UNIT 7

Part B

June 2011

80. 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

Ans: c

81. 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.

Ans: a

82. *Graves disease is associated with*

a. *insufficiency of thyroid hormones*
b. *excess of thyroid hormones*
c. insufficiency of corticosteroids
d. excess of growth hormones

Ans: b

December 2011

81. 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

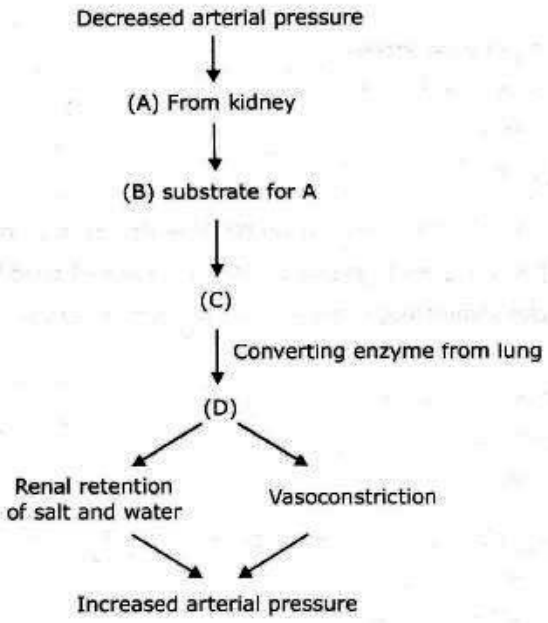
Ans: b

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

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

Ans: b

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



a. Renin, Angiotensin II, Angiotensin I, Angiotensinogen.
b. Angiotensin I, Angiotensinogen, Angiotensin II, Renin.
c. Renin, Angiotensin I, Angiotensin II, Angiotensinogen.
d. Renin, Angiotensinogen, Angiotensin I, Angiotensin II.

Ans: d

June 2012

79. Which one of the following changes will occur in the cell membrane of nodal tissue of heart, which results in an increased heart rate due to stimulation of sympathetic nerves?

a. Opening of sodium channels is facilitated
b. Potassium conductance is increased
c. Opening of L-calcium channels are facilitated
d. 'h' channels are inhibited

Ans: c

80. A person takes 1.0 ml of insulin injection daily at 8.00 AM. His son gave him 1.5 ml insulin at 8.00 AM considering the father will go to party and eat more during lunch. The father also avoided breakfast, as he planned to eat more during lunch. Which one of the following events will occur?

a. Father will be normoglycemic.
b. Father will be in hypoglycemic condition before lunch.
c. Father will be in hyperglycemic condition before lunch.
d. Blood glucose of father will be low after taking lunch.

Ans: b

December 2012

82. Which one of the following is responsible for the ejection of milk from mammary glands in mammals?

a. Oxytocin
b. Prolactin
c. Serotonin
d. Melatonin

Ans: a

83. The T-wave of ECG indicates

a. atrial depolarization
b. ventricular depolarization
c. ventricular repolarization
d. atrial repolarization

Ans: c

June 2013

83. What would be the outcome if the theca interna cells were destroyed in a *Graafian* follicle?

a. Immediate formation of corpus albicans.
b. Increased progesterone synthesis in the granulosa cells.
c. Decreased estrogen synthesis in the granulosa cells.
d. Formation of corpus hemorrhagicum.

Ans: c

84. The size of red blood cells (RBC) in venous blood is greater than that of arterial blood. This increased size of red blood cell in the venous blood is due to

a. the increased permeability of red blood cell (RBC) membrane.
b. the decreased osmotic pressure in plasma.
c. the increased osmotic pressure in RBC.
d. the dissociation of cytoskeletal proteins in RBC.

Ans: c

December 2013

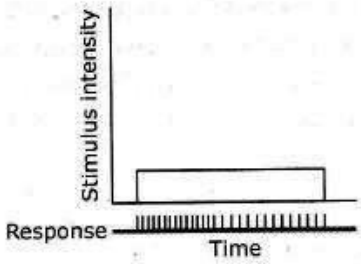
84. The only bone marrow cell that never appears in peripheral blood is

a. myeloblast
b. myelocyte
c. lymphoblast
d. megaloblast

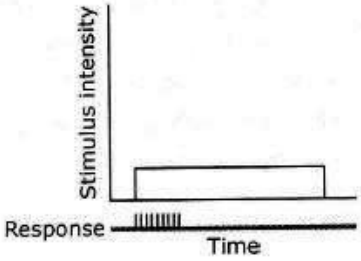
Ans: d

85. Various types of excitable tissues when stimulated showed response as shown in the figures below. Which one of them is an example of fast adapting tissue?

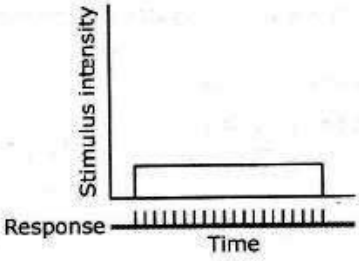
P.



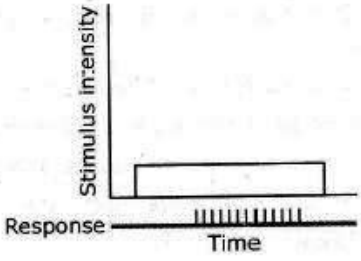
Q.



R.



S.



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

Ans: b

86. Thyroxin releasing hormone (TRH) receptor belongs to

a. nuclear receptor family
b. receptor tyrosine kinase family
c. G-protein–coupled receptor family
d. guanylate cyclase receptor family

Ans: c

June 2014

84. One hemoglobin molecule containing four heme groups can bind with four O_2. The reactions of Hb and O_2 are shown below. Which one of the following reactions is fastest?

a. $Hb_4 + O_2 \rightleftharpoons Hb_4O_2$
b. $Hb_4O_2 + O_2 \rightleftharpoons Hb_4O_4$
c. $Hb_4O_4 + O_2 \rightleftharpoons Hb_4O_6$
d. $Hb_4O_6 + O_2 \rightleftharpoons Hb_4O_8$

Ans: d

December 2014

77. Which one of the following cells in the renal corpuscle can influence glomerular filtration by its contraction?

a. Podocytes
b. Endothelial cells of glomerular capillaries
c. Parietal epithelial cells of Bowman's capsule
d. Mesangial cells

Ans: d

78. Production of excessive amount of corticotropin (ACTH) occurs in which one of the following?

a. Graves' disease
b. Cushing's syndrome
c. Grieg's syndrome
d. Alport's syndrome

Ans: b

79. The type-I glomus cells present in the carotid bodies contain granules which release some substances during hypoxia. Which one of the following is released in hypoxia?

a. Serotonin
b. GABA
c. Dopamine
d. IL-8

Ans: c

80. Which one of the following functions is *not* served by the plasma proteins?

a. Blood clotting
b. O_2 transport
c. Hormone binding and transport
d. Buffering capacity of blood

Ans: b

June 2015

85. The S wave of normal human ECG originates due to

a. septal and left ventricular depolarization.

b. late depolarization of the ventricular walls moving back toward the AV junction

c. left to right septal depolarization.

d. repolarization of atrium.

Ans: b

86. In which of the following conditions is Basal Metabolic Rate (BMR) the lowest?

a. Awake and resting

b. Prolonged starvation

c. Sleep

d. Higher environmental temperature

Ans: b

87. Which one of the following skeletal muscles of human body contains highest number of muscle fibre in a motor unit?

a. Muscles of hand

b. Extraocular muscles

c. Muscles of leg

d. Muscles of face

Ans: c

88. Which one of the following viruses cause acute gastrointestinal illness due to contamination of drinking water?

a. Norovirus

b. Poliovirus

c. Rotavirus

d. Filoviruses

Ans: a,c

89. An extraordinary sensory ability that elephants possess is

a. emission and detection of ultra high frequency sounds.

b. emission and detection of ultra low frequency sounds.

c. detection of changes in earth's magnetic field.

d. possession of ultraviolet vision.

Ans: b

Part C

June 2011

83. The time taken for atrial systole and diastole in a normal heart are t_{as} and t_{ad} seconds, respectively. If ventricular systole takes t_{vs} seconds, calculate the ventricular diastolic time (seconds).

a. $(t_{as} + t_{ad}) - t_{vs}$

b. $(t_{as} - t_{ad}) + t_{vs}$

c. $(t_{ad} - t_{as}) - t_{vs}$

d. $(t_{as} + t_{ad}) \times t_{vs}$

Ans: a

84. 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

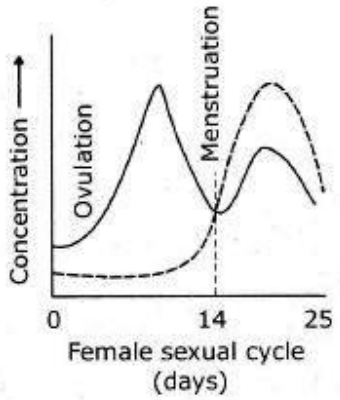
Ans: c

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

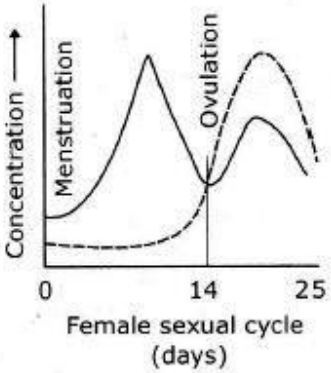
— estrogen

--- progesterone

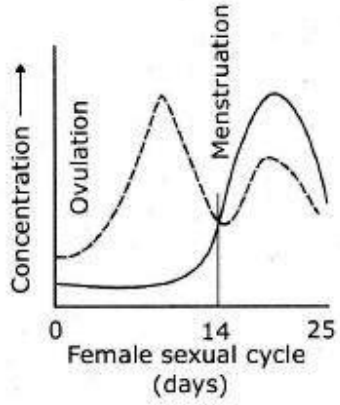
a.



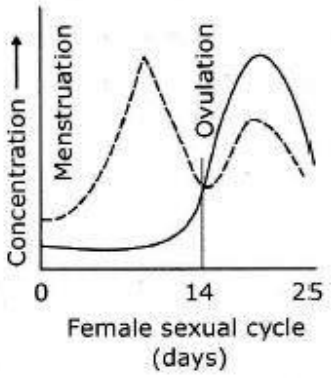
b.



c.



d.



Ans: b

86. 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

Ans: c

87. 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

Ans: b

December 2011

84. 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

Ans: a

85. 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 cms)

a. 0.17 mm
b. 1.7 mm
c. 3.4 mm
d. 170 μm

Ans: b

86. 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. $A_s + A_d > V_s + V_d$

Ans: a

87. 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.

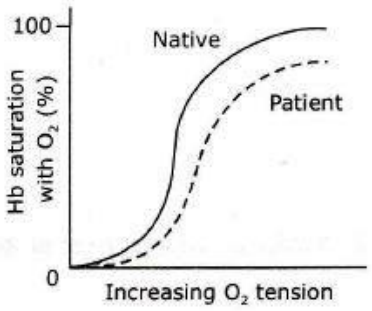
Which one of the following is *correct*?

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

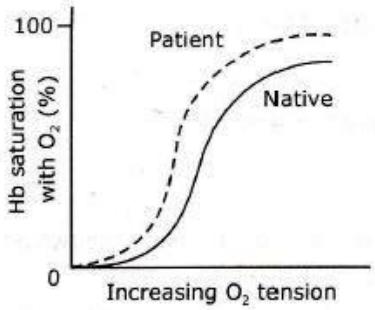
Ans: a

88. 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.

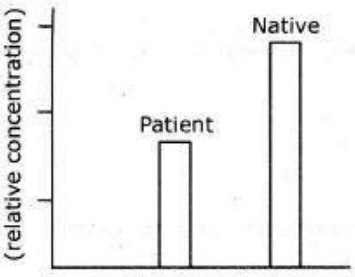
P.



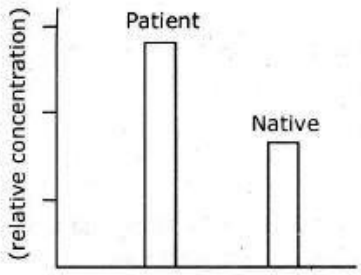
Q.



R.



S.



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

Ans: a

89. 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.

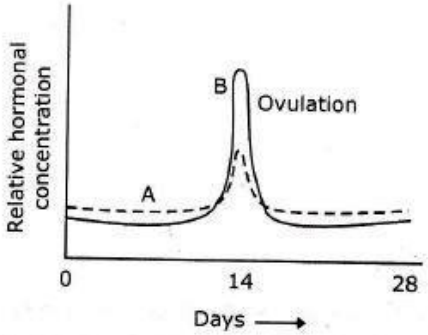
b. cholinergic and non-adrenoceptive neurons.

c. adrenergic terminals in 'A'.

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

Ans: b

90. 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

Ans: c

June 2012

81. Level of follicle stimulating hormone (FSH) during infancy and adulthood is the same but spermatogenesis is seen only during adulthood. mRNA levels coding for FSH receptor are also found to be the same in testis of both age groups. Which of the following investigations will clarify this paradox a little more?

a. Culture testicular cells and add LH to see testosterone production.

b. Culture testicular cells and add testosterone to see comparative rise in FSH mRNA from both age groups.

c. Culture testicular cells and add FSH to see comparative rise in cAMP production by both age groups.

d. Add both LH and FSH to testicular cells and evaluate cAMP production.

Ans: c

82. The intestinal absorption of glucose is impaired by the use of ouabain, an inhibitor of Na^+/K^+ ATPase. Indicate the *correct* explanation.

a. The inhibitor has blocked the transport of Na^+ from intestinal lumen to epithelial cells.

b. The inhibitor has blocked the transport of Na^+ from epithelial cells to the intestinal lumen.

c. The inhibitor has blocked Na^+ transport from epithelial cells to the interstitial space.

d. The inhibitor has blocked Na^+ transport from the interstitial space to epithelial cells.

Ans: d

83. The stereocilia of auditory hair cells are arranged in rows but the heights of stereocilia are not the same in all the rows. Though the height of stereocilia is the same within a particular row, the heights increase in subsequent rows. When the stereocilia of shorter rows are mechanically pushed towards the taller rows, the hair cells are depolarized but a push on opposite direction hyperpolarizes them. The significance of this graded height of stereocilia is:

P. Each row of stereocilia may be displaced independent of other rows in physiological conditions.

Q. The tip of the taller stereocilia will show greater displacement as compared to shorter ones when all the rows are moving in the same axis.

R. The hair cells will be depolarized or hyperpolarized in different grades when the axis of displacement is changed.

Ans: c

83. The stereocilia of auditory hair cells are arranged in rows but the heights of stereocilia are not the same in all the rows. Though the height of stereocilia is the same within a particular row, the heights increase in subsequent rows. When the stereocilia of shorter rows are mechanically pushed towards the taller rows, the hair cells are depolarized but a push on opposite direction hyperpolarizes them. The significance of this graded height of stereocilia is:

P. Each row of stereocilia may be displaced independent of other rows in physiological conditions.

Q. The tip of the taller stereocilia will show greater displacement as compared to shorter ones when all the rows are moving in the same axis.

R. The hair cells will be depolarized or hyperpolarized in different grades when the axis of displacement is changed.

S. The taller stereocilia are involved with depolarization and shorter ones are responsible for hyperpolarization.

Which one of the following is *correct*?

a. P only

b. Q only

c. Q and R

d. P and S

Ans: c

84. GnRH is secreted during infancy (0–6 months) and puberty onwards (4 years and above) in monkeys. However, i.v injection of GnRH during pre-pubertal period (about 2 years of age) led to elevated LH and FSH in blood compared to untreated 2 years old monkey. This suggests that:

P. Hypothalamus is active during pre-pubertal period.

Q. GnRH action on pituitary is age dependent.

R. Pituitary matures during adulthood.

S. Pituitary is active in all the stages of development in monkey.

Which one of the following is *true*?

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

Ans: d

85. A person has been suffering from night blindness. On consultation, the doctor advised the person to eat carrots and/or cod fish oil. After some time having seen no improvement, the doctor gave the person vitamin A injection. Still no marked improvement was seen. The doctor mooted several suggestions indicating lack of the following enzymes for the failure of treatment:

P. Retinol dehydrogenase

Q. Retinal reductase

R. Retinal isomerase

S. Retinal synthase

Which one of the following is *correct*?

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

Ans: a

86. A person suffering from thyrotoxicosis has extremely high level of thyroid hormone in blood. There is a failure of feedback regulation in hypothalamic-pituitary-thyroid axis. The detailed blood investigation exhibited high level of the following:

P. Thyroid stimulating hormone (TSH).

Q. Thyroid stimulating immunoglobulin (TSI).

R. Thyrotropin releasing hormone (TRH).

S. Parathyroid hormone (PTH).

In your opinion, which one of the following is the reason for such thyrotoxicosis?

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

Ans: b

December 2012

84. An experimentalist stimulates a nerve fibre in the middle of an axon and records the following observation. Which one of the observation is *correct*?

a. Nerve impulse is travelling in a direction towards cell body.

b. Nerve impulse is travelling in a direction towards telodendrons.

c. Nerve impulses are travelling in both the directions opposite to each other.

d. Nerve impulse is not moving in either direction.

Ans: c

85. Desert animals have longer loop of Henle compared to that of humans. It may be due to the following reasons:

P. Long loop of Henle is associated with greater amount of vasopressin secretion.

Q. In long loop of Henle, the counter-current exchanger is more effective.

R. Long loop of Henle conserves more water.

S. Long loop of Henle stimulates production of angiotensin II.

Which of the above reason(s) is/are *correct*?

a. P and Q

b. Q and R

c. R and S

d. only S

Ans: b

86. A boy eats a large serving of cheese having high amount of sodium. He hardly drinks any fluid. Inspite of this, the water and electrolyte balance was maintained. Which one of the following explanation is *correct*?

a. His aldosterone was decreased and alcohol dehydrogenase (ADH) was increased.

b. His aldosterone was increased and ADH was decreased.

c. There was no change in either of the hormones.

d. His sympathoadrenal system was stimulated.

Ans: a

87. The blood volume decreased when a mammal was bled rapidly. However, the cardiovascular changes resulting from hemorrhage could be minimized by the following compensatory mechanism:

P. Increased cerebral blood flow.

Q. Reduction of baroreceptor activity and stimulation of chemoreceptors.

R. Reabsorption of tissue fluid in blood.

S. Increased release of enkephalins and β-endorphins.

Which of the above is/are *correct*?

a. P and Q

b. Q and R

c. R and S

d. only S

Ans: b

88. The stomach of a person was partially removed during surgery of a gastric tumour. Despite taking a balanced diet, the person developed anemia. Following possible explanations were offered:

P. Lower gastric secretion inhibits folic acid absorption.

Q. Protein digestion was disturbed in partial gastrectomy.

R. Lower HCl secretion from stomach reduced iron absorption.

S. Lower secretion of intrinsic protein factor from stomach reduced VitB_{12} absorption.

Which of the above explanations were *correct*?

a. P and Q

b. Q and R

c. R and S

d. P and S

Ans: c

June 2013

85. In bone marrow, stem cells are committed to different lineages. Factors that stimulate the colonies of these different lineages are interleukin-3 (multi-CSF), granulocyte-macrophage colony stimulating factor (GM-CSF) and granulocyte or macrophage colony stimulating factor (G-CSF or M-CSF). In a mouse deficient in GM-CSF, the number of hematopoietic cells will be altered. Which one of the following is *correct*?

a. Mast cells will be normal in number while granulocytes and macrophages will be deficient in number.

b. Granulocytes count will be normal but not of macrophages.

c. Macrophage number will remain unaltered.

d. Mice will be deficient in all the three cell types.

