthase and allene oxide cyclase takes place in peroxisome.
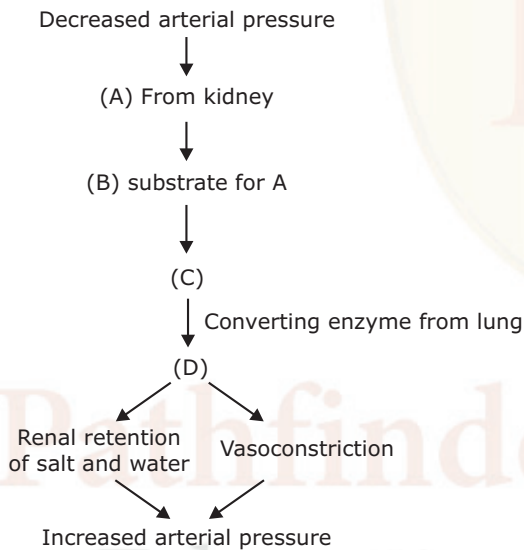
3. 12-oxo-phytodicnoic acid is first reduced and then converted to jasmonic acid by β-oxidation.

4. Final production of jasmonic acid takes place in chloroplast.

5. Action of allene oxide synthase and allene oxide cyclase takes place in chloroplast.

Which one of the following combination of above statements is *correct*?

a. 1, 2 and 3
b. 2, 4 and 4
c. 3, 4 and 5
d. 1, 3 and 5

Unit 7 | Part – B

081. In a normal human eye, for sharp image formation on the retina, maximum dioptric power is provided by the

a. retina
b. cornea
c. anterior surface of the lens
d. posterior surface of the lens

082. Which of the following waves is likely to be absent in a normal frog EGG?

a. P
b. Q
c. T
d. R

083. In this flow diagram name the chemicals A, B, C and D in proper sequence.

Decreased arterial pressure
↓
(A) From kidney
↓
(B) substrate for A
↓
(C)
↓ Converting enzyme from lung
(D)
↙ ↘
Renal retention of salt and water   Vasoconstriction
↘ ↙
Increased arterial pressure

a. Renin, Angiotensin II, Angiotensin I, Angioten-sinogen.
b. Angiotensin I, Angiotensinogen, Angiotensin II, Renin.
c. Renin, Angiotensin I, Angiotensin II, Angioten- sinogen.
d. Renin, Angiotensinogen, Angiotensin I, Angioten-sin II.

Unit 7 | Part – C

084. An isolated carotid sinus was prepared so that the pressure may be regulated by a pump and the resulting discharge in single carotid sinus nerve fibre could be recorded. The following are the possible observations.

P. No discharge when carotid sinus perfusion pressure was below 30 mm Hg.

Q. Linear increase in discharge frequency when carotid sinus perfusion pressure was gradually increased from 70 to 110 Hg.

R. Increase in discharge frequency was more prominent in greater pulsatile changes of carotid sinus pressure keeping the mean pressure identical in all cases.

S. Increase in discharge was more prominent in the falling phase of pulsatile change of carotid sinus pressure than in the rising phase.

Which one of the following is *correct*?

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

085. A 1 meter tall object was placed 10 meter in front of a normal eye. The size of the image on the retina will be (consider distance between lens and retina = 1.7 cm)

    a. 0.17 mm

    b. 1.7 mm

    c. 3.4 mm

    d. 170 μm

086. For a normal heart, the time taken for atrial systole and diastole are A_s and A_d seconds, respectively, while the same for ventricular systole and diastole are V_s and V_d. Which one of the following equations is *correct*?

    a. $A_s + A_d = V_s + V_d$

    b. $A_s + A_d < V_s + V_d$

    c. $A_s + A_d - V_s + V_d = 0$

    d. $A_s + A_d > V_s + V_d$

087. A monkey undergoes cerebellectomy. After the post-operative recovery, the monkey was given a task to press a bar. The possible observations are:

    P. Its hand would overshoot the target while reaching the bar.

    Q. It would be unable to move forelimbs.

    R. It would show intention tremor while trying to press the bar.

    S. It would press the bar with mouth instead of hand.

    Which one of the following is *correct*?

    a. P and R

    b. Q only

    c. S only

    d. Q and S

088. During the Spanish conquest of the Inca Empire at the high altitude in Peru, many soldiers fell sick. It was found that the sickness was due to low partial pressure of O_2 in the atmosphere at that altitude. To determine the reason, blood was collected from those patients. The circulating erythropoietin (EPO) level were estimated and the O_2-dissociation curve of haemoglobin were drawn and compared with the same in native people as depicted below.
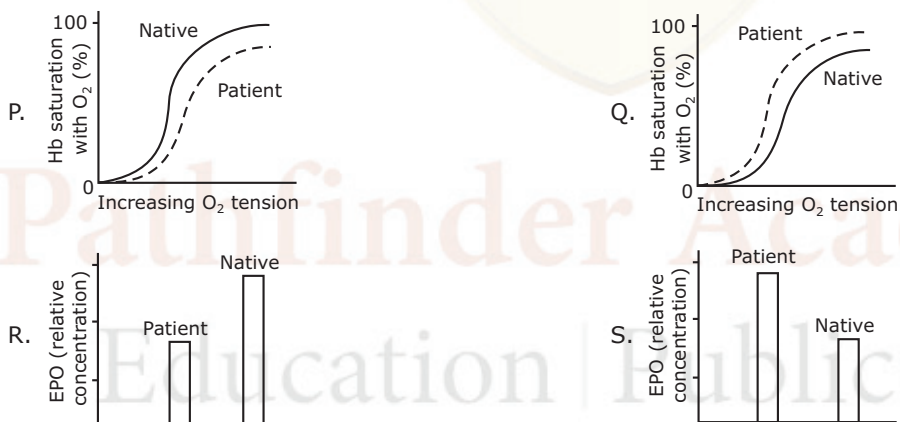
    Which one of the following combinations is logically *correct*?

    a. P and R

    b. P and S

    c. Q and R

    d. Q and S

089. In an animal experiment:

    P. Electrical stimulation of an area in the brain (A) increased a function (F) which was prevented by systemic injection of adrenergic antagonistic, prazosin.