Ans: a

86. An individual was suffering from digestive complications. It was observed that the individual had dehydrated gastrointestinal tract. When an advanced investigation was done, the person was found to have defects in the following:

P. cystic fibrosis transmembrane conductance regulator protein.

Q. glucose transporter protein.

R. Na^+/K^+ATPase.

S. Ca^{2+}ATPase.

Which of the above could be the cause for such a digestive disorder?

a. P only

b. Q and R

c. R and S

d. S only

Ans: a

87. The action potential was recorded intracellularly from a squid giant axon bathed in two types of fluid such as sea water and artificial sea water having lower concentration of sodium ions while maintaining the same osmotic pressure with choline chloride. The nature of action potential was different in the two bathing fluids. Which of the following results is most likely?

a. The resting transmembrane potential was not changed but the amplitude of action potential was increased with lower sodium concentration in the bathing fluid.

b. The amplitude of action potential was gradually decreased with reduction of sodium concentration in bathing fluid but the duration of action potential was prolonged.

c. The resting transmembrane potential was decreased and the amplitude of action potential was also decreased with lower sodium concentration in the bathing fluid.

d. The amplitude of action potential was not changed with reduction of sodium concentration in the bathing fluid but the duration of action potential was prolonged.

Ans: b

88. Three forms of dextrans namely neutral, polyanionic and polycationic having different molecular radii were injected separately in three groups of rats. The concentrations of dextrans in glomerular filtrate were measured to determine the filterability of the dextrans. The possible outcomes could be as follows:

P. The dextrans having smaller diameter have greater filterability than larger dextrans.

Q. Neutral dextrans were filtered more than polycationic and polyanionic dextrans.

R. Polycationic dextrans were filtered more than neutral and polyanionic dextrans.

S. Polyanionic dextrans were filtered more than neutral and polycationic dextrans.

Which one of the following combinations is *correct*?

a. P only

b. Q only

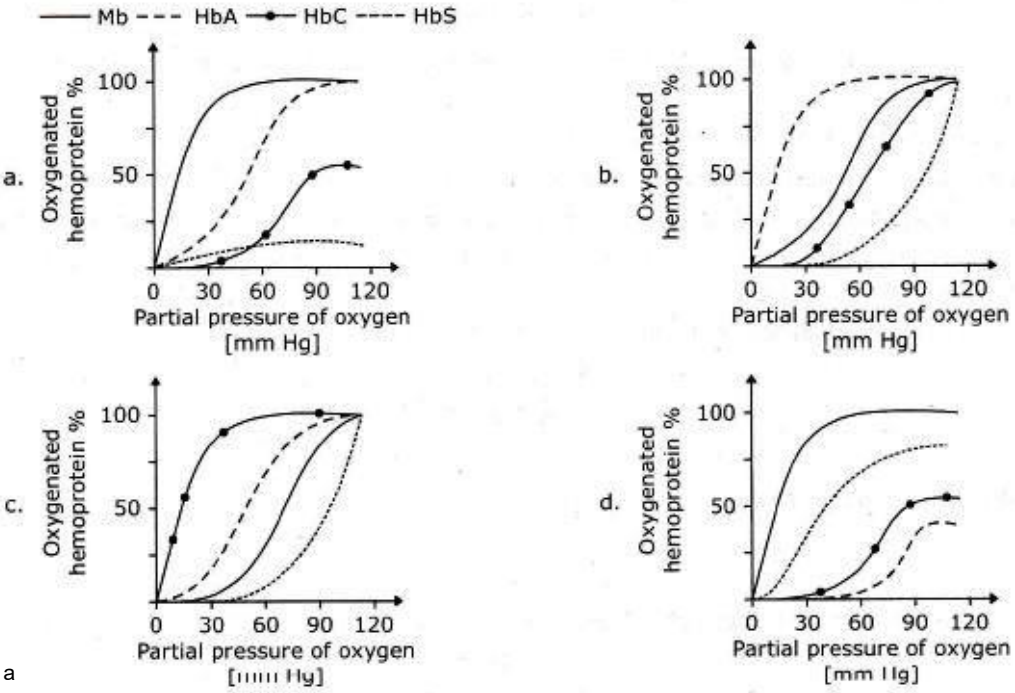
c. P and R

c. Q and S

Ans: c

December 2013

87. Myoglobin (Mb) in muscles, Hemoglobin A (HbA) in adult RBC, Hemoglobin C (HbC) in patients with thinner RBC and Hemoglobin S (HbS) in sickle cell disease are four different hemoproteins. Oxygen saturation kinetics of these four proteins is different. Which of the following profile is most plausible?



Ans: a

88. Water and electrolytes like Na^+ and Cl^- are lost from the body in diarrhoea. Oral administration of NaCl solution in this condition does not improve the situation. When glucose is administered with normal NaCl solution through oral route, the absorption of electrolytes along with water occurs and the patient recovers.

P. Glucose enhances ATP production in the mucosal cells of small intestine and thus facilitates sodium absorption.

Q. Glucose inhibits the diarrheal toxin induced cAMP production in the mucosal cells of small intestine.

R. Na^+ is co-transported with glucose on the apical surface of the mucosal cells of small intestine.

S. The epithelial sodium channels (ENaC) are activated by glucose in colon.

Which one of the following is *true*?

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

Ans: c

89. A patient has episodes of painful spontaneous muscles contraction, followed by periods of paralysis of the affected muscles. It was identified as primary hyperkalemic paralysis, an inherited disorder. The possible causes of the paralysis are

P. The elevation of extracellular K^+ causes hyperpolarization of skeletal muscle cells.

Q. The hyperpolarization of the muscle cell membrane inactivates sodium channels.

R. The elevation of extracellular K^+ causes depolarization of skeletal muscle cells.

S. The sodium channels are voltage inactivated in depolarized state.

Which one of the following is *true*?

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

Ans: d

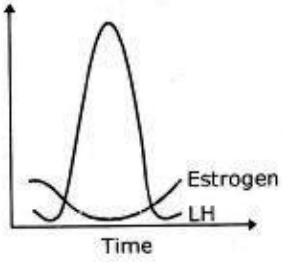
90. Maintaining the salt concentration and volume of plasma are two key parameters for physiological processes achieved by kidney. Which one of the following structural and functional combinations is the most efficient renal regulatory system in mammals?

Combination No.	Structural	Functional
a.	Large glomerulus, long proximal and distal tubules, long Henle's loop	Transepithelial potential in proximal tubule, countercurrent multiplier, ADH responsiveness of distal tubule
b.	Small glomerulus, short proximal and distal tubule, short Henle's loop	Transepithelial potential in distal tubule, very high ADH concentration in circulation
c.	Very large glomerulus, short proximal tubule, very long distal tubule, long Henle's loop	Very efficient glomerular filtration, prevention of solute loss
d.	Small glomerulus, long proximal and distal tubules, Henle's loop	Preventing water and solute filtration, excreting solute, lowering ADH responsiveness

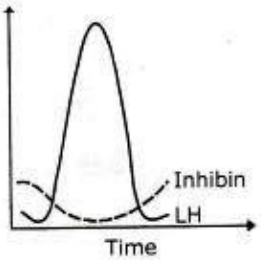
Ans: a

91. Which one of the following graphs best represents the hormone profile in a rat right after mating?

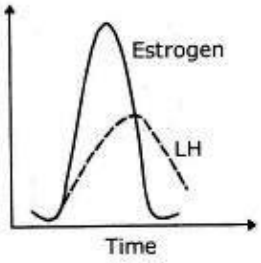
a.



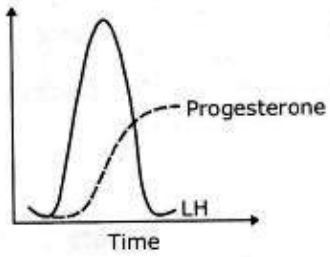
b.



c.



d.



Ans: c

June 2014

85. Respiration can be inhibited voluntarily for some time. The point at which respiration cannot be voluntarily inhibited is known as breaking point. Following explanations are offered for the breaking point:

P. J-receptors stimulate respiratory centers

Q. Hering-Breuer reflex operates

R. The rise of arterial pCO_2 stimulates the respiratory centre

S. The fall of arterial pO_2 stimulates the respiratory centre

Which of the above combination is *correct*?

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

Ans: c

86. A mechanical pressure was exerted on a specific location of a peripheral nerve of a mammal. The touch or pain receptors were stimulated from the skin surface innervated by the same nerve. The action potential generated by touch receptor stimulation was blocked beyond the point of mechanical pressure. But the action potential generated by pain receptor stimulation passes through the point of mechanical pressure.

Following explanations were offered for these observations:

P. The large diameter 'A' fibres were affected by mechanical pressure

Q. The small diameter 'C' fibres were not affected by mechanical pressure

R. The intermediate diameter 'B' fibres were affected by mechanical pressure

S. The large diameter 'A' fibres were not affected by mechanical pressure

Which of the above combinations is *correct*?

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

Ans: a

87. When a skeletal muscle with an intact nerve supply is stretched, the muscle contracts and the tone increases. The following explanations are offered for this observation:

P. Golgi tendon organ was stimulated by the stretching of muscle.

Q. γ-motor neurons were excited by the stimulated afferent nerve fibres from the stretched muscle.

R. Muscle spindle was stimulated by stretching of muscle.

S. α-motor neurons were excited by the stimulated afferent nerve fibres from the stretched muscle.

Which of the combination is *correct*?

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

Ans: c

88. An elderly person suffering from calcium deficiency was advised to take calcium rich food and to supplement the diet with vitamin D. The absorption of calcium in the intestine was increased with the supplementation of vitamin D. Following explanations were offered for this increased calcium absorption by vitamin D:

P. The synthesis of calbindin-D_{9K} and calbindin-D_{28K} in enterocytes was stimulated.

Q. The number of Ca^{2+}–ATPase molecules in enterocytes was increased.

R. The synthesis of divalent metal transporters 1 (DMT1) in the enterocytes was stimulated.

S. The number of hephaestin in the enterocytes was increased.

Which of the above combinations is *correct*?

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

Ans: a

December 2014

81. Different frequencies of sound were presented on the ear and the movement of basilar membrane was experimentally determined. The characteristics of movement of basilar membrane after presentation of 100 Hz sound are described in the following statements:

P. The base of basilar membrane showed resonance.

Q. The apex of basilar membrane showed resonance.

R. A wave travelled from the base to apex of basilar membrane but the maximum displacement was noted near the apex.

S. A wave travelled from the base to apex of basilar membrane but the maximum displacement was noted near the base.

Which one of the following is *correct*?

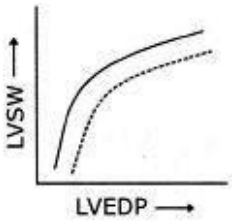
a. P and R
b. Q and S
c. R only
d. S only

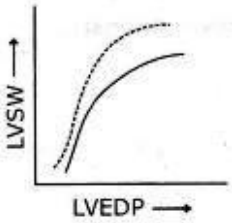
Ans: c

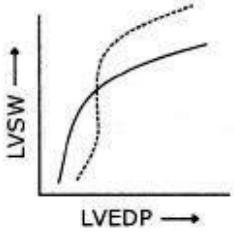
82. The changes in left ventricular stroke work (LVSW) according to the different left ventricular end-diastolic pressures (LVEDP, which indicates the initial myocardial fiber length) in a dog, under control conditions, were recorded, which follows Starling's law of the heart. This LVSW-LVEDP relationship was investigated in the same dog after constant infusion of norepinephrine, and these two data sets were plotted. Which one of the following graphs *correctly* represents the results obtained?

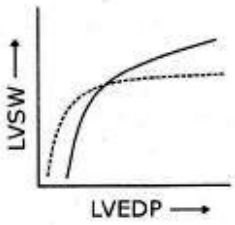
Control ———

Norepinephrine – – – – – – – –

a.


b.


c.


d.


Ans: b

83. When a nerve fiber is stimulated with increasing strength of stimulus, the action potential fails to generate even though the threshold level may be passed. The following statements may explain this accommodation of nerve fibre:

P. The critical number of open sodium channels required to trigger the action potential may never be attained due to slow depolarization.

Q. Potassium channels open in response to slow depolarization, which makes the nerve fiber refractory to depolarization.

R. The low threshold sodium channels remain open, which increases the threshold of firing of action potential.

S. The efflux of sodium and influx of potassium due to operation of Na^+, K^+–ATPase oppose the depolarization.

Which one of the following is *correct*?

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

Ans: b

84. The heart rate shows variation during respiratory rhythm in most human subjects. Which one of the following statements describing the changes of heart rate during respiratory phases is *true*?

a. The heart rate is accelerated during expiration, but no change occurs during inspiration.
b. The heart rate is accelerated during inspiration and decelerated during expiration.
c. The heart rate is accelerated during expiration and decelerated during inspiration.
d. The heart rate is accelerated during inspiration and no change occurs during expiration.

Ans: b

85. At 17 years, a 7 feet tall human was diagnosed with gigantism caused by pituitary tumor. The condition was surgically corrected by removal of the person's pituitary gland. Doctors advised hormonal therapy. The possible hormonal therapies that would be required for survival are

1. Thyroid hormone
2. Glucocorticoids
3. Glucagon
4. Growth hormone
5. Insulin

Which one of the following combination can be used?

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

Ans: a

86. Given below are few statements with reference to blood clot formation which results from triggered chain of reactions:

P. Conversion of fibrinogen to fibrin.

Q. Activation of factor XIII, which stabilizes fibrin mesh work.

R. Activation of factor XII, which promotes plasmin activation.

S. Enhancement of platelet aggregation.

Which one of the following combination of statements is *correct* with reference to roles of thrombin in hemostasis?

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

Ans: b

June 2015

90. During physical exercise, the oxygen supply to the active muscles is increased, which has been explained by the following statements:

P. Po_2 declines and Pco_2 rises in the active muscles.

Q. The temperature is increased and pH is decreased in active muscles.

R. 2, 3-biphosphoglycerate is decreased in RBC and P_{50} rises.

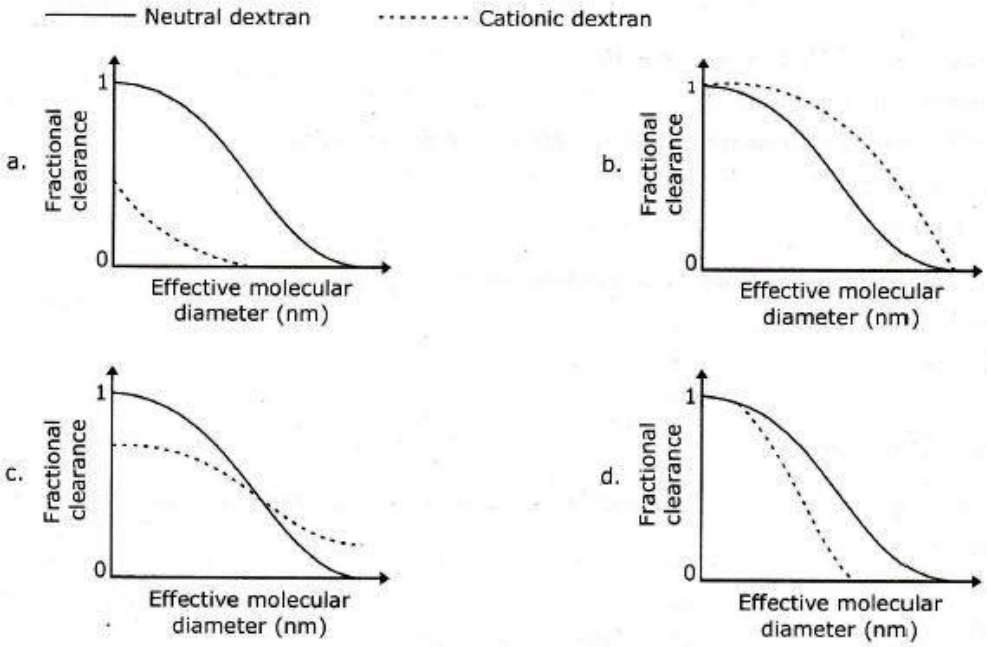
S. Metabolites accumulating in the active muscles increase the affinity of hemoglobin to oxygen.

Which one of the following is *not* correct?

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

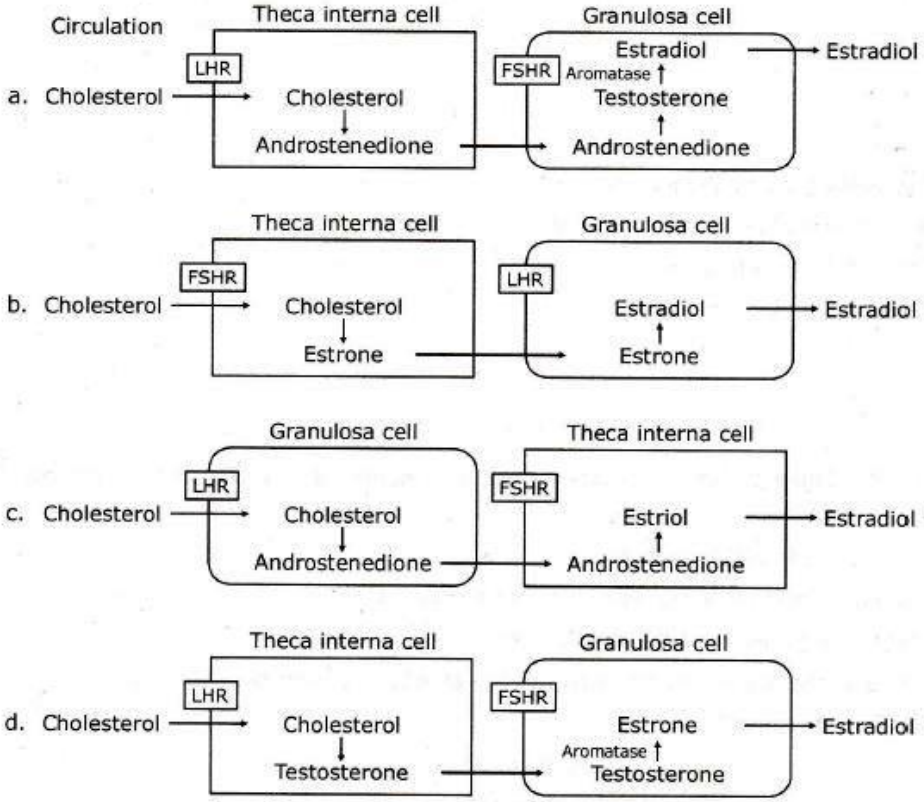
Ans: d

91. The fractional clearance of neutral and cationic dextran molecules of various sizes through kidneys of a rat is shown in the figures below. Which one of the following is *correct*?