    Q. Injection of carbachol (cholinergic agonist) into A also increased function F which was, however, not prevented by systemic injection of adrenergic antagonistic, prazosin.

    The results are likely to be due to the stimulation of

    a. nonadrenergic and cholinoceptive neurons.

    b. cholinergic and non-adrenoceptive neurons.

    c. adrenergic terminals in 'A'.

    d. both neurons and fibres passing through 'A'.

090. The graph represents relative plasma concentration of hormones (A and B) during reproductive cycle in a normal female. Which one of the following combinations is *correct*?
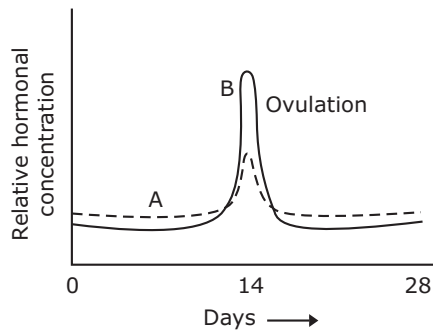
a. (A) is FSH and (B) is estrogen
b. (A) is estrogen and (B) is LH
c. (A) is FSH and (B) is LH
d. (A) is LH and (B) is FSH

Unit 8 | Part − B

091. A plant of the genotype AaBb is selfed. The two genes are linked and are 50 map units apart. What proportion of the progeny will have the genotype aabb?

a. 1/2
b. 1/4
c. 1/8
d. 1/16

092. The base analog 2-aminopurine pairs with thymine, and can occasionally pair with cytosine. The type of mutation induced by 2-aminopurine is

a. transversion
b. transition
c. deletion
d. nonsense

093. What kind of aneuploid gametes will be generated if meiotic non-disjunction occurs at first division? ('n' represents the haploid number of chromosomes)

a. only n + 1 and n
b. only n − 1 and n
c. both n + 1 and n − 1
d. either n + 1 or n − 1

Unit 8 | Part − C

094. Assuming a 1 : 1 sex ratio, what is the probability that three children from the same parents will consist of two daughters and one son?

a. 0.375
b. 0.125
c. 0.675
d. 0.75

095. Consider the following crosses involving grey (wild-type) and yellow body colour true breeding *Drosophila*:

	Cross	F1 progeny	F2 progeny
Cross 1	Grey female × yellow male	All males : grey All females : grey	Grey females: 98 Yellow males: 45 Grey males: 49
Cross 2	Yellow females × grey males	All males : yellow All females : grey	?

Assuming 200 F2 offsprings are produced in cross 2, which one of the following outcome is expected?

a. 97 grey males, 54 yellow females, 49 grey males.
b. 102 yellow males, 46 yellow females, 52 grey females.
c. 52 grey males, 49 yellow males, 48 yellow females, 51 grey females.
d. 98 grey males, 94 yellow females, 2 yellow males, 6 grey females.

096. The ABO blood type in human is under the control of autosomal multiple alleles. Colour blindness is recessive X-linked trait. A male with a blood type A and normal vision marries a female who also has blood type A and normal vision. The couple's first child is a male who is colour blind and has O blood group. What is the probability that their next female child has normal vision and O blood group?

    a. 1/4
    b. 3/4
    c. 1/8
    d. 1

097. The following is a schematic representation of region (showing six bands) of the polytene chromosome of *Drosophila*, along with the extent of five deletions (Del1 to Del5):

Recessive alleles *a*, *b*, *c*, *d*, *e* and *f* are known to correspond to each of the bands (1 to 6), but their order is not known. When the recessive alleles are placed against each of these deletions, the following results are obtained. The plus (+) in the table indicates wild type phenotype of the corresponding allele, while a minus (−) indicates the phenotype governed by the corresponding mutant allele.

	a	b	c	d	e	f
Del 1	+	−	−	−	+	+
Del 2	+	+	−	−	+	+
Del 3	−	+	−	−	+	+
Del 4	−	+	+	−	−	+
Del 5	−	+	+	+	−	−

Which one of the following indicates the correct location of the recessive alleles on the bands of the polytene chromosomes?

    a. a-3, b-1, c-2, d-4, e-5, f-6
    b. a-2, b-1, c-3, d-4, e-5, f-6
    c. a-4, b-1, c-2, d-3, e-5, f-6
    d. a-6, b-2, c-3, d-4, e-1, f-5

098. The following figure depicts the relationship between a genetic map for four genes (A, B, C and D) and their corresponding physical map:

The following statements are made to explain this relationship:

1. More number of recombination events occur between A and B as compared to B and C.

2. Lesser number of recombination events occur between C and D as compared to B and C.

3. Although the physical distance between A and B is less than that between C and D, the region between A and B is more recombinogenic.

4. The physical distance between A and B is less than that between C and D, and thus the region between A and B is less recombinogenic.

5. Although the physical distance between C and D is more than that between B and C, the region between C and D is less recombinogenic.

6. Although the physical distance between C and D is more than B and C, the region between C and D is more recombinogenic.
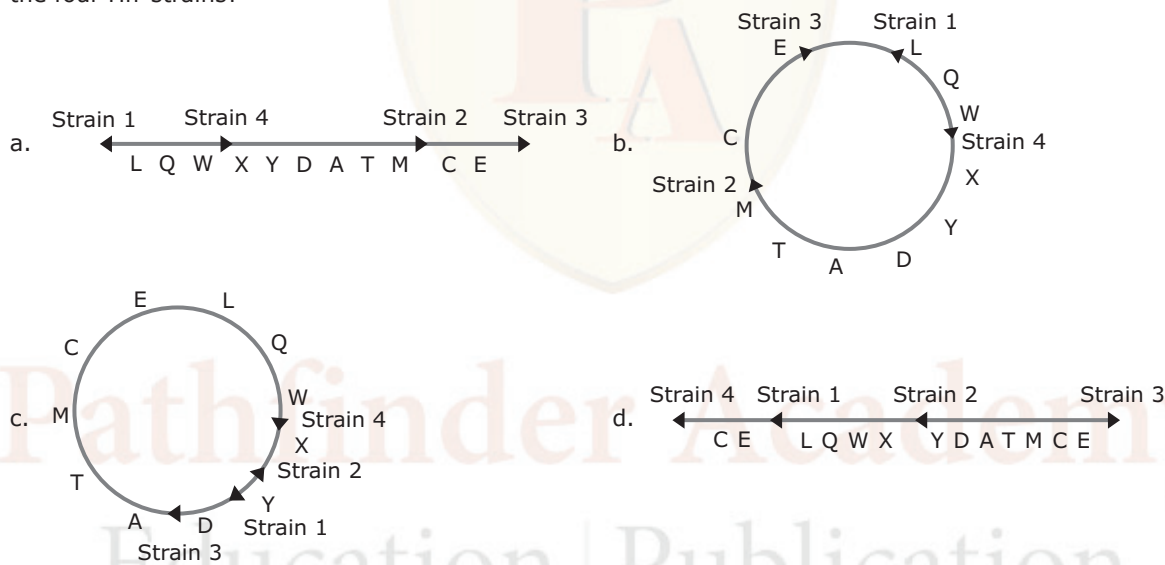
Which statements are *correct*?

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

099. In *E. coli* four Hfr strains donate the following genetic markers in the order shown below:

Strain 1	L	Q	W	X	Y
Strain 2	M	T	A	D	Y
Strain 3	E	C	M	T	A
Strain 4	W	Q	L	E	C

Which of the following depicts the *correct* order of the markers and the site of integration (→) of the F-factor in the four Hfr strains?

Unit 9 and 10 | Part – B

100. Aquatic primary production was measured using Light-and-Dark Bottle technique. If the initial oxygen concentration was I and the final oxygen concentration in the light bottle was L and that in the dark bottle D, the gross productivity (in terms of oxygen released) is given as

a. L – I
b. I – D
c. I – L
d. L – D

101. Which of the following processes interferes in sequence-based phylogeny?

a. Horizontal gene transfer
b. Adaptive mutations
c. DNA repair
d. Reverse transcription

102. Which of the following groups of species are typical of grassland habitats in India?

a. Black buck, wolf, great Indian bustard, lesser florican.

b. Spotted deer, dhole, peacock, finch-lark.

c. Sambar, tiger, paradise fly catcher.

d. Otter, cormorant, darter, pelican.

103. The atmosphere in a sealed space craft contains

a. pure oxygen

b. a mix of oxygen and nitrogen

c. a mix of oxygen and carbon dioxide

d. pressurised atmospheric air available normally on earth

104. The Hutchinsonian concept of ecological niche is based on

a. microhabitat occupied.

b. multidimensional hypervolume.

c. role played in the ecosystem.

d. a combination of role played and microhabitat occupied.

105. A specialist species has a

a. wider niche and high efficiency of niche utilization.

b. narrower niche and high efficiency of niche utilization.

c. wider niche and low efficiency of niche utilization.

d. narrower niche and low efficiency of niche utilization.

106. The rattans and canes that we use in furniture belong to

a. bamboos

b. palms

c. arborescent lilies

d. legumes

107. Horse shoe crabs belong to the group

a. Onychophora

b. Chelicerata

c. Uniramia

d. Crustacea

108. The presence of *Salmonella* in tap water is indicative of contamination with

a. industrial effluents

b. human excreta

c. agriculture waste

d. kitchen waste

109. Which of the following is not a physiological characteristic of early successional plants?

a. High respiration rate

b. Inhibition by far-red light

c. High transpiration rate

d. Low photosynthetic rate

110. In transverse sections of a young stem, if vallecular canals and carinal canals are present, then the plant belongs to

a. lycopodiales

b. isoetales

c. selaginellales

d. equisetales

111. *Batrachochytrium dendrobatidis*, a fungus, has been implicated in the decline of populations of

a. fish

b. frogs

c. pelicans

d. bats

112. Wetlands are conserved internationally through an effort called as

a. Basel convention

b. Rio convention

c. Montreal convention

d. Ramsar convention

Unit 9 and 10 | Part − C

113. Chlorophyll pigment composition and carbohydrate food reserves of some algal groups are given below:

Pigments: (i) Chlorophyll a and b; (ii) Chlorophyll a and c

Carbohydrate food reserve; (a) Paramylon; (b) Starch; (c) Laminarin; (d) Leucosin.

Identify the *correct* combination of the characters for the given groups.

a. Euglenophyta–(i and a); Bacillariophyta–(ii and d); Phaeophyta–(ii and c); Chlorophyta–(i and b).

b. Euglenophyta–(ii and a); Bacillariophyta–(ii and d); Phaeophyta–(i and c); Chlorophyta–(i and b).

c. Euglenophyta–(i and a); Bacillariophyta–(ii and b); Phaeophyta–(i and c); Chlorophyta–(ii and d).

d. Euglenophyta–(i and d); Bacillariophyta–(ii and a); Phaeophyta–(ii and c); Chlorophyta–(i and b).