Ans: b

92. Estradiol synthesis follows a 2-cell-2-gonadotropin theory, where partial synthesis occurs in the granulosa cells and the rest in the theca interna cells of the Graafian follicle. Which one of the following *correctly* represents estradiol synthesis and secretion?



Ans: a

93. The mechanism of sound localization in a horizontal plane by the human auditory system can be explained by

P. The difference in time between the arrival of stimulus in two ears.

Q. The difference in phase of the sound waves on two ears.

R. The difference in tuning curves of two auditory nerves.

S. The activity of neurons in superior olivary nucleus, but not by the neuronal activity of auditory cortex.

Which one of the following is *not* correct?

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

Ans: d

94. In high altitude, hypoxia induces increased number of circulating red blood cells, which can be explained by the following changes:

P. The transcription factors, HIFs, are produced.

Q. Erythropoietin secretion is increased.

R. Myoglobin context is decreased.

S. Cytochrome oxidase is decreased.

Which one of the following is *not* true?

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

Ans: d

UNIT 8

Part B

June 2011

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

Colorless precursor 1 $\xrightarrow{\text{Allele A}}$ Colorless precursor 2 $\xrightarrow{\text{Allele B}}$ Purple pigment

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 × 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

Ans: b

89. 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

Ans: d

90. 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

Ans: c

91. 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

Ans: a

December 2011

91. 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

Ans: d

92. 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

Ans: b

93. 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

Ans: c

June 2012

87. How many genetically different gametes can be made by an individual of genotype AaBbccDDEe, assuming they are independently assorting?

a. 3
b. 5
c. 8
d. 32

Ans: c

88. Mutation at two different loci of the same gene X results in altered functions. These two mutated versions of the gene X are called

a. alleles
b. complementation groups
c. interrupted genes
d. linkage groups

Ans: a

89. A gene encoding tRNA undergoes a mutational event in its anticodon region that enables it to recognize a mutant nonsense codon and permit completion of translation. Such a mutation is known as

a. silent mutation
b. neutral mutation
c. reversion
d. nonsense suppressor

Ans: d

90. Two pure lines of corn have mean cob length of 9 and 3 inches, respectively. The polygenes involved in this trait exhibit additive gene action. Crossing these two lines is expected to produce a progeny population with mean cob length (in inches) of:

a. 12.0
b. 7.5
c. 6.0
d. 2.75

Ans: c

December 2012

89. A cross was made between pure wild type males and brown eyed, curled winged females of *D. melanogaster*. The F1 females were test crossed. The F2 progeny obtained was as follows

Wild type	200
Brown eyes, curled wings	150
Brown eyes, normal wings	30
Normal eyes, curled wings	20
Total	400

The genetic distance (cM) between brown eye and curled wing loci is:

a. 12.5 b. 50

c. 150 d. 25

Ans: a

90. The effect of nonsense mutation could be nullified by reversion as well as suppression. Which of the following processes will help to distinguish between the two kinds of revertants?

a. Complementation

b. Transgenesis

c. Test for allelism

d. Recombination

Ans: d

91. 2-aminopurine induces mutation by

a. base pair change b. frameshift

c. duplication d. insertion

Ans: a

92. In a transformation experiment, donor DNA from an *E. coli* strain with the genotype $Z^+ Y^+$ was used to transform a strain of genotype $Z^- Y^-$. The frequencies of transformed classes were

$Z^+ Y^+$	200
$Z^+ Y^-$	400
$Z^- Y^+$	400
Total	1000

What is the frequency (%) with which Y locus is co-transformed with the Z locus?

a. 1 b. 20

c. 33.3 d. 40

Ans: b

June 2013

89. A chromosome aberration leads to change in the order of genes in a genetic map but does not alter its linkage group. This is due to

a. translocation
b. recombination
c. transposition
d. inversion

Ans: d

90. The concept of recon was proposed by Seymour Benzer by studying recombination between

a. lysis mutants of bacteriophage T4.
b. white eye mutants of *Drosophila melanogaster.*
c. biochemical mutants of *Neurospora crassa.*
d. auxotrophic mutants of *Escherichia coli.*

Ans: a

91. Aspartic acid (Asp) is specified by the codon GAU and GAC. After mutation, Asp is changed to Alanine represented by GCX, where X may be A, U, C or G. The reversion of the mutation could only be done with reactive oxygen species. The nature of the mutation is considered to be

a. transition
b. transversion
c. either transition or transversion
d. depurination

Ans: b

92. A cross is made between two plants with white flowers. All the F1 progeny had red coloured flower. This is because of

a. complementation
b. recombination
c. translocation
d. reversion

Ans: a

December 2013

92. A cross is made between a pure breeding plant having red coloured flowers with a pure breeding plant having white coloured flowers. Such a cross is called as

a. test cross
b. monohybrid cross
c. dihybrid cross
d. back cross

Ans: b

93. A *cis-trans* complementation test is carried out to identify

a. if two mutations are allelic in nature.
b. if two genes interact with one another.
c. the number of genes influencing a phenotype.
d. to understand the dominance/recessive relationships between alleles.

Ans: a

94. The following is the inheritance pattern of a trait under observation:

P. The trait often skips a generation.
Q. The number of affected males and females is almost equal.
R. The trait is often found in pedigrees with consanguineous marriages.

The trait is likely to be

a. autosomal recessive
b. autosomal dominant
c. sex-linked recessive
d. sex-linked dominant

Ans: a

June 2014

89. In an experiment involving mapping of 3 genes (a, b and c) in *Drosophila* a three point test cross is carried out. The parental cross was AAbbCC × aaBBcc. The genotypes of the double crossovers are: Aabbcc and aaBbCc. Based on this, determine the order of the genes.

a. a c b
b. c a b
c. a b c
d. b a c

Ans: a

90. A black Labrador homozygous for the dominant alleles (BBEE) is crossed with a yellow Labrador homozygous for the recessive alleles (bbee). On intercrossing the F1, the F2 progeny was obtained in the following ratio:

9 black : 3 brown : 4 yellow

This is an example of

a. recessive epistasis where allele e is epistatic to B and b.
b. dominant epistasis where allele E is epistatic to B and b.
c. recessive epistasis where allele e is epistatic to E.
d. complementary epistasis where allele b is epistatic.

Ans: a

91. In the following example, 3 independently assorting genes are known to govern coat color in mice. The genotype of few of the coat colors is given below:

Agouti : A – B – C –

Black : aa B – C –

Albino : – – – – cc

What will be the expected frequency of albinos in the F2 progeny from crosses of pure black with albino of the genotype *AAbbcc*?

a. 1/4
b. 1/16
c. 1/64
d. 9/64

Ans: a

92. The distance between bacterial genes as determined from interrupted mating experiments are measured in units of

a. cM
b. minutes
c. bp
d. micrometers

Ans: b

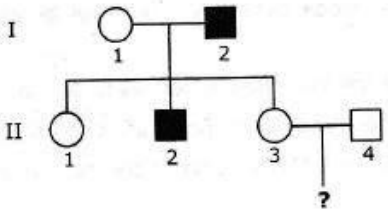
December 2014

87. 5-Bromouracil is a base analog that can cause mutation when incorporated into DNA. Which of the following is the most likely change that 5-bromouracil induces?

a. T : A to C : G
b. T : A to A : T
c. G : C to T : A
d. C : G to A : T

Ans: a

88. The following pedigree shows the inheritance of a common phenotype controlled by an autosomal recessive allele. The probability of carriers in the population is 1/3.



What is the probability that a child from parents II-3 and II-4 will show the phenotype?

a. 1/16
b. 1/18
c. 1/36
d. 3/16

Ans; c

89. An interrupted mating experiment was performed between Hfr Str^s a^+ b^+ c^+ and F^- Str^r a^- b^- c^- strains. The genotype of majority of streptomycin resistant (Str^r) exconjugant after 10, 20 and 30 minutes of interrupted mating is given below:

10 min	a^+ b^- c^-
20 min	a^+ b^- c^+
30 min	a^+ b^+ c^+

The most probable gene order would be

a. a b c
b. c a b
c. b a c
d. a c b

Ans: d

90. Two plants with white flowers are crossed. White flowers arise due to recessive mutation. All F1 progeny have red flowers. When the F1 plants are selfed, both red and white flowered progeny are observed. In what ratio will red-flowered plants and white-flowered plants occur?

a. 1 : 1
b. 3 : 1
c. 9 : 7
d. 15 : 1

Ans: c

June 2015

95. 'Segregation of alleles can occur at Anaphase I or at Anaphase II of meiosis'. With reference to this statement, which one of the following organism is an ideal model system for identifying stage of allelic segregation at meiosis?

a. *Neurospora crassa*
b. *Saccharomyces cerevisiae*
c. *Drosophila melanogaster*
d. *Pisum sativum*

Ans: a

96. Genes A, B and C control three phenotypes which assort independently. A plant with the genotype Aa Bb Cc is selfed. What is the probability for progeny which shows the dominant phenotype for *at least one* of the phenotypes controlled by genes A, B and C?

a. 1/64
b. 27/64
c. 63/64
d. Cannot be predicted

Ans: c

97. In an experiment, clones of a plant is grown in a field. The plants were observed to be of different heights. When a graph was plotted for frequency of plants (Y-axis) against different heights (X-axis), a bell-shaped curve was obtained. From the above it can be concluded that the observed variation in height is due to

a. it being a polygenic trait
b. environmental effect
c. variation in genotype
d. influence of environment on different genotypes

Ans: b

Part C

June 2011

92. 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. $V_G - V_E$

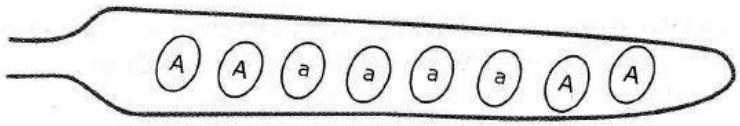
b. V_E / V_G

c. $\frac{V_G}{(V_G + V_E)}$

d. $\frac{V_G}{(V_G - V_E)}$

Ans: c

93. 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

Ans: a

94. 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

Ans: c

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

W (colorless precursor) $\xrightarrow{\text{Enzyme A}}$ X (Orange pigment)
+
Y (colorless precursor) $\xrightarrow{\text{Enzyme B}}$ Z (Brown pigment)

} Red eye color (wild type)

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

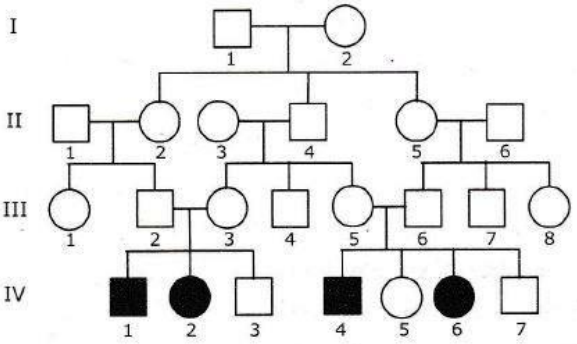
Ans: d

96. Mendel crossed tall pea plants with dwarf ones. The F1 plants were all tall. When these F1 plants were selfed to produce F2 generation, he got a 3:1 tall to dwarf ratio in the offspring. What is the probability that out of three plants (of F2 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

Ans: c

97. 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.

Ans: c

December 2011

94. 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

Ans: a

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

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

Ans: c

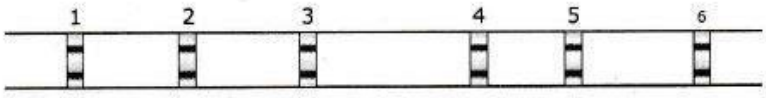
96. The ABO blood type in human is under the control of autosomal multiple alleles. Colour blindness is recessive X-linked trait. A male with a blood type A and normal vision marries a female who also has blood type A and normal vision. The couple's first child is a male who is colour blind and has O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

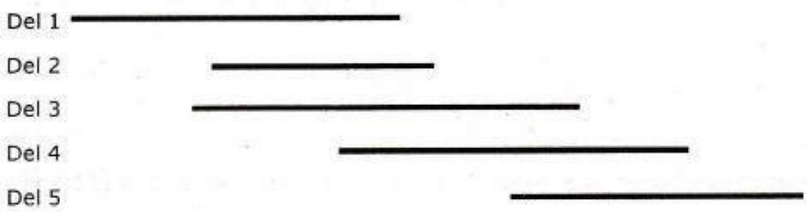
a. 1/4 b. 3/4

c. 1/8 d. 1

Ans: c

97. 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

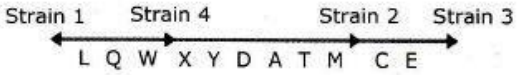
Ans: c

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

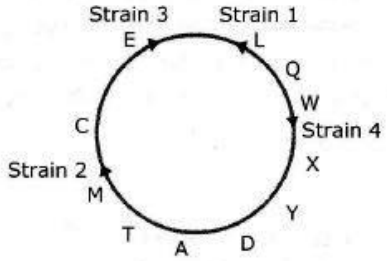
Strain 1:	L	Q	W	X	Y
Strain 2:	M	T	A	D	Y
Strain 3:	E	C	M	T	A
Strain 4:	W	Q	L	E	C

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?

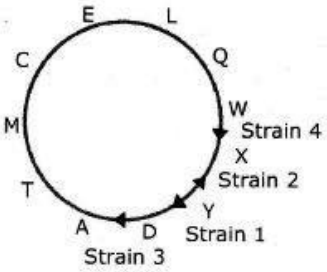
a.



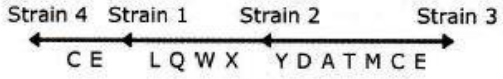
b.



c.

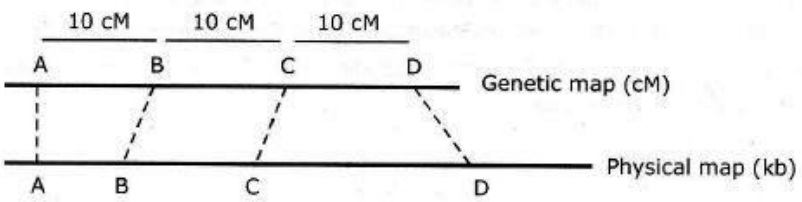


d.



Ans: b

99. 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

Ans: b

June 2012

91. When two independent pure lines of pea with white flowers are crossed, the F1 progeny has purple flowers. The F2 progeny obtained from selfing shows both purple and white flower in a ratio of 9 : 7. The following conclusions were made:

P. Two different genes are involved, mutations in which lead to formation of white flowers.

Q. These two genes show independent assortment.

R. This is an example of complementary gene action.

S. This is an example of duplicate genes.

Which of the above conclusions are *correct*?

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

Ans: d

92. A cell undergoing meiosis produces four daughter cells, two of which are aneuploids, while two are haploid. This can occur due to:

a. Non-disjunction during first meiotic division only.
b. Non-disjunction during second meiotic division only.
c. Non-disjunction during either first or second meiotic divisions.
d. Non-disjunction during both first and second meiotic divisions.

Ans: b

93. Three *E. coli* mutants are isolated which require compound 'A' for their growth. The compounds B, C and D are known to be involved in the biosynthetic pathway to A. In order to determine the pathway, the mutants were grown in a medium supplemented with one of the compounds, A to D. The results obtained are summarized below:

Mutant	Medium supplemented with compound			
	A	B	C	D
1	+	0	0	0
2	+	0	0	+
3	+	0	+	+

'+' indicates growth; '0' indicates lack of growth

Which of the following equations represents the biosynthetic pathway of A?

a. $B \rightarrow C \rightarrow D \rightarrow A$
b. $C \rightarrow D \rightarrow B \rightarrow A$
c. $B \rightarrow D \rightarrow C \rightarrow A$
d. $A \rightarrow C \rightarrow D \rightarrow B$

Ans: a

94. Following are four modes of inheritance

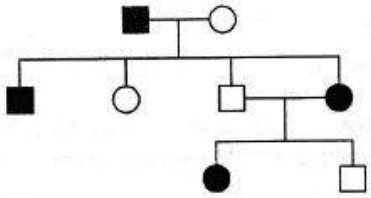
P. X-linked recessive

Q. X-linked dominant

R. Autosomal recessive

S. Autosomal dominant

Which of the above modes of inheritance can explain the pedigree shown below?



a. P and R

b. Q and R

c. R and S

d. S only

Ans: c

95. The auxotrophic strains of *E. coli*: A (*met*$^-$ *bio*$^-$ *thr*$^+$ *leu*$^+$ *thi*$^+$) and B (*met*$^+$ *bio*$^+$ *thr*$^-$ *leu*$^-$ *thi*$^-$) were incubated together for 18 hours in a liquid complete medium and then ~10^8 cells were plated on a minimal medium. Prototrophs were observed at a frequency of 1×10^{-7} cells. This may have happened by a process of genetic recombination between the two strains or by mutation of the strains. Which of the following control experiments would help rule out the possibility of mutation?

a. Plating strains A and B directly on minimal medium.

b. Growing the mixture of strains A and B for 18 hours and then plating on complete medium.

c. Growing strains A and B individually in a liquid complete medium for 18 hours and then plating them on a minimal medium.

d. Growing the obtained prototrophs in a liquid complete medium for 18 hours and then plating them on a minimal medium.

Ans: c

96. Four different mutant lines showing similar phenotype were identified from a genetic screen. When genetic crosses among these mutants were carried out, the first mutant was found to complement the second, third and fourth mutant lines. However, no other complementation was observed. How many complementation groups do the four mutant lines belong to?

a. one

b. two

c. three

d. four

Ans: b

97. Why lysogenic cycle is more beneficial to a virus than lytic cycle under certain circumstances?

a. The lysogenic cycle prevents local extinction of the host while still retaining its infection potential.

b. By integrating with the bacterial chromosomes, the genetic instructions for the virus become refreshed after one or more replication events during binary fission.

c. Lysogenic infection cycles do not harm their host cells, so they can produce virus particles indefinitely.

d. Lysogeny causes more mutations to occur in the virus, creating more variants upon which natural selection can operate.

Ans: a

98. The rates of mutation in *E. coli* from *lac*$^-$ to *lac*$^+$ are determined using a medium containing lactose, as the only source of energy. The principle of spontaneity of mutations can be said to be violated if:

a. the rate of mutation increases during starvation.

b. in the presence of lactose, the rate of mutation from *lac*$^-$ to *lac*$^+$ is increased but overall rate of mutation is not.

c. the rate of mutation in *lac* gene is always greater than that in other genes.

d. the rate of mutation in *lac* gene is always less than that in other genes.

Ans: b

December 2012

93. The RFLP pattern observed for two pure parental lines (P1 and P2) and their F1 progeny is represented below. Further, the P1 plant had red flowers while the P2 had white flowers. The F1 progeny was backcrossed to P2. The result obtained, showing the number of progeny with red and white flowers and their RFLP patterns is also represented below.

	P1	P2	F1	Progeny of the cross between F1 and P2			
Phenotype	Red	White	Red	Red		White	
RFLP pattern							
Number of progeny				45	5	45	5

Which one of the following conclusions made is *correct*?

a. The DNA marker and the gene for the flower color are 10cM apart.

b. The marker and the gene for the flower color are 5cM apart.

c. The marker and the phenotype are independently assorting.

d. The marker and the gene for the color segregate from one another.

Ans: a

94. Wild type T4 bacteriophage can grow on B and K strains of *E. coli* forming small plaques. rII mutants of T4 bacteriophage cannot grow on *E. coli* strain K (non-permissive host), but form large plaques on *E. coli* strain B (permissive host). The following two experiments were carried out:

Experiment I : *E. coli* K cells were simultaneously infected with two rII mutants (a^- and b^-). Several plaques with wild type morphology were formed.

Experiment II : *E. coli* B cells were simultaneously infected with the same mutants as above. T4 phages were isolated from the resulting plaques and used to infect *E. coli* K cells. Few plaques with wild type morphology were formed.

Which one is the *correct* conclusion made regarding the rII mutants, a^- and b^- from the above experiments?

a. The mutations a^- and b^- belong to two different cistrons (experiment I) and there is no recombination between them (experiment II).

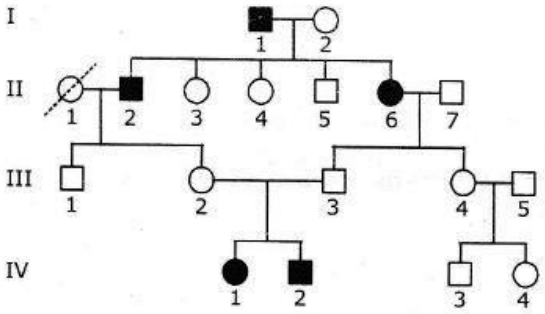
b. The mutations a^- and b^- belong to two different cistrons (experiment I) and they recombined (experiment II).

c. The mutations a^- and b^- to two different cistrons (experiment II) and they recombined (experiment I).

d. The mutants a^- and b^- belong to the same cistron (experiment I) and they did not recombine (experiment II).

Ans: b

95. The following pedigree represents inheritance of a trait in an extended family



What is the probable mode of inheritance and which individuals conclusively demonstrate this mode of inheritance?

a. Autosomal recessive, III-2, 3 and IV-1, 2 conclusively demonstrate the mode of inheritance.

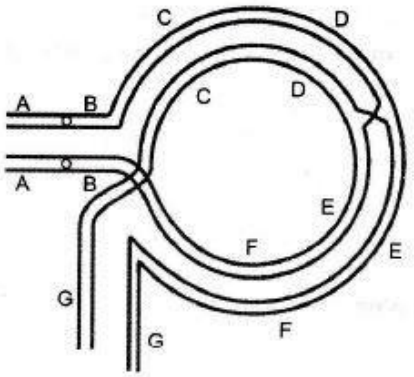
b. Autosomal recessive, I-1, 2 and II-2 conclusively demonstrate the mode of inheritance.

c. Autosomal dominant, III-2, 3 and IV-1, 2 conclusively demonstrate the mode of inheritance.

d. X-linked recessive, II-3, 4 and 5 conclusively demonstrate the mode of inheritance.

Ans: a

96. Following is the diagram of a paracentric inversion heterozygote ABCDEFG/ABFEDCG involved in recombination during meiosis I:



The consequence of this recombination will be the formation of

P. a dicentric and an acentric chromosome in meiosis I as the chiasmata gets terminated.

Q. no dicentric or acentric chromosome but appearance of deletion and duplication in both the chromosomes.

R. all non-viable gametes.

S. non-viable gametes from crossover products.

Which of the above statements are *correct*?

a. P and Q

b. P and R

c. P and S

d. Q and R

Ans: c

97. An *E. coli* strain has *metB1* (90 min) and *leuA5* (2 min) mutations. It also has *strA7* (73 min) mutation and *Tn5* transposon which confers streptomycin and kanamycin resistance, respectively, inserted in its chromosome. The mutant strain was crossed with an Hfr strain that is streptomycin sensitive and has a *hisG2* mutation (44 min) that makes it require histidine. After incubation for 100 min, the cells were plated on minimal plate supplemented with leucine, histidine and streptomycin to select the *metB* marker. After purifying 100 of the Met^+ transconjugants, one finds that 15 are His^-, 2 are Leu^+ and 12 are kanamycin sensitive. The unselected markers are

P. *metB1* and *leuA5* mutation

Q. *leuA5* and *Tn5* insertion mutation

Which of the above statements is *correct* and what is the position of transposon insertion?

a. P and before 73 min

b. Q and before 44 min

c. Q and before 73 min

d. P and before 44 min

Ans: b

98. A chemist synthesized three new chemical compounds, M1, M2 and M3. The compounds were tested for their mutagenic potential and were found to be highly mutagenic. Tests were made to characterize the nature of mutations by allowing the reversion with other mutagens. The following results were obtained:

Mutations produced by	Reversed by			
	2 Aminopurine	Nitrous acid	Hydroxyl amine	Acridine orange
M1	No	No	No	No
M2	Yes	Yes	No	No
M3	No	No	No	Yes

Which one of the following conclusions drawn regarding the nature of mutations by the compounds is *correct*?

a. M1 – transversion, M2 – insertion, M3 – deletion.

b. M1 – transition, M2 – transversion, M3 – insertion.

c. M1 – insertion, M2 – transition, M3 – transversion.

d. M1 – transversion, M2 – transition, M3 – insertion.

Ans: d

June 2013

93. A novel enzyme was identified in humans. The following approaches are available to identify the chromosome on which the gene encoding the enzyme is present:

P. Suppress the activity of enzyme by RNAi.

Q. Identify polymorphism in the population and carry out pedigree analysis to study its inheritance.

R. Purify the enzyme, decipher its amino acid sequence, predict its DNA sequence and search for its presence in the available human genome sequence.

S. Create chromosome addition lines by making somatic hybrids between human and mouse cells, identify lines showing the enzyme activity and the human chromosome present in it.

Which of the above approaches can be used?

a. P or Q

b. Q or R

c. R or S

d. P or R

Ans: c

94. In an experiment on transposition in an eukaryotic system, an intron was cloned within a transposable element and allowed to transpose from a plasmid to genomic DNA. The intron was found to be absent in the transposable element in its new location. It is

a. not a case of transposition.

b. a case of replicative mode of transposition.

c. a case of conservative mode of transposition.

d. a retroposon.

Ans: d

95. In a plant species, a segregating line (one that contains both homozygotes and heterozygotes at a locus) can be made homozygous by repeated selfing for several generations. What is the level of remaining heterozygosity after three generations of selfing, if the level of heterozygosity in generation '0' is denoted as 1?

a. 0.5

b. 0.25

c. 0.125

d. 0.0625

Ans: c

96. Given below is the result of a complementation test for six independent mutants (1 to 6).

1	2	3	4	5	6	
0	+	0	+	+	0	1
	0	+	+	+	+	2
		0	+	+	0	3
			0	0	+	4
				0	+	5
					0	6

'+' represents complementation; '0' represents non-complementation.

Based on the above, which one of the following conclusions is *correct*?

a. The mutations can be ordered in a single cistron as 1-3-5-2-4-6.

b. All mutations belong to a single cistron, but their order cannot be determined.

c. There are three cistrons, mutations 1, 3 and 6 represent one cistron, 4 and 5 represent the second cistron and 2 represents the third cistron.

d. There are three linkage groups, mutations 1, 3 and 6 represent linkage group A, 4 and 5 represent linkage group B, and 6 represents linkage group C.

Ans: c

97. In a hospital three babies were mixed up. The blood group of the babies were A, B and AB. In order to identify the parents of the babies, the blood groups of the parents were determined. The results obtained were:

Parent set 1 - A and AB

Parent set 2 - AB and O

Parent set 3 - B and AB

Which of the following conclusions can be definitively made?

a. The baby with blood group A is the child of the parent set 2.

b. The baby with blood group AB is the child of the parent set 1.

c. The baby with blood group B is the child of the parent set 3.

d. The parentage of none of the babies can be determined from the given information.

Ans: d

98. There are two mutant plants. One shows taller phenotype than wild type, whereas the other has the same height as the wild type. When these two mutations were brought in together by genetic crosses, the double mutant displayed even taller phenotype than the tall mutant plants. This genetic interaction is called

a. antagonistic interaction.

b. additive interaction.

c. synergistic interaction.

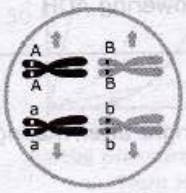
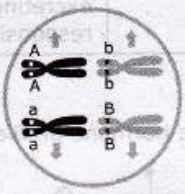
d. suppressive interaction.

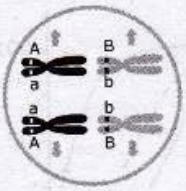
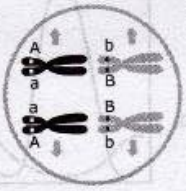
Ans: c

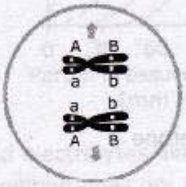
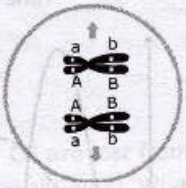
December 2013

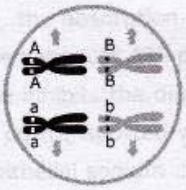
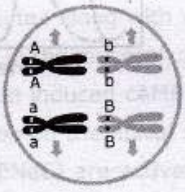
95. Which of the following representations of chromosomal arrangement in meiotic metaphase I best explains the Law of Independent Assortment?

% of cells with arrangement

a. 50%  and  50%

b. 50%  and  50%

c. 50%  and  50%

d. 100%  or  100%

Ans: a

96. Which of the following statements are *true* for Robertsonian translocations?

1. The size of the homologous chromosome involved in translocation will differ.
2. Genes on the chromosome involved in translocation will show linkage with genes with which it normally independently assorts.
3. There will be change in the physical map, but no change in the genetic map.
4. It can be identified by G-banding of chromosomes.
5. It can be identified by C-banding of chromosomes.
6. It can lead to Down's syndrome

Which one of the following combinations is *correct*?

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

Ans: c

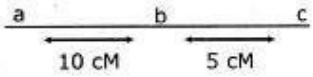
97. Ames test is used to evaluate mutagens in the environment. Which of the following statements about Ames test are *true*?

1. The mutagenic effect of a compound is tested using an auxotrophic strain of *Salmonella typhimurium*.
2. The mutagenic effect of a compound is tested using *His*$^-$ strain of *Escherichia coli*.
3. Using appropriate strains, compounds causing base substitutions and frameshift mutations can be distinguished.
4. Liver enzymes are important as they are activated by test compound to evaluate its mutagenicity potential.
5. Many compounds may have to be converted to bioactive metabolites, which is carried out by the enzymes from the liver.

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

Ans: c

98. The genetic map of three genes in *Drosophila melanogaster* is given below:



A cross, as given below is made between individuals of the genotype:

$$\frac{a^+ \quad b^+ \quad c}{a^+ \quad b^+ \quad c} \times \frac{a \quad b \quad c^+}{a \quad b \quad c^+}$$

The female F_1 progeny are test-crossed and 1000 progeny are obtained. Assuming that there has been no double crossover, what is the expected number of progeny with the genotype?

P. $\frac{a^+ \quad b \quad c^+}{a \quad b \quad c}$

Q. $\frac{a^+ \quad b^+ \quad c^+}{a \quad b \quad c}$

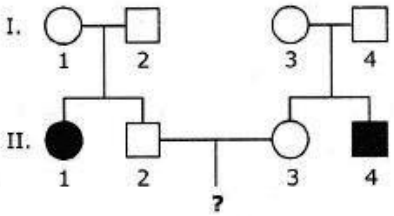
R. $\frac{a^+ \quad b^+ \quad c}{a \quad b \quad c}$

Select the set which shows the *correct* number of expected progeny:

a. P-100 ; Q-50 ; R-850
b. P-50 ; Q-25 ; R-425
c. P-100 ; Q-850 ; R-50
d. P-0 ; Q-425 ; R-75

Ans: b

99. The following pedigree shows the inheritance pattern of a rare recessive disorder with complete penetrance.



A child from marriage between individuals II-2 and II-3 will show the disorder only if the parents carry the recessive allele. What is the probability that the child will show the disorder?

a. 1/9, and the probability of the parents to carry the recessive allele is 2/3.
b. 1/4, and the probability of the parents to carry the recessive allele is 3/4.
c. 1/16, and the probability of the parents to carry the recessive allele is 2/3.
d. 1/64, and the probability of the parents to carry the recessive allele is 3/4.

Ans: a

100. DNA from a strain of bacteria with genotype a^+ b^+ c^+ d^+ e^+ was isolated and used to transform a strain of bacteria that was a^- b^- c^- d^- e^-. The transformed cells were tested for the presence of donated genes. The following genes are found to be co-transformed:

P. a^+ and d^+

Q. b^+ and e^+

R. c^+ and d^+

S. c^+ and e^+

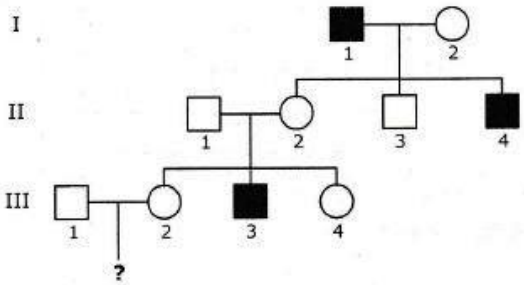
The order of genes on the bacterial chromosome is

a. a – b – c – d – e
b. a – d – c – e – b
c. a – c – d – e – b
d. a – d – b – e – c

Ans: b

June 2014

93. The inheritance pattern of a common trait which shows complete penetrance is shown below:



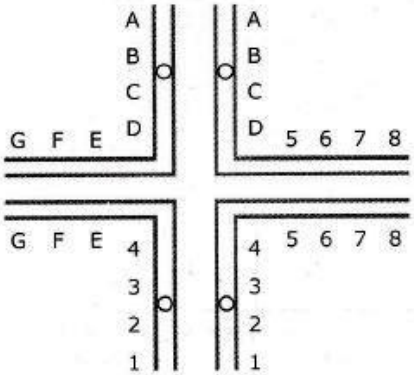
Based on the above pedigree, fill in the blanks from the options given below:

"The trait is [A]. The probability that a child from the marriage of individual III-1 and III-2 will show the trait is [B], considering that the individual III-1 is a carrier of the trait."

	A	B
a.	Y-linked	0
b.	Y-linked	1/2
c.	Autosomal	1/8
d.	Autosomal	1/6

Ans: c

94. The following statements were made regarding chromosome pairing (shown in the figure below) and subsequent segregation during meiosis I in the reciprocal translocation heterozygote:



P. Three ways of segregation in Anaphase I would be: adjacent 1 (vertically in the above figure), adjacent 2 (horizontally) and alternate.

Q. Gametes resulting from adjacent 1 and adjacent 2 segregation will be non-viable because of deletions and duplications of several genes.

R. All gametes resulting from alternate segregation will be viable as they will carry both normal chromosomes or both chromosomes having translocations in the two poles, respectively.

S. A dicentric and an acentric chromosome will be generated following alternate segregation.

Which of the following combination of statements will most appropriately explain the consequence?

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

Ans: b

95. A series of cell lines was created by fusing mouse and human somatic cells. In mouse-human somatic cell hybrids, human chromosomes tend to get lost before becoming a stable cell line. Some hybrid cell lines may carry human chromosome deletions. Each cell line was examined for the presence of chromosomes and for the production of an enzyme. The following results were obtained:

Cell line	Gene product	Chromosomal segments									
		1p	1q	2p	2q	3p	3q	4p	4q	5p	5q
A	+	+	+	-	-	+	+	-	-	+	+
B	+	-	-	+	+	-	-	+	+	+	+
C	-	+	+	-	-	+	+	-	+	-	+
D	+	-	-	+	+	+	+	-	-	+	-
E	-	+	+	+	+	-	+	-	-	-	-

Which segment of the chromosome has the gene encoding for the enzyme?

a. 1p
b. 5p
c. 5q
d. 4p

Ans: b

96. The following table summarizes the result of a cross between two strains of *Neurospora* having the alleles D and d, respectively. The table shows the different patterns of octad arrangement and the number of ascus observed of each type.

	Octads					
	D	d	D	d	D	d
	D	d	D	d	D	d
	D	d	d	D	d	D
	D	d	d	D	d	D
	d	D	D	d	d	D
	d	D	D	d	d	D
	d	D	d	D	D	d
	d	D	d	D	D	d
Number of ascus observed	115	125	14	16	17	13

Total = 300

Based on the above, fill in the blanks from the options given below,

"The first two columns are from meiosis with no crossover between locus D and [A]. The patterns for these two columns represent [B] segregation pattern. The distance between the locus D and the centromere is [C] map units".

	A	B	C
a.	d allele	first division	10
b.	centromere	first division	10
c.	d allele	second division	20
d.	centromere	second division	10

Ans; b

97. A hypothetical gene encodes a protein with the following amino acid sequence:

Phe- Pro- Thr- Ala- Val- Arg- Ser

A mutation of single nucleotide alters the amino acid sequence to

Phe- Leu- Leu- Leu- Leu- Val

A second single nucleotide mutation occurs in same gene restoring back the amino acid sequence to the original.

The following statements were made regarding the nature and location of the first mutation and that of the intragenic suppressor mutation:

P. The first mutation is a deletion in the second codon.

Q. The first mutation is an insertion in the second codon.

R. The intragenic suppressor mutation is an insertion in the second codon.

S. The intragenic suppressor mutation is a deletion in the third codon.

Which combination of the above statements is *correct*?

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

Ans: a

December 2014

91. Autotetraploids arise by the doubling of 2n complement to 4n. There are three different pairing possibilities at meiosis in tetraploids as given below:

P. Two bivalents

Q. One quadrivalent

R. One univalent + one trivalent

Which of the above pairings can lead to production of diploid gamete?

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

Ans: d

92. The following is the amino acid sequence of a part of a protein encoded by gene 'X'.

...Phe Leu Val Pro Ser Tyr Cys...

A mutant for gene 'X' is isolated following treatment with a mutagen. The amino acid sequence of the same region encoded by the mutant gene is as follows:

...Phe Leu Phe Arg Arg Ile...

Which of the following mutagens is most likely to have been used?

a. 5-bromouracil
b. 2-amino purine
c. Ethyl methanesulfonate
d. Acridine orange

Ans: d

93. A co-transduction experiment was performed to decipher the linear order of 4 genes: a, b, c and d. Three sets of experiments were done where transductions were selected for a (Set-1) or b (Set-2) or c (Set-3) and screened for co-transduction of the other markers.