114. Identify the synapomorphies in the following cladogram:
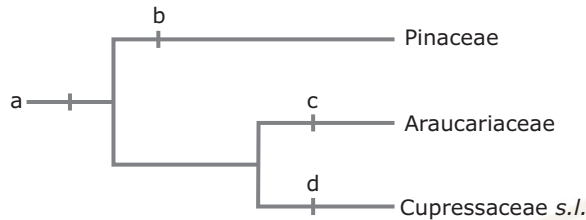
a. (a) seeds with long terminal wing; (b) ovules 1-20 per scale; (c) resin canals; (d) 1 ovule per scale.

b. (a) resin canals; (b) seeds with long terminal wing; (c) 1 ovule per scale; (d) ovules 1-20 per scale

c. (a) resin canals; (b) ovules 1-20 per scale; (c) seeds with long terminal wing; (d) 1 ovule per scale.

d. (a) seeds with long terminal wing; (b) ovules 1-20 per scale; (c) 1 ovule per scale; (d) resin canals.

115. During a field study, three insects with the following characteristics were observed:

P. elongate, membranous wings with net-like venation, long and slender abdomen, large compound eyes.

Q. small bodied, sucking mouth parts, narrow wings fringed with setae.

R. sclerotized forewings, membranous hindwings, chewing mouth parts.

They can be identified to their respective orders as

a. P-Orthoptera; Q-Hemiptera; R-Coleoptera.

b. P-Odonata; Q-Coleoptera; R-Hemiptera.

c. P-Orthoptera; Q-Odonata; R-Coleoptera.

d. P-Odonata; Q-Thysanoptera; R-Coleoptera.

116. From among the five animals listed below, match the two attributes–amniotic egg, and endothermy, with the correct animal(s):

1. Fish

2. Frog

3. Crocodile

4. Pigeon

5. Zebra

a. amniotic egg: 2, 3, 4; endothermy: 4, 5

b. amniotic egg: 3, 4, 5; endothermy: 4, 5

c. amniotic egg: 1, 2, 3, 4; endothermy: 3, 4, 5

d. amniotic egg: 2, 3, 4; endothermy: 3, 4, 5

117. Which of the following is *not* true for a critically endangered species?

a. Reduction of population breeding ability due to increased relatedness through the action of incompatibility mechanisms in plants or behavioural difficulties in animals.

b. The individuals of the species which have declined to low numbers are still a genetically open system.

c. Loss of some alleles from the species causing loss of genetic diversity with consequent inability to respond rapidly to selection.

d. Expression of deleterious alleles and increased homozygosity increases mortality of young, and inbreeding depression leads to reduced offspring fitness.

118. In the global nitrogen cycle, the following microbial organisms are involved in three important process–denitrification, nitrification and nitrogen fixation.

1. *Rhizobium*

2. *Nitrosomonas*

3. *Nitrobacter*

4. *Pseudomonas*

5. *Azotobacter*

Which of the following is the *correctly* matched pair of process and its causative species?

a. Denitrification - (2); nitrogen fixation - (3) and (4); nitrification - (4)

b. Denitrification - (4); nitrogen fixation - (1) and (5); nitrification - (3)

c. Denitrification - (5); nitrogen fixation - (1) and (4); nitrification - (4)

d. Denitrification - (2); nitrogen fixation - (1) and (4); nitrification - (3)

119. Which of the following graphs illustrates the current consensus on the role of *disturbance* on the species richness of a community?
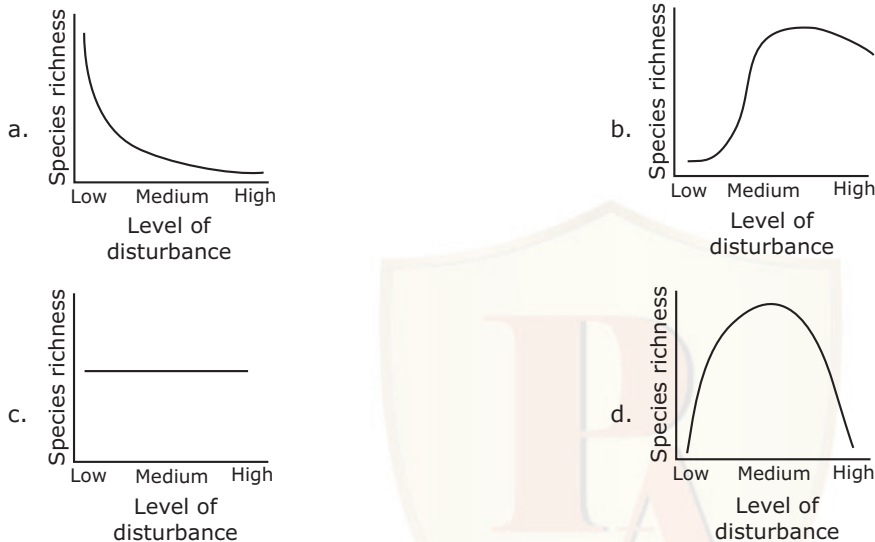
120. Suppose you discovered a new species about which you know only two facts: it is small-sized (<10 cm) and short-lived (<20 days). Which of the following reproductive strategies is most likely to be *true* for this species?

a. Breeds early and more than once in life and produces large number of small-sized offspring.

b. Breeds late and only once in life and produces large number of small-sized offspring.

c. Breeds early and only once in life and produces large number of small-sized offspring.

d. Breeds early and only once in life and produces a small number of large-sized offspring.