Set - 1

Selected for	Co-transduction	Frequency
a	b	31
a	c	3
a	d	89

Set - 2

Selected for	Co-transduction	Frequency
b	a	22
b	c	78
b	d	68

Set - 3

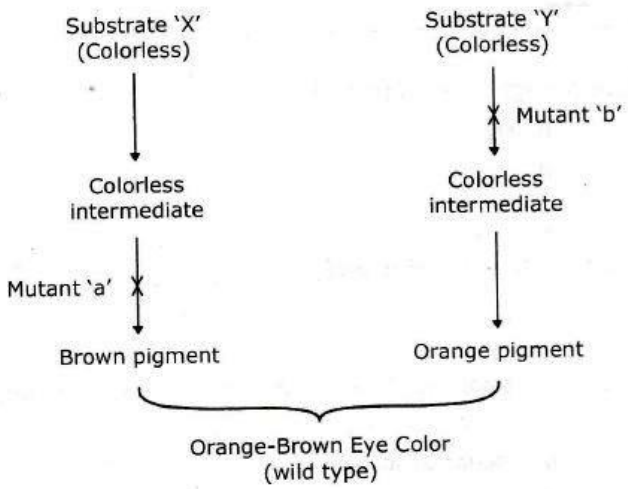
Selected for	Co-transduction	Frequency
c	a	0
c	b	69
c	d	43

Based on the frequencies shown above, identify the most likely order in the genome.

a. a b c d
b. b c d a
c. c d a b
d. a d b c

Ans: d

94. A hypothetical biochemical pathway for the formation of eye color in insect is given below.



Two autosomal recessive mutants 'a' and 'b' are identified which block the pathway as shown above. Considering that the mutants are not linked, what will be the phenotype of the F2 progeny if crosses were made between parents of the genotype aaBB × AAbb, and the F1 progeny are intercrossed?

a. 9 orange-brown : 3 orange : 3 brown : 1 colorless

b. 9 orange-brown : 7 colorless

c. 1 orange : 2 colorless

d. 15 orange-brown : 1 colorless

Ans: a

95. In *Neurospora*, the mutant *stp* exhibits erratic stop-and-start growth. When a female of *stp* strain is crossed with a normal strain acting as a male, all progeny individuals showed *stp* mutant phenotype. However, the reciprocal cross resulted in all normal progeny individuals. These results can be explained on the basis of

P. maternal inheritance

Q. sex limited inheritance

R. sex influenced inheritance

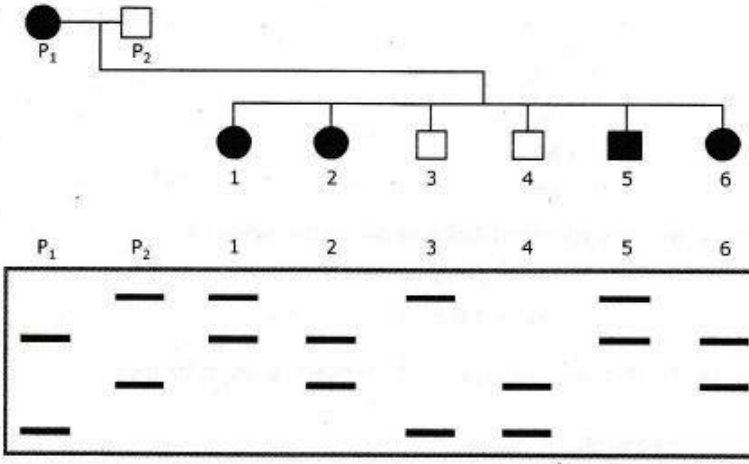
S. *stp* mutation may be located in mitochondrial DNA

The most appropriate statement or combination of the above statements for explaining the experimental results is:

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

Ans: *

96. An analysis of four microsatellite markers was carried out in a family showing a genetic disorder. The results are summarized below:



Based on the above, which of the markers shows linkage to the disorder?

a. M1
b. M2
c. M3
d. M4

Ans: b

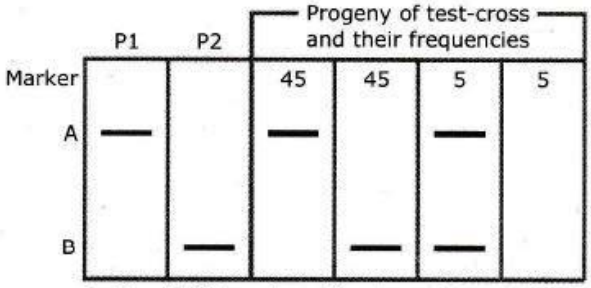
June 2015

98. A cross was made between Hfr met^+ arg^+ leu^+ str^S X F^- met^- arg^- leu^- str^R, in which leu^+ exconjugants are selected. If the linear organization of the genes are leu^+ arg^+ met^+, which one of the following genotypes is expected to occur in the lowest frequency?

a. leu^+ arg^- met^-
b. leu^+ arg^+ met^-
c. leu^+ arg^+ met^+
d. leu^+ arg^- met^+

Ans: d

99. Two homozygous individuals (P1 and P2) were genotyped using dominant DNA markers A and B, as shown below. The F_1 progeny obtained was test crossed. The frequency of progeny with which different genotypes appear, is given below:



Profile of DNA markers following gel electrophoresis

The following conclusions were made:

P. In the F1, markers A and B are linked and in coupling phase (*cis*).

Q. In the F1, markers A and B are linked and in repulsion phase (*trans*).

R. The distance between A and B is 10 cM.

S. The distance between A and B is 15 cM.

Which of the above conclusions are *correct*?

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

Ans: c

100. A plant with red fruit is crossed to a plant with white fruit. The F1 progeny had red fruits. On selfing the F1, two kinds of progeny were observed, plants with red-fruits and those with white-fruits. To test whether it was a case of recessive epistatic interaction a chi-square test was performed. A value of 1.062 was obtained (chi-square value at $P_{0.05}$ = 3.841 for degree of freedom = 1). The following statements were made:

P. The null hypothesis was that plants with red and white fruit will occur in a 9 : 7 ratio.

Q. The null hypothesis was that plants with red and white fruits will occur in a 1 : 1 ratio.

R. Based on the chi-square value, it is a case of recessive epistatic interaction.

S. Based on the chi-square value, it is not a case of recessive epistatic interaction.

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

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

Ans: a

101. Somatic recombination was caused by mild exposure to radiation on flies heterozygous for a given allele during specific stages of development and the individuals were allowed to develop. Such individuals are likely to have

P. Clones of homozygous cells in heterozygous body.

Q. Site specific mutagenesis.

R. Twin spots, i.e., patches of mutants cells and homozygous wild type cells in heterozygous body.

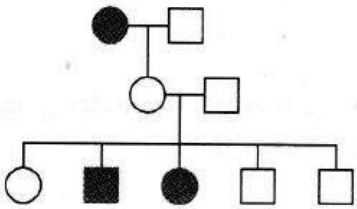
S. Tissue specific expression of the given allele.

Which of the following combination of answers will be most appropriate?

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

Ans: c

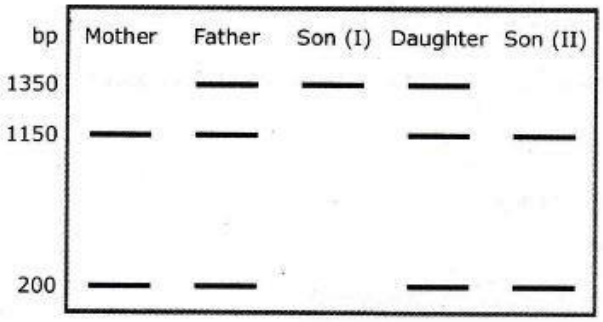
102. The below pedigree shows the inheritance of a rare allele. The allele is



a. X-linked recessive
b. autosomal recessive
c. dominant with incomplete penetrance
d. autosomal recessive with incomplete penetrance

Ans: c

103. Sickle cell anemia is a recessive genetic disease caused due to a point mutation in the 6th codon abolishing one of the MspII endonuclease digestion site present in the β-globin gene. MspII digested DNA from a normal person gives two bands, 1150 bp and 200 bp, in β-globin gene. A family with a proband (based on the disease phenotype) gave the following MspII digestion pattern:



The following conclusions were down:

1. Son (I) is the proband and the given mutation is not present in Son (II).
2. The daughter is a carrier for the given mutation.
3. The gene is X-linked and thus Son (I) becomes the proband.
4. The father and daughter are affected.
5. A *de novo* mutation in same site on normal allele has allowed appearance of disease phenotype in the proband.

Which of the following combination of conclusions will be the most appropriate for the figure given above?

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

Ans: aAn

UNIT 9 & 10

Part B

June 2011

98. *Imperfect fungi* is a group represented by fungal species which have
    a. simple mycelia
    b. unknown mechanisms of sexual reproduction
    c. unknown phylogenetic relationship
    d. lost its survival mechanism against harsh environments

Ans: b

99. Which of the following is *not* a characteristic of phylum chordata?
    a. Pharyngeal slits
    b. Amniotic egg
    c. Postanal tail
    d. Notochord

Ans: b

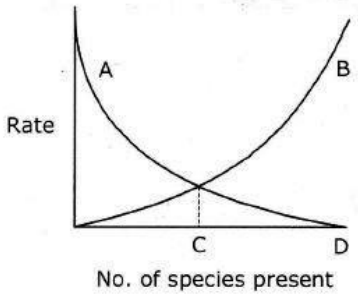
100. The most commonly used method of estimating primary productivity of a pond involves measurement of the amount of
    a. CO_2 utilized
    b. autotroph biomass
    c. oxygen released
    d. organic carbon

Ans: c

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
    a. aquatic autotrophs are small.
    b. aquatic herbivores are more efficient feeders.
    c. terrestrial autotrophs are less efficient feeders.
    d. terrestrial autotrophs have more indigestible tissues.

Ans: d

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



a. extinction, immigration, equilibrium number of species, size of species pool.
b. immigration, extinction, equilibrium number of species, size of species pool.
c. extinction, immigration, size of species pool, equilibrium number of species.
d. immigration, extinction, size of species pool, equilibrium number of species.

Ans: b

103. Name the ectothermic animal that can thermoregulate by behavioural means rather than by physiological means.

a. Bumble bee in an orchard
b. Tuna fish in the ocean
c. Lizard in a desert
d. Flatworm in a pond

Ans: c

104. Which of the following is a characteristic of an early seral community?

a. Narrow niche specialization
b. High species diversity
c. Low community production
d. Open mineral cycling

Ans: d

105. In India, brown antlered deer (sangai) is found only in the floating landmasses of

a. Wular lake
b. Sasthamkotta lake
c. Dal lake
d. Lok Tak lake

Ans: d

December 2011

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

Ans: 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

Ans: a

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.

Ans: a

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

Ans: b

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.

Ans: b

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.

Ans: b

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

a. bamboos
b. palms
c. arborescent lilies
d. legumes

Ans: b

107. Horse shoe crabs belong to the group

a. Onychophora
b. Chelicerata
c. Uniramia
d. Crustacea

Ans; b

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

Ans: b

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

Ans: d

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

Ans: d

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

a. fish
b. frogs
c. pelicans
d. bats

Ans: b

112. Wetlands are conserved internationally through an effort called as

a. Basel convention
b. Rio convention
c. Montreal convention
d. Ramsar convention

Ans: d

June 2012

99. Which of the following organism is widely used as a biocontrol agent in organic farming?

a. *Rhizobium tropicii*

b. *Trichoderma viridis*

c. *Fusarium oxysporum*

d. *Nostoc muscorum*

Ans: b

100. A paraphyletic group

a. contains unrelated organisms.

b. includes the most recent common ancestor but not all of its descendents.

c. includes all the representatives of a clade but not the most recent common ancestor.

d. contains all the representatives of a clade and the most recent common ancestor.

Ans: b

101. Which of the following is *not* an adaptive modification in a xerophytic plant?

a. Strongly developed sclerenchyma

b. Sunken stomata

c. Sparse stomata

d. Presence of lacunar tissues

Ans: d

102. If milk is left open, lactose is fermented first to produce acid. This is followed by proteolytic bacterial activity which increases the pH. Ultimately milk fats are degraded to produce rancidity. This is an example of

a. ecological succession

b. microbial antagonism

c. interference competition

d. microevolution

Ans: a

103. Symbiotic biological nitrogen fixation takes place with the association between a plant and a nitrogen fixing prokaryote as shown in the following table:

List of plants	*Nitrogen fixing*
P. Soybean	1. *Frankia*
Q. *Casuarina*	2. *Bradyrhizobium*
R. *Gunnera*	3. *Anabaena*
S. *Azolla*	4. *Nostoc*

The *correct* combination is

a. P–1, Q-2, R-3, S-4

b. P–2, Q-1, R-4, S-3

c. P–3, Q-2, R-1, S-4

d. P–4, Q-3, R-2, S-1

Ans: b

104. Secondary sewage treatment involves

a. physical removal of solids from polluted water by filtration and sedimentation.

b. removal of chemical remains by precipitation.

c. removal of dissolved organic compounds by activated sludge or trickling filter.

d. removal of microbial pathogens by chlorination or ozonization.

Ans: c

105. Based on per molecule, which of the following gas has the most powerful greenhouse effect?

a. CO_2

b. CH_4

c. N_2O

d. CFCs

Ans: d

December 2012

99. The 'Tribe' refers to a taxonomic group recognized between the ranks

a. genus and species
b. family and genus
c. order and family
d. class and order

Ans: b

100. A plant species has been described for the first time by author 'x'. Later, the species has been transferred to some other genus by author 'y'. Then the author citation for the new combination will be

a. x et y
b. x ex y
c. (x) y
d. (y) x

Ans: c

101. The group which is no longer considered under fungi is

a. Ascomycetes
b. Basidiomycetes
c. Chytridiomycetes
d. Oomycetes

Ans: d

102. The following table shows survival and fertility data for a seasonally breeding species.

Season	Proportion surviving	Fertility
0	1.0	0
1	0.5	20
2	0.0	–

Based on above data, net reproductive rate (R_0) of the species will be

a. 1
b. 5
c. 10
d. 20

Ans: c

103. Which of the following is *not* a characteristic of late successional forest plant species?

a. Large seed size, high root to shoot ratio.
b. Long seed dispersal distance, long seed viability.
c. Slow growth rate, long maximum life span.
d. Low light saturation intensity, high efficiency at low light.

Ans: b

104. Which of the following organisms do not possess the ability to fix nitrogen?

a. Organisms specialized for high altitude
b. Marine plankton
c. Eukaryotic organisms
d. Acidophilic organisms

Ans: c

105. Which of the following greenhouse gases has got highest atmospheric life time?

a. CO_2
b. CH_4
c. N_2O
d. CFCs

Ans: d

June 2013

99. Cladistic classification is based on

a. sequential order in which branches arise from a phylogenetic tree.

b. the order of sequence divergence.

c. morphological features and skeleton of individuals.

d. cellular organization and cytoskeleton.

Ans: a

100. Tautonym is an informal taxonomic designation used for animals referring to

a. same name for genus and species.

b. same name for species and subspecies.

c. trinomial nomenclature.

d. the name of the author for the species.

Ans: a

101. A marine biologist dug up a small animal from the ocean floor. The animal was uniformly segmented with short, stiff appendages and soft, flexible skin. It had a complete digestive system and an open circulatory system but no exoskeleton. Based on this description, the animal appears to be a

a. lancelet

b. roundworm

c. mollusc

d. crustacean

Ans: b

102. Which of these programs is used to conserve a species facing extinction?

a. Captive breeding

b. Natural resources

c. Sustainable use

d. Edge effects

Ans: a

103. A grasshopper population is being assessed by capture-mark-release-recapture method. On the first day, 100 grasshoppers were captured from a given area in 1 hour time, marked and released. On the next day during recapture, 10 marked and 90 unmarked grasshoppers could be found in the same time period from same area. What will be the estimated population size in the given area?

a. 80

b. 100

c. 1,000

d. 10,000

Ans: c

104. Free-living nitrogen fixers can survive in different ecological niches. Identify the *incorrect* combination from the following list:

a. *Azotobacter* – acidic soil

b. *Deraxia* – alkaline soil

c. *Beijerinckia* – acid soil

d. *Frankia* – neutral soil

Ans: a

105. A plot of soil contaminated with diesel oil was inoculated with oyster mushrooms. After 4 weeks, more than 95% of the polycyclic aromatic hydrocarbons had been reduced to non-toxic compounds. This process is called

a. phytoremediation

b. chemoremediation

c. mycoremediation

d. zooremediation

Ans: c

December 2013

101. Chinese Brake fern (*Pteris vittata*) is a hyperaccumulator of

a. Cadmium
b. Arsenic
c. Lead
d. Chromium

Ans: b

102. The fungal group presently classified under protists is

a. Zygomycetes
b. Oomycetes
c. Deuteromycetes
d. Discomycetes

Ans: b

103. The fungus associated with human oral or vaginal infection is

a. *Fusarium*
b. *Aspergillus*
c. *Candida*
d. *Pneumocytis*

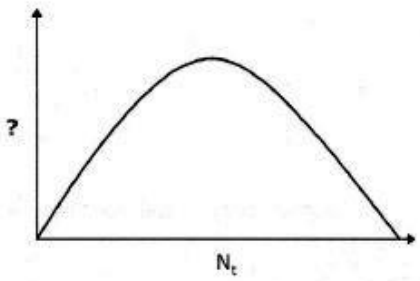
Ans: c

104. Which one of the following advancements in animal classification is *correct*?

a. Protostomes → Pseudocoelomates → Deuterostomes → Eucoelomates.
b. Acoelomates → Protostomes → Eucoelomates → Deuterostomes.
c. Pseudocoelomates → Eucoelomates → Protostomes → Deuterostomes.
d. Protostomes → Deuterostomes → Acoelomates → Eucoelomates.

Ans: c

105. The following graph is for a logistically growing population, with N_t plotted on the X-axis. What is the parameter plotted on the Y-axis?



a. dN/dt
b. N_{t+1}
c. $\frac{dN}{dt} \cdot \frac{1}{N}$
d. K

Ans: a

106. Annual weeds of arable lands are classified as

a. phonerophytes
b. therophytes
c. chamaephytes
d. geophytes

Ans: b

107. The most common vegetation in the Western Ghats of India is tropical moist deciduous forest but that in Deccan plateau is depleted thorn forest. The possible reason is

a. richer soil of Western Ghats compared to Deccan plateau.
b. extensive deforestation in Deccan plateau compared to Western Ghats.
c. higher rainfall in Western Ghats compared to Deccan plateau.
d. higher temperature in Deccan plateau compared to Western Ghats.

Ans: c

June 2014

98. The organs *radula* and *clitellum* are found in

a. Coelenterata and Echinodermata, respectively.

b. Echinodermata and Coelenterata, respectively.

c. Annelida and Mollusca, respectively.

d. Mollusca and Annelida, respectively

Ans: d

99. *Branchiostoma* is a

a. deuterostome and schizocoelomate.

b. protostome and schizocoelomate.

c. deuterostome and enterocoelomate.

d. protostome and enterocoelomate.

Ans: c

100. Which of the following is a *correct* hierarchial sequence for classifying a living organism?

a. Domain-Kingdom-Phylum-Class-Order-Family-Genus-Species.

b. Kingdom-Domain-Phylum-Class-Order-Family-Genus-Species.

c. Domain-Kingdom-Phylum-Order-Class-Family-Genus-Species.

d. Kingdom-Domain-Phylum-Order-Class-Family-Genus-Species.

Ans: a

101. The present global warming trend is expected to result in an increased incidence of malaria in temperate countries. The supposed underlying mechanism is that

a. higher temperatures make temperate country people more vulnerable to diseases.

b. malarial parasite grows better at higher temperatures.

c. the vector mosquito species requires warmer temperatures for reproduction.

d. anti-malaria drugs are less effective in temperate countries.