121. Autotrophs in the aquatic ecosystem, unlike their counterparts in the terrestrial ecosystem, are mostly microscopic and very low in indigestible (to the herbivores) matter. This explains the fact that compared to the terrestrial ecosystem, in the aquatic ecosystem

a. Productivity/Biomass ratios are higher and energy transfer rates to higher trophic levels are faster.

b. Productivity/Biomass ratios are lower and the energy transfer rates to higher trophic levels are slower.

c. Productivity/Biomass ratios are lower and the energy transfer rate to higher trophic levels are faster.

d. Productivity/Biomass ratios are higher and the energy transfer rate to higher trophic levels are slower.

122. Ecological compression differs from character displacement in that it operates on a

a. shorter timescale and does not involve heritable change.

b. longer timescale and does not involve heritable change.

c. shorter timescale and involves heritable change.

d. longer timescale and involves heritable change.

Unit 11 | Part – B

123. The first living beings on earth were anaerobic because

a. there was no oxygen in air

b. oxygen damages proteins

c. oxygen interferes with the action of ribozymes

d. they evolved in deep sea

124. The peacock's tail is an example of

a. natural selection
b. diversifying selection
c. sexual selection
d. group selection

Unit 11 | Part – C

125. Number of trials required for rats to learn a task when they were exposed to various conditions were as follows:

Experimental conditions	Observations
P. Light: light dark cycle – 12h: 12h	N-trials
Q. Bright light – 24h	Significantly more trials than 'N'
R. Bright Light – 24h + continuous physical disturbance	Significantly more trials than 'N'
S. Dark light – 24h + continuous physical disturbance	Significantly more trials than 'N'

Which of the following inferences is most appropriate?

a. Continuous light enhanced learning.
b. Continuous darkness inhibited learning.
c. Physical activity inhibited learning.
d. Learning was reduced by sleep loss.

126. Assume a male sparrow (species X) is hatched and reared in isolation and allowed a critical imprinting period to hear the song of a male of another sparrow (species Y). Now after the isolation, what kind of behaviour will species X show?

a. It will sing the song of species Y that it had heard in the critical period.
b. It will sing the song of its own species X.
c. It will not sing at all.
d. It will sing a song not sung by either X or Y.

127. The genetic relatedness (r) of an individual to his nephew is 0.25. The alleles that cause uncles to care for nephews will spread, according to Hamilton's Rule, only if the fitness benefit is

a. equal to the cost of care
b. more than the cost of care by 25%
c. double the cost of care
d. four times the cost of care

128. Several distinct time periods and different routes might explain the entrance of marsupials into Australia.

P. Late Jurassic–early therians arrived in Antarctica–Australia where the marsupials subsequently evolved.
Q. Early to middle Cretaceous–early marsupials arrived in Australia from northern regions and then radiated in isolation.
R. Paleocene–marsupials entered Australia from South-East Asia.
S. Eocene–chance dispersal of marsupials into Australia.

Which of the following is the *correct* combination?

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

129. The frequencies of two alleles p and q for a gene locus in a population at Hardy-Weinberg equilibrium are 0.3 and 0.7, respectively. After a few generations of inbreeding, the heterozygote frequency was found to be 0.28. The inbreeding coefficient in this case is

a. 0.42
b. 0.28
c. 0.33
d. 0.67

130. Which of the following behavioural changes are expected in a rat when its nucleus accumbens is experimentally ablated?
    a. Aggressive behaviour increases
    b. Exploratory behaviour decreases
    c. Nest-building activity increases
    d. Level of parental care drops

Unit 12 and 13 | Part − B

131. To keep them in a totipotent state, embryonic stem cells need to be maintained in a medium supplemented with
    a. growth hormone
    b. leukemia inhibiting factor
    c. nestin
    d. insulin

132. One of the methods for finding common regulatory motifs present in a set of coregulated genes is
    a. Prosite
    b. MEME
    c. MatInspector
    d. PSSM

133. Measurement and mapping with spatial resolution the membrane potential of a cell, which is too small for microelectrode impalement, is done using
    a. radioisotope
    b. voltage-sensitive dye
    c. pH sensitive chemical
    d. vital dyes

134. A sample counted for one minute shows a count rate of 752 cpm. For how many minutes should it be counted to have 1% probable error?
    a. 13
    b. 5
    c. 2
    d. 75

Unit 12 and 13 | Part − C

135. Genomic DNA of transgenic plants (P1, P2 and P3) obtained by transforming with binary vector A whose map is depicted below, was digested with BamH I and Sal I and hybridized with a labelled fragment X
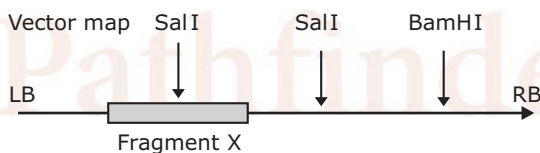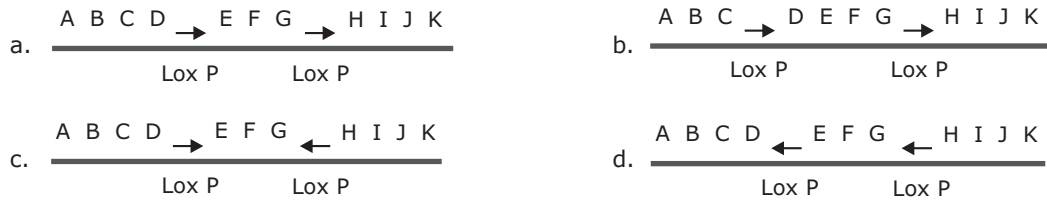

The pattern obtained in Southern hybridization is shown below:

Based on the above, which of the following interpretation is *correct*?
    a. All the plants (P1, P2 and P3) contain two copies of the transgene.
    b. P1, P3 contain one and P2 contains two copies of the transgene.
    c. P1 contains two, whereas P2 and P3 contain one copy of transgene each.
    d. P1 and P2 contain two and P3 contains one copy of the transgene.

136. Cre/loxP system is used by phage PI to remove terminally redundant sequences that arise during packaging of the phage DNA. Cre-lox system can be used to create targeted deletions, insertions and inversion in genomes of transgenic animals and plants. Consider a series of genetic markers A to K. How should the Lox P sites be positioned in order that Cre recombinase can create an inversion in the EFG segment relative to ABCD and HIJK?

a.
$$\underset{\text{Lox P}}{\text{A B C D} \rightarrow \text{E F G}} \underset{\text{Lox P}}{\rightarrow \text{H I J K}}$$

b.
$$\underset{\text{Lox P}}{\text{A B C} \rightarrow \text{D E F G}} \underset{\text{Lox P}}{\rightarrow \text{H I J K}}$$

c.
$$\underset{\text{Lox P}}{\text{A B C D} \rightarrow \text{E F G}} \underset{\text{Lox P}}{\leftarrow \text{H I J K}}$$

d.
$$\underset{\text{Lox P}}{\text{A B C D} \leftarrow \text{E F G}} \underset{\text{Lox P}}{\leftarrow \text{H I J K}}$$

137. The following are statements about molecular markers in the context of plant breeding

    P. Molecular markers can be used for elimination of undesirable traits.

    Q. Molecular markers cannot be used for estimation of the genetic contribution of each individual parent in a segregating population.

    R. Molecular markers are used for mapping of QTLs, which is also possible by conventional techniques.

    S. Molecular markers can be used for selection of individuals from a population that are homozygous for the recurrent parent genotype at loci flanking the target locus.

    Which of the above statements are *true*?

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

138. Enzymes are nowadays used extensively in bio-processing industries.

    Enzyme 1 is used for treatment of hides to provide a finer texture, in leather processing and manufacture of glue. Enzyme 2 is used for clarification of fruit juices.

    Identify enzymes 1 and 2

	Enzyme 1	Enzyme 2
a.	Amylase	Pectinase
b.	Protease	Amylase
c.	Protease	Pectinase
d.	Pectinase	Amylase

139. Stem cell therapies are being used in regenerative medicine like forming new adult bone, which usually does not regrow to bridge wide gaps. Successful attempts have now been made in this area because the same paracrine and endocrine factors were found to be involved in both endochondral ossification and fracture repair. Few methods to achieve the above are given below:

    P. Develop a collagen gel containing plasmids carrying the human parathyroid hormone gene and place in the gap between the ends of the broken leg.

    Q. Develop a gel matrix disc containing genetically modified stem cells to secrete BMP4 and VEGF-A and implant it at the site of the wound

    R. Make scaffolds of material that resemble normal extracellular matrix that could be molded to form the shape of a bone needed and seed them with bone marrow stem cell

    S. Develop a collagen gel containing plasmids carrying the human bone marrow cells and place them between the ends of the bones.

    Which of the above methods would you employ to develop a new functional bone in patients with severely fractured bones?

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

140. In order to prevent tetanus in neonates, one of the following treatments can be adopted.

    A. Treatment of the infant with anti-toxin and the toxoid.

    B. Immunize the mother with the toxoid.

    In case of A, the treatment can be given

    a. immediately after birth.

    b. after the onset on the condition.

    In case of B, the immunization has to be done

    c. before pregnancy.

    d. late in the pregnancy.

    The *correct* combination is

    a. A/a
    b. A/b
    c. B/c
    d. B/d

141. In the following statement taken from a research paper, what does p in the parenthesis stand for?

    "The mean temperature of this region now is significantly higher than the one 50 years ago ($p < 0.05$, t-test)"

    a. ratio of the mean temperatures of the time periods tested.

    b. probability of the error of rejecting a true null hypothesis.

    c. probability of the error of accepting a false null hypothesis.

    d. probability of the t-test being effective in detecting significant differences in the mean annual temperatures of the two time periods.

142. In an *in vitro* experiment using radiolabelled nucleotides, a researcher is trying to analyze the possible products of DNA replication by resolving the products using urea-polyacrylamide gel electrophoresis. In one experimental set up RNase H was added (Set 1), while in another set no RNase H was added (Set 2).

    The possible observations of this experiment could be

    P. There is no difference in the mobility of labelled DNA fragments between the Set 1 and Set 2.

    Q. There is distinct difference in the mobility of the newly synthesized labelled DNA fragments between Set 1 and Set 2.

    R. The mobility of the newly synthesized labelled DNA fragments in case of Set 1 is faster as compared to the Set 2.

    S. The mobility of the newly synthesized labelled DNA fragments in case of Set 1 is slower as compared to the Set 2.

    Which of the following combinations represent *correct* observations?

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

143. In 'TaqMan' assay for detection of base substitutions (DNA variant), probes (oligonucleotides) with fluorescent dyes at the 5'-end and a quencher at 3'-end are used. While the probe is intact, the proximity of the quencher reduces the fluorescence emitted by reporter dye. If the target sequences (wild type or the variant) are present, the probe anneals to the target sequence, downstream to one of the primers used for amplifying the DNA sequence flanking the position of the variants. For an assay two flanking PCR primers, two probes corresponding to the wild type and variant allele and labelled with two different reporter dyes and quencher were used. During extension the probe may be cleaved by the Taq-polymerase separating the reporter dye and the quencher. Three individuals were genotyped using this assay. Sample for individual I shows maximum fluorescence for the dye attached to the wild type probe, sample for individual II shows maximum fluorescence for the dye attached to variant probe and sample for individual III exhibits equal fluorescence for both the dyes. Which of the following statement is *correct*?

a. Individual I is homozygous for the variant allele.

b. Individual II is homozygous for variant allele.

c. Individual II is homozygous for wild type allele.

d. Individual III is homozygous for wild type allele.