Ans: c

102. The most important reproductive strategies of big trees in a forest are

a. earlier age at first reproduction and production of a large number of small seeds.

b. earlier age at first reproduction and production of a small number of large seeds.

c. later age at first reproduction and production of a large number of small seeds.

d. later age at first reproduction and production of a small number of large seeds.

Ans: d

December 2014

97. Schizocoelous coelom formation, mouth formation from embryonic blastopore, spiral and determinate cleavage are characteristic of

a. deuterostomes

b. pseudocoelomates

c. protists

d. protostomes

Ans: d

98. An example of the species interaction called commensalism is

a. nitrogen-fixing bacteria in association with legume plant roots.

b. microbes in living human gut.

c. female mosquito deriving nourishment from human blood.

d. Orchid plant growing on the trunk of a mango tree.

Ans: d

99. Which of the following is a *correct* match of the animal with its taxonomic group?

a. Hirudinea-Leech; Chelicerata-Horse shoe crab; Cestoda-Tapeworm; Echinoidea-Sea urchins; Cephalopoda-Octopus; Oligochaeta-Earthworm

b. Hirudinea-Earthworm; Chelicerata-Horse shoe crab; Cestoda-Octopus; Echinoidea-Tapeworm; Cephalopoda-Earthworm; Oligochaeta-Leech

c. Hirudinea-Tapeworm; Chelicerata-Leech; Cestoda-Tapeworm; Echinoidea-Horse shoe crab; Cephalopoda-Earthworm; Oligochaeta-Octopus

d. Hirudinea-Leech; Chelicerata-Tapeworm; Cestoda-Earthworm; Echinoidea-Sea urchins; Cephalopoda-Octopus; Oligochaeta-Horse shoe crab.

Ans: a

100. Individuals with greater mass have a smaller surface area to volume ratio, which helps to conserve heat. This is known as

a. Leibig's rule
b. Cope's rule
c. Gloger's rule
d. Bergmann's rule

Ans: d

101. The population density of an insect species increases from 40 to 46 in one month. If the birth rate during that period is 0.4, what is the death rate?

a. 0.25
b. 0.15
c. 0.87
d. 0.40

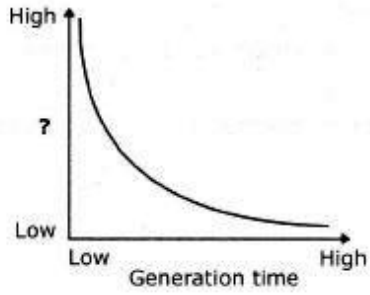
Ans: a

102. In which ecosystem is the detrital pathway of energy flow most important?

a. Lakes
b. Grasslands
c. Tropical rainforests
d. Oceans

Ans: c

103. What parameter plotted on Y-axis against generation time, would yield the curve shown in the figure?



a. Survivorship
b. Body size
c. Lifespan
d. Intrinsic rate of increase

Ans: d

June 2015

104. In eusocial insects, males develop from unfertilized eggs while females develop from fertilized eggs. The ultimate consequence of this difference is that

a. in any colony there are always more males than females.

b. a female is genetically more closely related to her sister than to her own offspring.

c. females are behaviorally more dominant than the males.

d. in any colony there are always more females than males.

Ans: b

105. The phylum in which the animals are bilaterally symmetrical in the larval stage and radially symmetrical in the adult stage is

a. Coelenterate
b. Nematoda
c. Mollusca
d. Echinodermata

Ans: d

106. Which of the following fungal groups has septate hyphae and reproduces asexually by budding, conidia and fragmentation?

a. Basidiomycota
b. Zygomycetes
c. Chytrids
d. Glomeromycota

Ans: a

107. The general relation between generation time (T) and population growth rate (r) is described by the equation

a. $\ln r = \ln a - b \ln T$
b. $r = a - b T$
c. $\ln r = \ln a + b \ln T$
d. $r = a + b T$

Ans: a

108. Which of the following is *not* semelparous?

a. Dracena
b. Bamboo
c. Cicada
d. Mayfly

Ans: a

109. The dynamics of any subpopulation within a metapopulation differs from that of a normal population in that the

a. birth rates are lower than the death rates.
b. death rates are lower than the birth rates.
c. immigration and emigration rates are significantly higher.
d. immigration and emigration rates are negligible.

Ans: c

110. Which of the following is likely to contribute to the stability of an ecosystem?

a. High number of specialists
b. Fewer number of functional links
c. More omnivores
d. Linear rather than reticulate food webs

Ans: c

Part C

June 2011

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

a. neotype for A only

b. neotype for both A and B

c. neotype for A and lectotype for B

d. lectotype for both A and B

Ans: b

107. Assume a new subspecies *Ficus callosa* subsp. *microcarpa* has been published by Jacobs. The nomenclature of the resulting entities would be

a. *F. callosa* and *F. callosa* subsp. *microcarpa* Jacobs.

b. *F. callosa* subsp. *microcarpa* Jacobs and other yet to be named subspecies of *F. callosa*.

c. *F. callosa* subsp. *callosa* Jacobs and *F. callosa* subsp. *microcarpa* Jacobs.

d. *F. callosa* subsp. *callosa* and *F. callosa* subsp. *microcarpa* Jacobs.

Ans: b

108. An organism has the following architectural pattern:

1. Multicellular with germ layers.
2. A coelom derived from the mesoderm.
3. Primary bilateral symmetry with secondary radial symmetry.
4. Presence of endoskeletal plates.

Such an organism is most likely to

P. have mesohyl as its connective tissue.

Q. undergo torsion, whereby the mouth and anus are properly oriented.

R. be devoid of a brain but have calcareous spicules.

S. have comb plates to help in locomotion.

Which of the following is/are *true*?

a. P and R

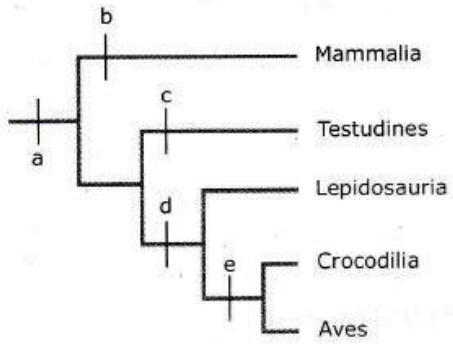
b. R only

c. S only

d. Q and R

Ans: b

109. Identify the apomorphic characters marked in the cladogram:



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

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

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

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

Ans: d

110. According to MacArthur and Wilson's equilibrium theory, which of the following is *true*?

a. Larger islands and islands closer to continent are expected to have more species than smaller and isolated islands.

b. Smaller islands and islands far from the continent are expected to have more species than larger and isolated islands.

c. Smaller islands and islands closer to the continent are expected to have more species than far away smaller and isolated islands.

d. More species are expected on all islands irrespective of their size and distance from the continent.

Ans: a

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

a. (L-D) and (L-I), respectively

b. (L-I) and (L-D), respectively

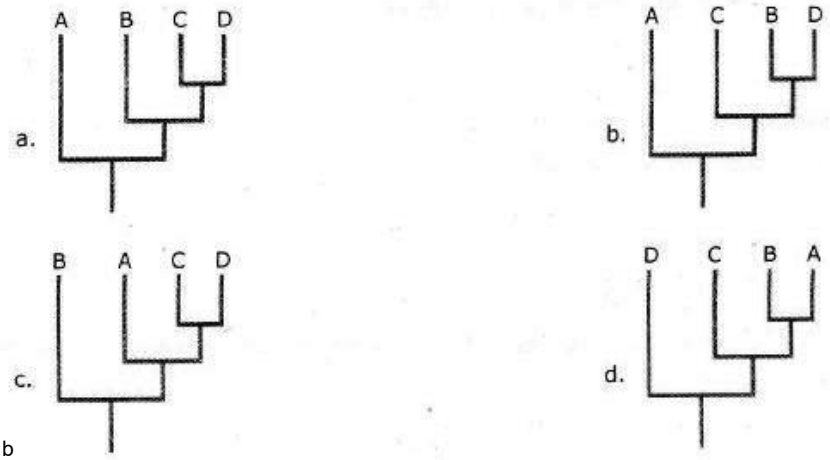
c. (L-I) and (I-D), respectively

d. (L-D) and (I-D), respectively

Ans: a

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



Ans: b

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?

a. It depends on how one defines niche.

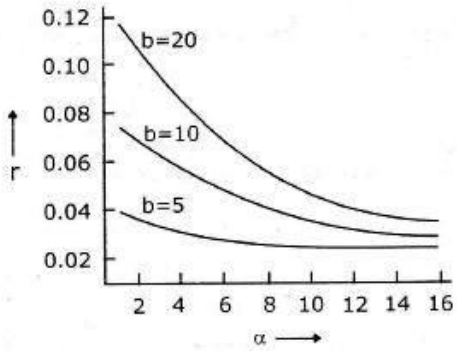
b. There are in nature many instances of continued coexistence of closely related species.

c. The principle is universally true.

d. It does not predict the outcome where both the species are equally strong competitors.

Ans: a

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



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

a. The later the age of first reproduction, the lower is the population growth rate achieved.

b. The population growth rate decreases as first reproduction is postponed to a later state, regardless of the fecundity.

c. At any α, the higher the fecundity, the higher is the population growth rate achieved.

d. As the age at first reproduction is postponed further, the benefits of increasing fecundity on the population growth rate become progressively negligible.

Ans: d

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),

a. P and C are controlled by B, and Z is controlled by T.

b. P, Z and C are all controlled by T.

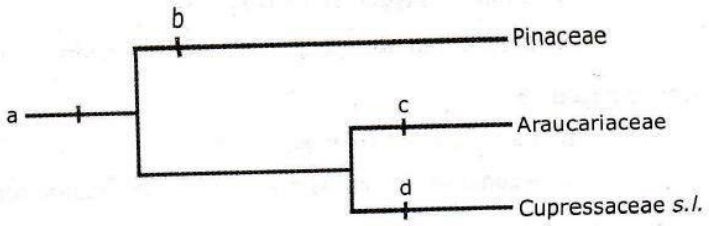
c. P is controlled by B, Z is controlled by T and C is controlled by B.

d. P is controlled by T, Z is controlled by B and C is controlled by T.

Ans: b

December 2011

113. 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.

Ans: b

114. 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).

Ans: a

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.

Ans: a

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

Ans: b

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.

Ans: b

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)

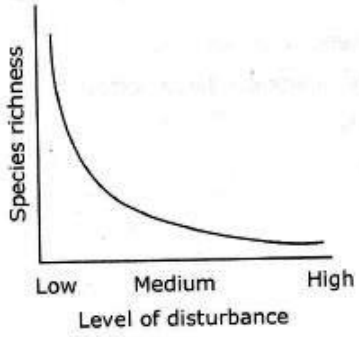
c. Denitrification - (5); nitrogen fixation - (1) and (4); nitrification - (4)

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

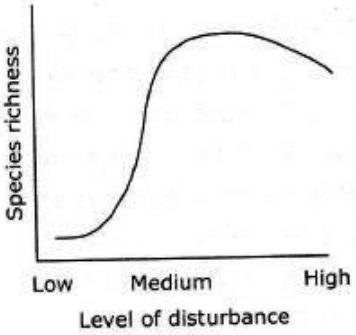
Ans: b

119. Which of the following graphs illustrates the current consensus on the role of *disturbance* on the species richness of a community?

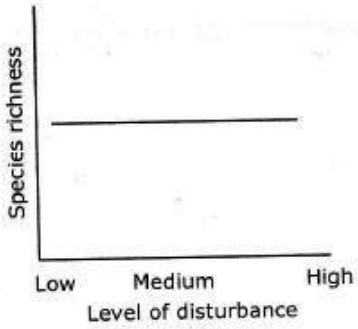
a.



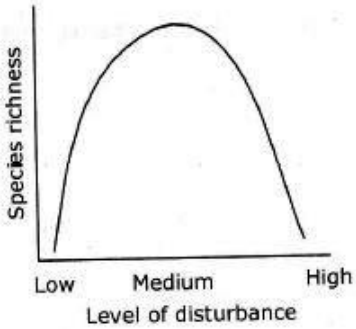
b.



c.



d.



Ans: d

120. Suppose you discovered a new species about which you know only two facts: it is small-sized (<10cm) 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.

Ans: c

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.

Ans: a

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.

Ans: a

June 2012

106. A species has the following population characteristics:

P. Reduction in population size ≥90% over the last 10 years or 3 generations.

Q. Geographic range: Extent of occurrence: <100 km^2 and Area of occupancy: <10 km^2.

R. Population size less than 50 matured individuals.

S. Probability of extinction in the wild is at least 50% within the next 10 years or 3 generations.

To which of the following categories the species will be assigned according to IUCN categorization of threatened species (version 3.1)?

a. Endangered
b. Vulnerable
c. Critically endangered
d. Extinct in the wild

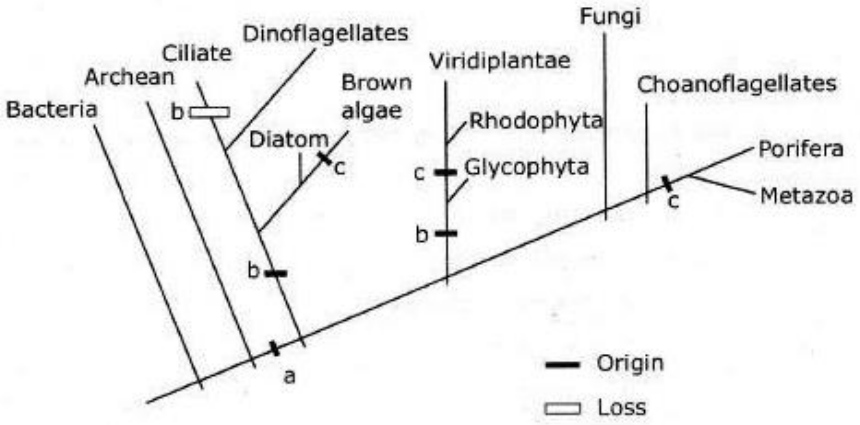
Ans: c

107. Which of the following hypothesis best explains the occurrence of Himalayan floral elements in Western Ghats of India?

a. Continental drift theory
b. Deccan trap theory
c. Himalayan glaciation theory
d. Coromandel coast hypothesis

Ans: c

108. Identify a, b and c in the figure;



a. a = mitochondria; b = multicellularity; c = chloroplast
b. a = mitochondria; b = chloroplast; c = multicellularity
c. a = chloroplast; b = multicellularity; c = mitochondria
d. a = chloroplast; b = nucleus; c = multicellularity

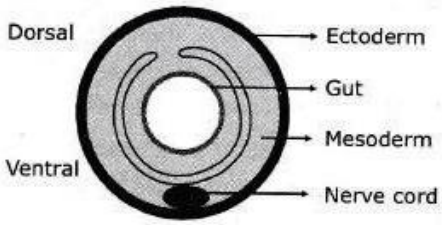
Ans: b

109. In which of the following classes of vertebrates there are groups of animals without limbs?

a. Fish, reptiles and mammals
b. Reptiles only
c. Reptiles and amphibians
d. Amphibians only

Ans: c

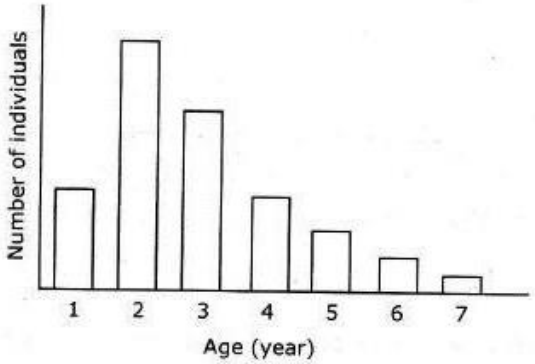
110. The schematic section given below of animal indicates that the animal is



a. triploblastic, coelomic, invertebrate
b. triploblastic, acoelomic invertebrate
c. diploblastic, coelomic, invertebrate
d. triploblastic, coelomic, vertebrate

Ans: a

111. At a given time, the age class distribution of a population was as shown in the figure;



Which of the following can be inferred from the figure?

a. Age class 2 has maximum fecundity.
b. Age class 2 has maximum survival.
c. Age class distribution is at equilibrium.
d. Age class distribution is not at equilibrium.

Ans: d

112. While studying the diversity of 4 communities, 5 species and 50 individuals were recorded from each community. The number of individuals under each species was listed as mentioned in the following table. In which of the following communities Pielou's Evenness Index (e) will be 1?

	Community	Species				
		1	2	3	4	5
a.	A	20	8	7	5	10
b.	B	10	10	10	10	10
c.	C	10	12	10	8	10
d.	D	1	1	1	1	46

Ans: -

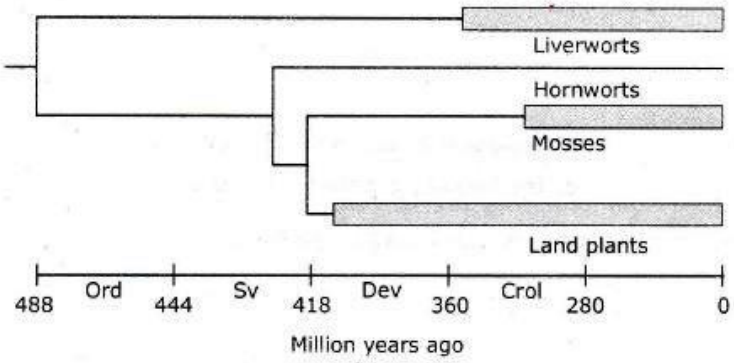
113. Average annual precipitation and temperature are two important determinants of world's major biomes. Which of the following combinations is *correct*?

Temperature and precipitation	*Biome*
P. 25°C temperature and 255 cm precipitation	1. Temperate forest
Q. 15°C temperature and 300 cm precipitation	2. Savannah
R. 15°C temperature and 100 cm precipitation	3. Temperate rain forest
S. 25°C temperature and 255 cm precipitation	4. Tropical rain forest

a. P–4, Q–3, R–1, S–2
b. P–3, Q–2, R–4, S–1
c. P–2, Q–1, R–3, S–4
d. P–1, Q–4, R–2, S–3

Ans: a

114. According to fossil records, the earliest fossils of liverworts are found in the late Devonian, of mosses in the early Cretaceous, and vascular plants in the late Silurian/early Devonian. *Anthoceros* (hornworts) fossils have not been discovered. Reading fossil records we would say that vascular plants appeared first, then mosses and then liverworts.



However, phylogenetic relationships (shown in the figure) suggest otherwise. It may be that

1. evolutionary history can be read directly from the fossil record.
2. the moss lineage goes back to at least early Silurian/early Devonian.
3. fossils can only set a maximum age for a lineage.
4. fossils can only set a minimum age for a lineage.
5. the divergence between liverworts and the rest of land plants goes back to at least the early Ordovician.

Which of the following statements is *correct*?