144. Figures A and B respectively represent the dideoxy sequencing gels obtained for partial sequences from 5'-ends of a bacterial gene and its mutant (with a point mutation)

A : Wild-type   B : Mutant
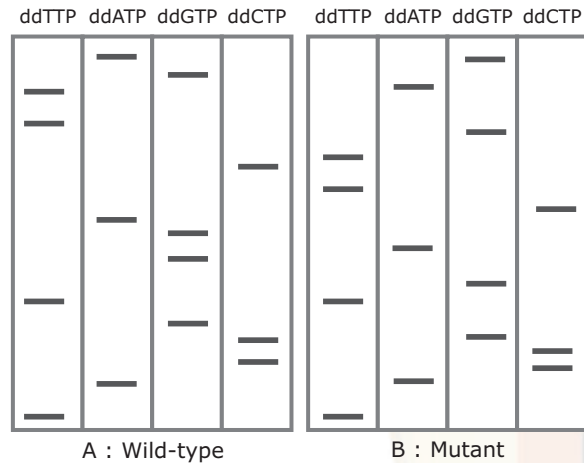
What type of mutation has occurred in the gene?

a. Nonsense

b. Missense

c. Frameshift

d. Transversion

145. The most important property of any microscope is its power of resolution, which is numerically equivalent to D, the minimum distance between two distinguishable objects. D depends on three parameters namely, the angular aperture, α, the refractive index, N, and wavelength, λ, of the incident light. Below are given few possible options to increase the resolution of the microscope.

P. Decrease the value of λ or increase either N or α to improve resolution.

Q. Moving the objective lens closer to the specimen will decrease sin α and improve the resolution.

R. Using a medium with high refraction index between the specimen and the objective lens to improve the resolution.

S. Increase the wavelength of the incident light to improve the resolution.

Which of the following combination of above statements is *correct*?

a. P and R

b. Q and R

c. P and S

d. R and S

Answers

PART – A

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

PART – B and C

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

Explanations

003. $\angle$A is larger than $\angle$C and smaller than $\angle$B by the same amount means that,

$\angle$A – $\angle$C = $\angle$B – $\angle$A

2$\angle$A = $\angle$B + $\angle$C; given that $\angle$B = 67°

2$\angle$A = 67° + $\angle$C …(1)

As we know that, in triangle $\angle$A + $\angle$B + $\angle$C = 180°

$\angle$A + 67° + $\angle$C = 180°

$\angle$A = 180° – (67° + $\angle$C)

From equation (1), 2 × [180° – (67° + $\angle$C)] = 67° + $\angle$C

360° – 134° – 2$\angle$C = 67° + $\angle$C

3$\angle$C = 360° – 134° – 67° = 360° – 201° = 159°

So, $\angle$C = 159°/3 = 53°

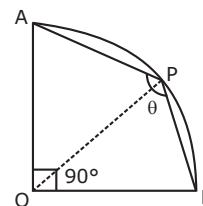007. P is the mid-point of arc AB. Radius OP bisects both $\angle\theta$ and $\angle APB$.

There are two isosceles triangles, $\triangle OPA$ and $\triangle OPB$.

All the base four angles are equal because OP bisects $\angle\theta$.

$\angle OAP = \angle OPA = \angle OPB = \angle OBP = \angle OBP = x°$

In quadrilateral OAPB, $4x = 360° - 90° = 270°$

$\angle\theta = 2x = 135°$

019. Energy expenditure $E = \dfrac{1}{2}mv^2$; where, m is the mass and v is the velocity or speed.

Here the speed remains same in two cases. So, energy expenditure (E) is proportional to mass or weight of the body.

Thus, $E_1 : E_2 = W_1 : W_2 = 1 : 0.8$; because overweight person losing 20% of his body weight.

So, energy expenditure (E_2) in the second case would also be 20% less.

024. $\Delta G = \Delta G^{0\prime} + 2.303\ RT \log Q$; where, $Q = \dfrac{[\text{Products}]}{[\text{Reactants}]}$ and $R = 1.987$ cal/K-mol

When a reaction is at equilibrium, substitution of $\Delta G = 0$, then

$\Delta G^{0\prime} = -2.303\ RT \log K_{eq}$; where, $Q = K_{eq} = \dfrac{[\text{Products}]}{[\text{Reactants}]}$

$\Delta G^{0\prime} = -2.303 \times 1.987$ cal/K-mol $\times 298 \times \log 100 = -4.576061 \times 298 \times 2 = -2727$ kcal/mole

028. Henderson–Hasselbalch equation is, $pH = pK_a + \log \dfrac{[HCO_3^-]}{[H_2CO_3]}$

$7.4 = 6.1 + \log \dfrac{[HCO_3^-]}{[H_2CO_3]}$

$\log \dfrac{[HCO_3^-]}{[H_2CO_3]} = 7.4 - 6.1 = 1.3$

$\dfrac{[HCO_3^-]}{[H_2CO_3]} = \dfrac{20}{1}$

029. Given $1U = 10$ μmol PP_i/15 min (for this enzyme)

$V_{max} = 2800$ U/mg enzyme

$\dfrac{\text{Number of moles of substrate}}{\text{mg} \times \text{second}} = \dfrac{2800\ U}{mg} \times \dfrac{10\ \mu mol\ PPi}{15\ min} \times \dfrac{1\ min}{1U} \times \dfrac{1\ min}{60\ s} = 31.1\ \mu mol\ PP_i\ s^{-1}\ mg^{-1}$

037. A major practical distinction between the eukaryotic RNA Pol is drawn from their response to the bicyclic octapeptide α-amanitin. In all eukaryotic cells the activity of RNA polymerase II is rapidly inhibited by low concentrations of α-amanitin. RNA polymerase I is not inhibited. The response of RNA polymerase III to α-amanitin is less well conserved; in animal cells it is inhibited by high levels, but in yeast and insects it is not inhibited.