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

Ans: b

115. In Lotka and Voltera's two species competition model:

$$\frac{dN_1}{dt} = r_1 N_1 \left(\frac{K_1 - N_1 - N_2\alpha_{12}}{K_1} \right) \text{ and } \frac{dN_2}{dt} = r_2 N_2 \left(\frac{K_2 - N_2 - \alpha_{21} N_1}{K_2} \right)$$

Where *N* represents population size, r growth rate and *K* maximum carrying capacity for species 1 and 2. The interspecific competition coefficient $\alpha_{12} < 1$ will mean:

a. individuals of species 2 have less inhibiting effect on individuals of species 1 than individuals of species 1 on others of their own species.
b. individuals of species 2 have a greater inhibiting effect on individuals of species 1 than individuals of species 1 on others of their own species.
c. individuals of species 1 have less inhibiting effect on individual members of species 2 than individual of species 2 on others of their own species.
d. individuals of species 1 have a greater inhibiting effect on individuals of species 2 than individuals of species 2 on others of their own species.

Ans: a

December 2012

106. Four Cnidarians with the following characteristics were observed:

P. Asexual polyps and sexual medusae; solitary or colonial; both freshwater and marine

Q. Polyp stage reduced or absent, medusae with velum; solitary; all marine

R. Polyp stage reduced, bell shaped medusae; solitary; all marine

S. All polyps, no medusae; solitary or colonial; all marine

They can be identified to their respective classes

a. P – Scyphozoa Q – Anthozoa R – Cubozoa S – Hydrozoa

b. P – Hydrozoa Q – Scyphozoa R – Cubozoa S – Anthozoa

c. P – Anthozoa Q – Cubozoa R – Hydrozoa S – Scyphozoa

d. P – Cubozoa Q – Scyphozoa R – Anthozoa S – Hydrozoa

Ans: b

107. Identify the proteobacteria based on the key given below:

i. Cause disease in humans	(ii)
i. Do not cause disease in humans	(iii)
ii. An obligate intracellular parasite	(A)
ii. Not an obligate intracellular parasite	(B)
iii. Live in insects	(C)
iii. Do not live in insects	(iv)
iv. Chemoautotrophic	(D)
iv. Not Chemoautotrophic	(v)
v. Plant pathogen	(E)
v. Not a plant pathogen	(vi)
vi. Fix nitrogen	(vii)
vi. Do not fix nitrogen	(F)
vii. Associated with legumes	(G)
vii. Not associated with legumes	(H)

a. A – Rickettsia; B – Brucella; C – Wolbachia; D – Nitrobacter; E – Agrobacterium; F – Acetobacter; G –Rhizobium; H – Azospirillum.

b. A – Rickettsia; B – Wolbachia; C – Brucella; D – Nitrobacter; E – Acetobacter ; F – Agrobacterium; G – Rhizobium; H – Azospirillum.

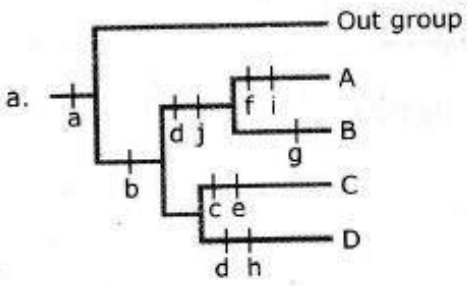
c. A – Rickettsia; B – Brucella; C – Wolbachia; D – Nitrobacter; E – Agrobacterium; F – Acetobacter; G – Azospirillum; H – Rhizobium.

d. A – Rickettsia; B – Brucella; C – Wolbachia; D – Nitrobacter; E – Acetobacter; F – Agrobacterium; G – Azospirillum; H – Rhizobium.

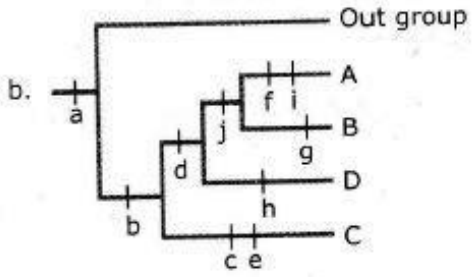
Ans: a

108. Which of the following phylogenetic trees appropriately uses principle of parsimony?

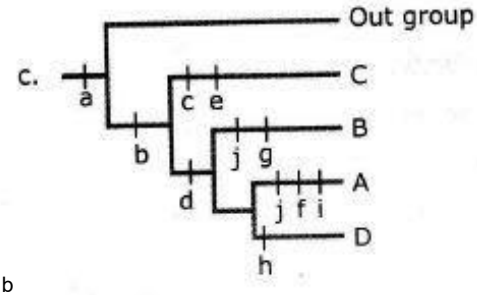
a.



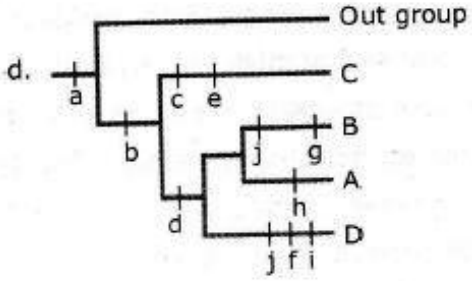
b.



c.

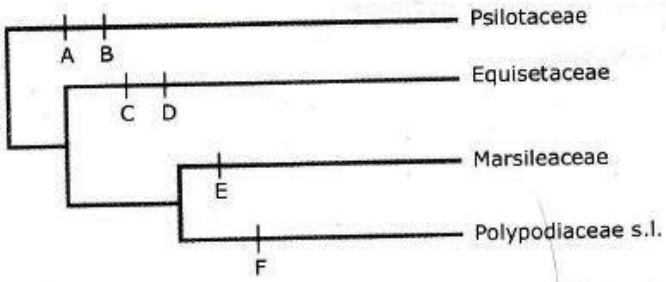


d.



Ans: b

109. Identify the characters shown in the diagram depicting phylogenetic relationships among major groups of ferns and fern allies.



a. A–Roots absent, B–Sporangiophores, C–Vertical, interrupted annulus, D–Heterospory, E–Leaves scale like, F–Elaters.

b. A–Roots absent, B–Leaves scale like, C–Sporangiophores, D–Elaters, E–Heterospory, F–Vertical, interrupted annulus.

c. A–Leaves scale like, B–Sporangiophores, C–Elaters, D–Heterospory, E–Roots absent, F–Vertical, interrupted annulus.

d. A–Heterospory, B–Roots absent, C–Elaters, D–Sporangiophores, E–Leaves scale like, F–Vertical, interrupted annulus.

Ans: b

110. Associate the forest/vegetation type with the plants:

1. Grass land
2. Subalpine forest
3. Shola forest
4. Subtropical pine forest
5. Tropical thorn forest
6. Tropical dry deciduous forest
7. Tropical semievergreen forest
8. Tropical wet evergreen forest

a. 1- Ilex, 2- Dichanthium, 3- Abies, 4- Pinus, 5- Acacia, 6- Anogeissus, 7- Cinnamomum, 8- Dipterocarpus.

b. 1- Dichanthium, 2- Abies, 3- Ilex, 4- Pinus, 5- Acacia, 6- Anogeissus, 7- Cinnamomum, 8- Dipterocarpus.

c. 1- Dichanthium, 2- Abies, 3- Ilex, 4- Pinus, 5- Dipterocarpus, 6- Cinnamomum, 7- Acacia, 8- Anogeissus.

d. 1- Anogeissus, 2- Dichanthium, 3- Ilex, 4- Pinus, 5- Acacia, 6- Abies, 7- Cinnamomum, 8- Dipterocarpus.

Ans: b

111. The following table shows the summary of characters between two taxa based on presence (1) and absence (0) data

	Taxon A		
Taxon B		1	0
	1	40	18
	0	22	20

Which of the following represents Jaccard's coefficient and Simple matching coefficient respectively?

a. 0.8, 0.5

b. 0.6, 0.5

c. 0.8, 0.6

d. 0.5, 0.6

Ans: d

112. Possible explanations for the age related decline in primary productivity of trees are:

P. As trees grow larger with age, they have more tissues that respire and loose energy and proportionately less leaf area to photosynthesize.

Q. Nutrient limitation by nitrogen due to reduced rate of woody litter decomposition as forest ages.

R. As trees become larger, water transport to the top canopy leaves becomes limited because of increased hydraulic resistance. This results in reduced stomatal conductance and reduction in photosynthetic rate.

Which of the above is/are *correct*?

a. P, Q and R

b. Only P

c. Only P and R

d. Only Q and R

Ans: d

113. Species characteristics that make them more prone to extinction are listed below:

P. High degree of specialization

Q. High sexual dimorphism

R. High trophic status

S. Short life span

Which of the following is the *correct* combination?

a. P, Q and R

b. P, R and S

c. P, Q and S

d. Q, R and S

Ans: b

114. Based on the information given in the table below, which combination is *correct*?

Biographic zone	Plant	Animal
A_1-Mediterranean	B_1-*Rhododendron*	C_1-Gibbon
A_2-Indo-Chinese	B_2-*Dipterocarpus*	C_2-Jaungle Fowl
A_3-Indo-Malayan	B_3-*Euphorbia*	C_3-Takin
A_4-Peninsular India	B_4-Deodar	C_4-Ibex

a. $A_1 - B_3 - C_3$

b. $A_2 - B_1 - C_4$

c. $A_3 - B_2 - C_1$

d. $A_4 - B_4 - C_2$

Ans: c

115. Identify the pollinators for the flowers with following pollination syndromes

P. Flowers dull colored, located away from foliage, floral parts turgid.

Q. Flowers bright red, crowded, turgid, nectar watery and sucrose rich.

R. Flowers white with pleasant odor, corolla tube long, night blooming.

a. P–Bird, Q–Bat, R–Butterfly
b. P– Bat, Q–Bird, R–Moth
c. P–Bat, Q–Bird, R–Bee
d. P–Bird, Q–Bat, R–Carrion fly

Ans: b

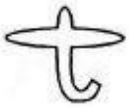
116. Which of the following combinations is good for setting up a nature reserve:

P.

Linked reserves

Q.

Large, compact shape

R. 

High edge to area ratio

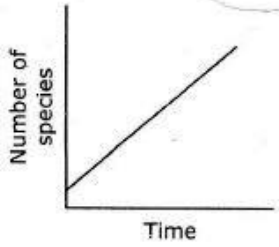
S.

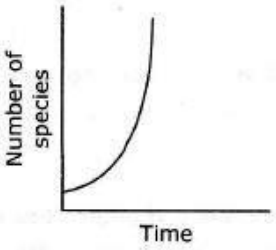
Surrounding area of same ecosystems

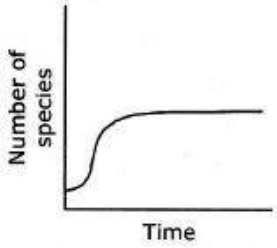
a. P, Q and R
b. Q, R and S
c. P, R and S
d. P, Q and S

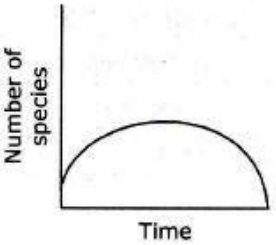
Ans: d

117. If the number of new species evolving is directly proportional to the number of existing species and the probability of extinction of any species is inversely proportional to the number of existing species, the number of species present at a time during evolution will follow a curve given by:

a. 

b. 

c. 

d. 

Ans: c

June 2013

106. The following table gives vascular tissue characteristics of four divisions of Tracheophyta.

Divisions	Vascular tissue characteristics
P. Psilophyta	1. Well-developed tracheid and pits in lateral wall.
Q. Lycopodiophyta	2. Tracheids.
R. Sphenophyta	3. Tracheids, vessels and well-developed phloem.
S. Pteridophyta	4. Primitive tracheids and pits in lateral wall.

Identify the *correct* combinations:

a. P–1, Q–2, R–3, S–4

b. P–2, Q–1, R–4, S–3

c. P–4, Q–3, R–2, S–1

d. P–3, Q–4, R–1, S–2

Ans: b

107. Which of the following is *not* an advantage to seed-based reproduction?

a. Reserve food material is provided for the developing embryo.

b. Seed coat protects the embryo and allows it to remain dormant until favourable environmental conditions are available.

c. The amount of energy spent per female gametophyte is less than that spent on making a spore.

d. The female gametophyte remains on the sporophyte which provides protection and nourishment.

Ans: c

108. As per the International Code of Botanical Nomenclature, 2006 (Vienna Code), which of the following is a Nothospecies?

a. *Polypodium vulgare* subsp. *prionodes* (Asch.) Rothm.

b. *Polypogon monspeliensis* (L.) Desf.

c. *Agrostis stolonifera* L.

d. *Agrostis stolonifera* L. x *Polypogon monspeliensis* (L.) Desf.

Ans: d

109. Which of the following groups have only two wings?

a. Honey bee, beetle, ant.

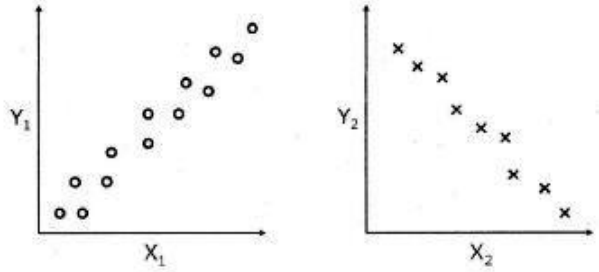
b. Butterfly, housefly, fruitfly.

c. Dragonfly, butterfly, fruitfly.

d. Housefly, fruitfly, mosquito.

Ans: d

110. In a study of sexual isolation in a species of salamander, scientists brought together males and females from different populations and from the same population. They observed the frequency of mating and calculated a sexual isolation index. One graph shows the relationship between mating frequency and genetic distance, and the other shows the relationship between sexual isolation index and geographic isolation.



Choose the appropriate terms for X_1, Y_1, X_2 and Y_2 in the figures, above.

a. X_1 = Geographic distance, Y_1 = Sexual isolation index; X_2 = Genetic distance, Y_2 = mating frequency.

b. X_1 = Geographic distance; Y_1 = mating frequency; X_2 = Genetic distance, Y_2 = Sexual isolation index.

c. X_1 = Genetic distance; Y_1 = mating frequency; X_2 = Sexual isolation index; Y_2 = Geographic distance.

d. X_1 = Genetic distance; Y_1 = Geographic distance; X_2 = Sexual isolation index; Y_2 = mating frequency.

Ans: a

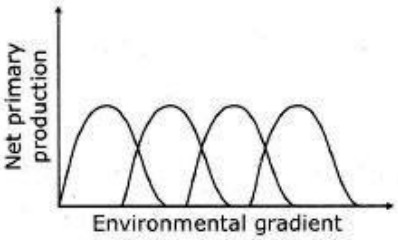
111. India has currently 17 biosphere reserves representing different ecosystems. These conservation areas significantly differ from the conventional protected areas of the country. Identify the *correct* combination of attributes (1 to 7) that best explains the concept of biosphere reserve.

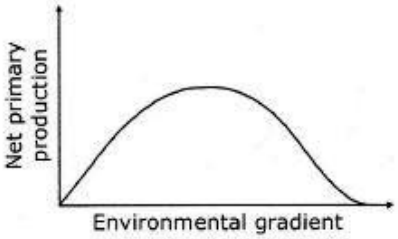
1. Conservation,
2. Education,
3. Human habitation allowed,
4. Human habitation not allowed,
5. Strong legal back-up,
6. No supporting act,
7. Research.

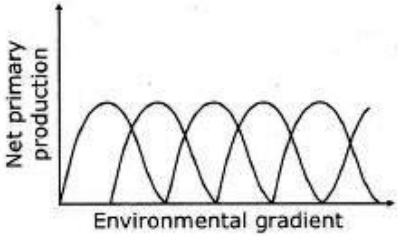
a. 1, 2, 3, 6, 7
b. 1, 2, 4, 6, 7
c. 1, 2, 3, 5, 7
d. 1, 4, 5, 7

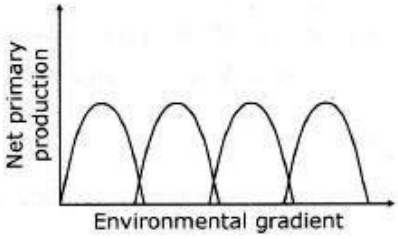
Ans: a

112. Followings are the niche characteristics of the constituent species and resource partitioning pattern in different ecosystems. Which of these would lead to competitive exclusion of species?

a.


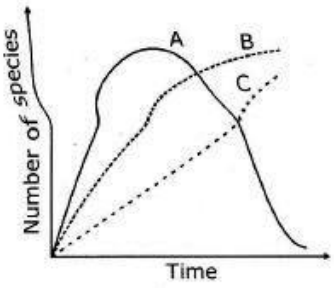
b.


c.


d.


Ans: b

113. Environmental conditions can influence accumulation of species in successional communities. Curves representing changes in forest species over time are given in the figure below. Which of the following keys is *correct* for the curves?



a. A = xeric, B = mesic, C = intermediate.
b. A = intermediate, B = xeric, C = mesic.
c. A = intermediate, B = mesic, C = xeric.
d. A = mesic, B = intermediate, C = xeric.

Ans: d

114. A plant with blue-coloured flowers was observed to attract a large number of pollinators. However, these flowers were not producing any nectar. Which of the following can be a logical explanation to the observation?

a. There could be another species in the vicinity that has blue flowers and is rich in nectar.
b. There is no other species with blue flowers in the vicinity so pollinators are compelled to visit this species.
c. Pollinators may not have blue-colour vision.
d. Pollinators may be able to see only blue colour.

Ans: a

115. Three islands have identical habitat characteristics. On first island rodent species A is present at a density 325/km^2. Second island has only species B at a density of 179/km^2. On the third island, both A and B co-exist with densities 297/km^2 and 150/km^2, respectively. Which of the following can be inferred from this?

a. The two species do not compete with each other.

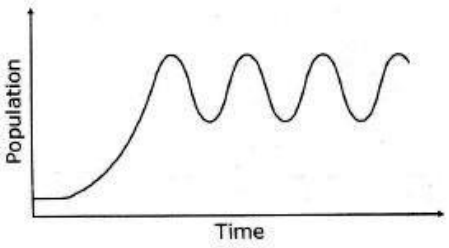
b. The intra-species competition is more intense than inter-species competition.

c. The inter-species competition is more intense than intra-species competition.

d. The inter and intra species competition are of the same intensity.

Ans: b

116. A few males and females of a species were introduced to a new island. Their population was monitored over several generations and followed a pattern shown in the figure.



Which of the characteristics of the species does *not* explain the pattern?

a. Skewed sex ratio (more females than males).

b. Large litter size.

c. Delayed sexual maturity.

d. Effects of intra-uterine development on fecundity.

Ans: a

December 2013

108. Which one of the following plants group combinations reflects *correct* increasing order of the number of species it has?

a. Gymnosperms, Bryophytes, Algae, Angiosperms

b. Angiosperms, Algae, Gymnosperms, Fungi

c. Algae, Bryophytes, Gymnosperms, Angiosperms

d. Angiosperms, Gymnosperms, Bryophytes, Algae

Ans: a

109. Coelomates have

1. fluid filled body cavity.
2. a complete lining called peritoneum, derived from mesoderm covering the body cavity.
3. a complete lining called peritoneum, derived from ectoderm covering the body cavity.
4. Round worm as representative of this group.
5. Flat worm as representative of this group.