Source: Gene IX by Benjamin Lewin

044. Correct option should be P and R.

045. Homing introns encode an endonuclease that is responsible for their movement. The endonuclease cleaves a recognition sequence within the target gene and generates short overhanging ends. This double-stranded break triggers a gene conversion event in which the intact version of the gene is copied and used to repair the break. Group II homing introns are retro-elements that use an RNA intermediate. The proteins they encode have both endonuclease and reverse transcriptase activity.

Source: Molecular Biology by David Clark, Southern Illinois University

047. Initiation Factor 1 (IF1) is required for the initiation of translation in *Escherichia coli*. However, the precise function of IF1 remains unknown. Current evidence suggests that IF1 is an RNA-binding protein that sits in the A-site of the decoding region of 16S rRNA. IF1 binding to 30S sub-units changes the reactivity of nucleotides in the A site to chemical probes.

   IF3 is an RNA-binding protein. It is known to function as:

   1. IF3 antagonizes the association between 30S and 50S subunits;

   2. IF3 accelerates the on-rate of codon–anticodon interaction at the P-site, thus stimulating the formation of 30S initiation complexes.

   Source: *The EMBO Journal (2001) 20, 4560 – 4569*

   Source: *J. Mol. Biol. (2000) 299, 1-15*

074. In the current view, ethylene is sensed by a family of receptors that show similarity to the bacterial two-component histidine kinases, and function as *negative regulators* of the pathway. Binding of the ethylene gas *turns off* the receptors, resulting in the inactivation of another negative regulator of ethylene signaling, CTR1, a Raf-like protein kinase that directly interacts with the receptors. EIN2, a protein of unknown biochemical activity that functions as a positive regulator of the pathway, acts downstream of CTR. Activation of EIN2 by ethylene leads to the activation of EIN3 and EIN3-like transcription factors. In the absence of ethylene, the levels of EIN3 protein are extremely low because of the function of two F-box-containing proteins, EBF1 and EBF2, that target EIN3 for proteasome-mediated degradation. In the presence of ethylene, the EIN3 protein accumulates in the nucleus and initiates a transcriptional cascade, resulting in the activation and repression of hundreds of genes.

   Source: *Science (2004) by Jose M Alonso, Anna N Stepanova*

085. From Lens equation, we have $\frac{1}{f} = \frac{1}{d_0} + \frac{1}{d_i}$; where, d_0 = object distance, d_i = image distance and f = focal length.

   $$\frac{1}{0.017} = \frac{1}{10} + \frac{1}{d_i}$$

   $$\frac{1}{d_i} = 58.82 - 0.10 = 58.72.$$

   So, d_i = 0.017 m

   For image height, we have $\frac{h_i}{h_o} = -\frac{d_i}{d_0}$; where, h_o = height of the object, h_i = height of the image.

   $$\frac{h_i}{1} = -\frac{0.017}{10}$$

   h_i = −0.0017 m = −1.7 mm

091. Types of gametes from AaBb: $\frac{1}{4} AB + \frac{1}{4} Ab + \frac{1}{4} aB + \frac{1}{4} ab$

   Parents genotype: AaBb   ×   AaBb

   　　　　Gametes: AB   ab   Ab   aB   AB   ab   Ab   aB
   　　　　　　　　1/4 1/4 1/4 1/4   1/4 1/4 1/4 1/4

   Proportion of the progeny of genotype, $aabb = \frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$

094. Each possible birth order = 1/8

   $P(G, G, B) = P(G, B, G) = P(B, G, G) = \frac{1}{8}$

   So, $P(2G, 1B) = \frac{1}{8} + \frac{1}{8} + \frac{1}{8} = \frac{3}{8} = 0.375$

096. There is a 1/2 chance that one parent will give the recessive O-chromosome.

Probability of recessive alleles given by parents to child $= \dfrac{1}{2} \times \dfrac{1}{2} = \dfrac{1}{4}$

Probability that a girl will have normal vision = 1

Probability that a child will be a girl = 1/2

Probability that their next child will be a girl and will have O blood group $= \dfrac{1}{4} \times 1 \times \dfrac{1}{2} = \dfrac{1}{8}$

127. According to the Hamilton's rule, r × B > C

Where, r is the genetic relatedness, B is the fitness benefit and C is the cost.

0.25 × B > C

$B > \dfrac{C}{0.25}$

So, B > 4C

129. Inbreeding coefficient $= \dfrac{2\,pq - H_{obs}}{2\,pq} = \dfrac{2 \times 0.3 \times 0.7 - 0.28}{2 \times 0.3 \times 0.7} = \dfrac{0.42 - 0.28}{0.42} = \dfrac{0.14}{0.42} = 0.33$

Where, H_{obs} = frequency of observed heterozygote, frequency of p = 0.3 and frequency of q = 0.7.

144. Sequence on Sanger's gel is read from bottom to top (5' → 3'). So, if we read sequence of the strains we observe that,

Wild-type 5' TAC CGT GGA CTT GA 3'

Mutant   5' TAC CGT G**AC TTG AG 3'**

If we align these sequence we find that a single change caused frameshift (insertion or deletion) which resulted in change of sequence after TACCGTG (shown in bold). If it would have been missense mutation rest of the sequence after one base should not change. In case of nonsense mutation stop codon should be introduced.

145. Wavelength, aperture N are related through Abbe's equation as,

$D = \dfrac{0.61\lambda}{N \sin\alpha}$

D should be as small as possible for better resolution. In order to make D small, λ should be small, N and α should be large. Therefore, decrease in the value of λ or increase either N or α will improve resolution (statement P) and using a medium with high refraction index (N) between the specimen and the objective lens to improve the resolution (statement R).

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