Select the *correct* combination.

a. 1, 3 and 4

b. 1, 3 and 5

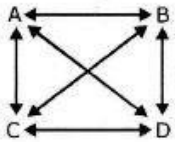
c. 1, 2 and 4

d. 1 and 2

Ans: d

110. In the following diagram, two models of succession are represented. In this diagram A, B, C and D are species and arrows indicate 'is replaced by'

1. A → B → C → D ↻

2. 

Based on the above, which statement is *correct*?

a. Figure 1 represents facilitation model and figure 2 represents tolerance model.

b. Figure 1 represents tolerance model and figure 2 represents facilitation model.

c. Figure 1 represents facilitation model and figure 2 represents inhibition model.

d. Figure 1 represents tolerance model and figure 2 represents inhibition model.

Ans: c

111. Most biologists agree that seaweeds are protists. Some biologists think that at least some seaweeds should be considered plants, not protists. Which of the following would support the latter one?

a. Certain seaweeds contain several kinds of specialised cells.

b. Certain seaweeds have multicellular organization.

c. Certain seaweeds are found to be prokaryotic.

d. Certain seaweeds undergo sexual and asexual reproduction.

Ans: b

112. Which of following shows the *correct* systematic hierarchy?

a. Kingdom → Phylum → Subphylum → Superclass → Class → Subclass → Cohort → Order → Suborder → Superfamily → Family → Subfamily → Genus → Subgenus → Species → Subspecies

b. Kingdom → Phylum → Subphylum → Cohort → Superclass → Class → Subclass → Superfamily → Family Subfamily → Order → Suborder → Genus → Subgenus → Species → Subspecies

c. Kingdom → Phylum → Class → Order → Cohort → Family → Genus → Species

d. Kingdom → Phylum → Class → Cohort → Family → Order → Genus → Species

Ans: a

113. Lindeman's efficiency between trophic levels is depicted by the formula:

Efficiency $= \frac{A}{B}$; where, A and B, respectively are:

a. 'assimilation at trophic level n' and 'assimilation at trophic level n–1'

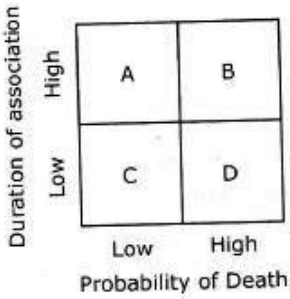
b. 'intake at trophic level n' and 'assimilation at trophic level n–1'

c. 'assimilation at trophic level n' and 'net productivity at trophic level n–1'

d. 'intake at trophic level n' and 'net productivity at trophic level n–1'

Ans: a

114. The following matrix shows the relationship between probability of death and duration of species association.



In the above, A, B, C and D are:

a. A-Parasites, B-Parasitoids, C-Grazers, D-Predators

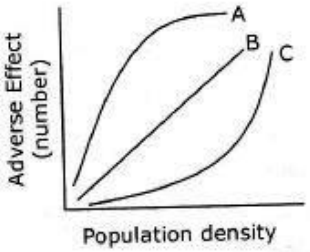
b. A-Carnivores, B-Herbivores, C-Parasites, D-Parasitoids

c. A-Grazers, B-Parasites, C-Herbivores, D-Parasitoids

d. A-Predators, B-Parasitoids, C-Parasites, D-Carnivores

Ans: a

115. An observation was made on a species experiencing three factors A, B and C in order to infer a density dependent population regulation by a factor. The following graph shows the relationship between the adverse effect of the factors in terms of number and population density.



Based on the above observation, which of the following is *correct*?

a. A-Density independent; B-Density dependent; C-Inversely density dependent.

b. A-Inversely density dependent; B-Density independent; C-Density dependent.

c. A-Density dependent; B-Inversely density independent; C-Density independent.

d. A-Density dependent; B-Density independent; C-Inversely density dependent.

Ans: b

116. Which of the following biotic provinces are part of Deccan Peninsula biogeographic zone of India?

a. Malabar Cost, Western Plateau, Eastern Plateau.

b. Western Ghats, Central Plateau, Eastern Plateau.

c. Central Plateau, Eastern Plateau, Chhota Nagapur.

d. Central Plateau, Malabar Cost, Western Ghats.

Ans: c

June 2014

103. Some key characteristics of the four classes of phylum Mollusca are listed below:

P. They have two lateral (left and right) shells (valves) hinged together dorsally; they do not have distinct head or radula; they disperse from place to place largely as larvae.

Q. They generally creep on their foot; the heads of most of this group have a pair of tentacles with eyes at the end; during embryological development, they undergo torsion.

R. They have oval bodies with overlapping calcareous plates; underneath the plates, the body is not segmented; they creep along using a broad, flat foot surrounded by a groove or mantle cavity in which the gills are arranged.

S. They have highly developed nervous system; most members of this class have closed circulatory systems.

The *correct* match of the above characteristics with the classes of Mollusca is

a. P–Polyplacophora Q–Bivalvia R–Gastropoda S–Cephalopoda

b. P–Cephalopoda Q–Polyplacophora R–Bivalvia S–Gastropoda

c. P–Bivalvia Q–Gastropoda R–Polyplacophora S–Cephalopoda

d. P–Gastropoda Q–Bivalvia R–Cephalopoda S–Polyplacophora

Ans: c

104. The list below includes names of animal phyla and classes.

1. Echinodermata
2. Cephalopoda
3. Annelida
4. Mollusca
5. Hirudinea
6. Asteroidea
7. Arthropoda
8. Crustacea.

For a leech and lobster, the *correct* classification of phylum and class, respectively, is

a. Leech: Phylum – 4, Class – 2; Lobster: Phylum – 1, Class – 8.

b. Leech: Phylum – 3, Class – 2; Lobster: Phylum – 4, Class – 3.

c. Leech: Phylum – 3, Class – 5; Lobster: Phylum – 7, Class – 8.

d. Leech: Phylum – 1, Class – 7; Lobster: Phylum – 3, Class – 6.

Ans: c

105. Which of the following set of observations is *true* with reference to a comparison of aquatic (A) and terrestrial (T) ecosystems?

a. Number of trophic levels is more in A than in T.
Productivity/Biomass ratio is higher in T than in A.
Herbivore assimilation efficiency is higher in A than in T.

b. Number of trophic levels is more in T than in A.
Productivity/Biomass ratio is greater in A than in T.
Herbivore assimilation efficiency is higher in T than in A.

c. Number of trophic levels is more in T than in A.
Productivity/Biomass ratio is higher in T than in A.
Herbivore assimilation efficiency is higher in T than in A.

d. Number of trophic levels is more in A than in T.
Productivity/Biomass ratio is greater in A than in T.
Herbivore assimilation efficiency is higher in A than in T.

Ans: d

106. The following statements are related to excretion in invertebrates:

P. Flame cells are found in molluscs and jelly fish.

Q. Nephridia and Malpighian tubules convert ammonia to urea for water conservation.

R. Green glands are found in flatworms and help in the excreta elimination.

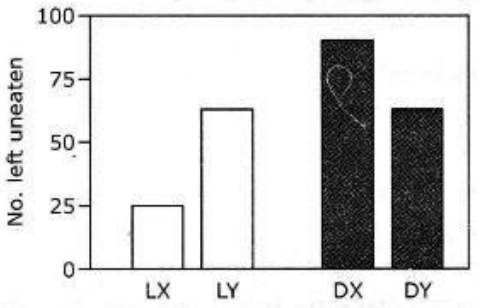
S. Excretory canals in nematodes carry waste materials to excretory pores in the body wall.

Choose the *correct* answer.

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

Ans: d

107. Fish species X and Y feed on mayfly nymphs in their stream habitat. In a laboratory experiment, the predation intensity of X and Y on their prey was tested under dark (D) and light (L) conditions. Thus, the experimental protocol included four aquaria -LX, LY, DX and DY. In each aquarium containing 100 mayfly nymphs, one fish was introduced and allowed to feed for 30 minutes. Then the fish was removed and the number of mayfly nymphs left uneaten in each aquarium was counted. The results are shown graphically below



The most significant conclusion from the results is:

a. X is a visual predator, but has less predation impact on the prey than Y.

b. X is a visual predator and has greater predation impact on the prey than Y.

c. Y is a visual predator and has greater predation impact on the prey than X.

d. Y is a visual predator but has less predation impact on the prey than X.

Ans: b

108. There are three species of frogs–A, B and C. Species A does not provide parental care for its eggs and larvae. Species B is subjected to predation by a predator that selectively feeds only on small-sized larvae. Species C faces progressively decreasing opportunities for breeding with increasing age. Assuming that resources available for reproduction are similar for A, B and C, which of the following strategies would have been favored?

a. A should produce large number of small-sized offspring; B should produce a small number of large-sized offspring; C should breed earlier in life.

b. Species A and B should produce a small number of large-sized offspring and C should breed earlier in life.

c. Both species A and B should produce a large number of small-sized offspring and C should breed later in life but increase its clutch size.

d. Species A should produce a small number of large-sized offspring; B should produce a large number of small-sized offspring and C should breed earlier in life with a small clutch size.

Ans: a

109. A small lake has three trophic levels-phytoplankton (autotrophs), Zooplankton (herbivore) and planktivorous fish (primary carnivore). Into this lake, a population of piscivorous fish (secondary carnivore) was introduced to study the 'top-down' effects". What is the expected long-term consequence of such an introduction to phytoplankton and zooplankton trophic levels?

a. Zooplankton biomass will increase and phytoplankton biomass will decrease.

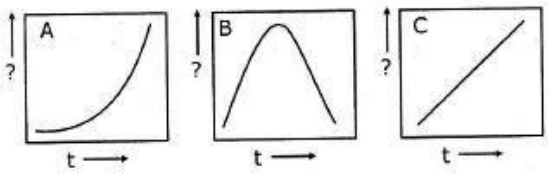
b. Zooplankton biomass will decrease and phytoplankton biomass will increase.

c. The biomasses of both zooplankton and phytoplankton will increase.

d. The biomasses of both zooplankton and phytoplankton will decrease.

Ans: a

110. The three graphs (A, B, C) show population growth (N) patterns in relation to N or time (t).



Which of the following is *correct* with reference to the Y-axis label and the type of population growth?

a. A: Y-axis: N, exponential growth
B: Y-axis: dN/dt, logistic growth
C: Y-axis: ln(N), exponential growth

b. A: Y-axis: dN/dt, exponential growth
B: Y-axis: ln(N), logistic growth
C: Y-axis: N, exponential growth

c. A: Y-axis: ln(N), exponential growth
B: Y-axis: dN/dt, logistic growth
C: Y-axis: N, exponential growth

d. A: Y-axis: dN/dt, exponential growth
B: Y-axis: ln(N), logistic growth
C: Y-axis: N, exponential growth

Ans: a

111. Following are the characteristics of species that make them more or less prone to extinction:

Rare – a
Common – b
Good dispersal rate – c
Poor dispersal rate – d
Low specialization – e
High specialization – f
High variability – g
Low variability – h
Low trophic status – i
High trophic status – j
Long life span – k
Short life span – l
High reproductive output – m
Low reproductive output – n

Which of the following is the *correct* combination of characteristics that makes the species more prone to extinction?

a. a d f g j l n
b. a c f h i k m
c. b d e g i l n
d. b c f h j k m

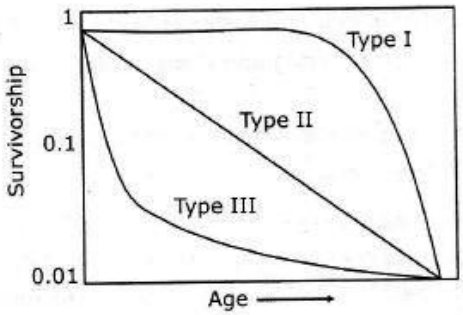
Ans: a

112. Three Indian animals – cormorant, lion-tailed macaque and gerbil are to be matched with the ecosystem they inhabit–Wetland (A), Desert (B), Deciduous forest (C), or Rain Forest (D). Which of the following is the *correct* match of each animal with its habitat?

a. Cormorant – D; Lion-Tailed macaque – C; Gerbil – B
b. Cormorant – A; Lion-Tailed macaque – C; Gerbil – D
c. Cormorant – A; Lion-Tailed macaque – D; Gerbil – B
d. Cormorant – B; Lion-Tailed macaque – C; Gerbil – D

Ans: c

113. Following is the diagram of three idealized survivorship curves of animals.



Find the correct match between the group of animals and the respective survivorship curves.

a. Marine pelagic fish and large mammals –III and I, respectively.
b. Marine pelagic fish and large mammals –I and II, respectively.
c. Some birds and large mammals –I and III, respectively.
d. Marine pelagic fish and some birds –I and III, respectively.

Ans: a

December 2014

104. Which of the following statements best describe archaebacteria?

a. Mostly autotrophic, cell wall contains peptidoglycan, 60S ribosomes, live in extreme environment.
b. Divide by fission, not susceptible to lysozyme, live in extreme environments, mostly autotrophic.
c. Not susceptible to lysozyme, contain Golgi and linear chromosomes.
d. Chitinous cell wall, obligate aerobic, circular chromosomes.

Ans: b

105. Which of the following statements is *not* correct?

a. Stomata are present in mosses and hornworts but absent in liverworts.
b. Only the lycophytes have microphylls and almost all other vascular plants have megaphylls.
c. Monocot pollen grains have three openings whereas eudicot pollen grains have one opening.
d. Monocots have fibrous root system whereas eudicots have taproot.

Ans: c

106. In Group I are given 4 orders of class Insecta. Match each one with a common name (Group II) and its diagnostic characters (Group III)

Group – I

A. Dermaptera

B. Ephemeroptera

C. Odonata

D. Plecoptera

Group – II

E. Ant

F. Mayfly

G. Grasshopper

H. Damselfly

I. Stonefly

J. Earwig

Group – III

i. Elongate, membranous wings with net-like venation, abdomen long and slender, compound eyes occupy most of head, hemimetabolous metamorphosis.

ii. Elongate chewing mouthparts, thread-like antennae, abdomen with unsegmented forceps-like cerci, hemimetabolous metamorphosis.

iii. Forewing long, narrow and leathery, hindwing broad and membranous, chewing mouthparts, hemimetabolous metamorphosis.

iv. Elongate abdomen with two or three tail filaments, two pairs of membranous wings with many veins, forewings triangular, short, bristle-like antennae, hemimetabolous metamorphosis.

v. Adults with reduced mouthparts, elongate antennae, long cerci, nymphs aquatic with gills, hemimetabolous metamorphosis.

vi. Wings membranous with few veins, well developed ovipositors, sometimes modified into a sting, mouth parts modified for biting and lapping, holometabolous metamorphosis.

a. A-J-ii
b. B-I-vi
c. C-H-v
d. D-F-i

Ans: a

107. Which of the following is a *correct* match of the animal with its attribute?

Animal	Attribute
P. Rotifer	1. Nauplius larval stage
Q. Sea anemone	2. Radial symmetry
R. Barnacle	3. Pseudocoelomate body cavity
S. Sea urchin	4. Water vascular system

a. P–3, Q–2, R–1, S–4
b. P–2, Q–3, R–1, S–4
c. P–3, Q–4, R–1, S–2
d. P–4, Q–3, R–2, S–1

Ans: a

108. Which of the following is a *correct* statement?

a. Euglenids have a spiral or crystalline rod inside flagella.

b. Pheophytes have a spiral or crystalline rod inside flagella.

c. Euglenids have a hairy and smooth flagella.

d. Euglenids and pheophytes both have a spiral or crystalline rod inside flagella.

Ans: a

109. Which of the following characteristics make *Amborella* the most basal living angiosperm?

a. Carpels fused by tissue connection and absence of vessel elements.

b. Absence of carpels and presence of vessel elements.

c. Carpels free and presence of vessel elements.

d. Presence of carpels and absence of vessel elements.

Ans: d

110. Following is a table showing selected characteristics of important fungal groups.

Fungal group	Characteristic
A	No regularly occurring septa in thallus
B	Perforated septa
C	Forms arbuscular mycorrhizae on plant roots
D	Have zoospores with flagella

In the above table, the fungal groups A, B, C and D, are, respectively,

a. Chytridiomycetes, Ascomycetes, Glomeromycetes, Zygomycetes.

b. Zygomycetes, Ascomycetes, Glomeromycetes, Chytridiomycetes.

c. Ascomycetes, Zygomycetes, Glomeromycetes, Chytridiomycetes.

d. Chytridiomycetes, Zygomycetes, Ascomycetes, Glomeromycetes.

Ans: b

111. Complete the following hypothetical life table of a species to calculate the net reproductive rate R_0:

Age class (x)	Number alive (n_x)	Number of dying (d_x)	Age specific survivorship	Age specific fertility	$l_x m_x$
0 - 1	1000			0	
1 - 2	800			0	
2 - 3		200		0.5	
3 - 4	300	100		1.0	
4 - 5		200		1.0	

The calculated R_0 will be

a. 0.75

b. 1.00

c. 0.65

d. 1.15

Ans: a

112. Following four types of species were observed in a community:

P. Species A has a large effect on community because of its abundance.

Q. Species B has a large role in community out of proportion to its abundance.

R. Status of species C provides information on the overall health of an ecosystem.

S. Significant conservation resources are allocated to species D which is single, large and instantly recognizable.

According to above description, species A, B, C and D are called respectively,

a. Dominant, Keystone, Indicator and Flagship

b. Keystone, Flagship, Dominant and Indicator

c. Keystone, Dominant, Indicator and Flagship

d. Flagship, Dominant, Keystone and Indicator

Ans: a

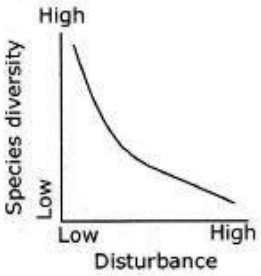
113. Which of the following is the *correct* decreasing order for the rate of decomposition of litter constituents?

a. Hemicellulose, cellulose, lignin, phenol
b. Cellulose, hemicellulose, phenol, lignin
c. Hemicellulose, cellulose, phenol, lignin
d. Lignin, phenol, hemicellulose, cellulose

Ans: a

114. The possible relationships between level of disturbance and species diversity in a biological community are that species diversity

P. is unaffected by disturbance.
Q. is highest at intermediate levels of disturbance.
R. decreases exponentially with increasing levels of disturbance.
S. starts decreasing only at higher levels of disturbance.

1.


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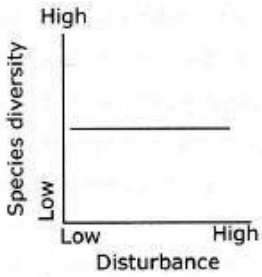

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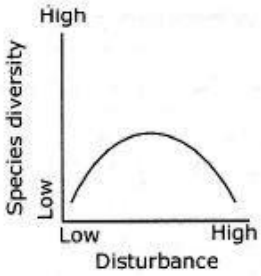

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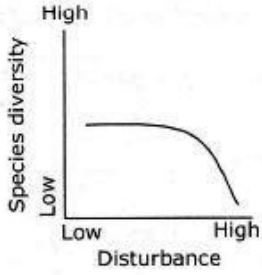
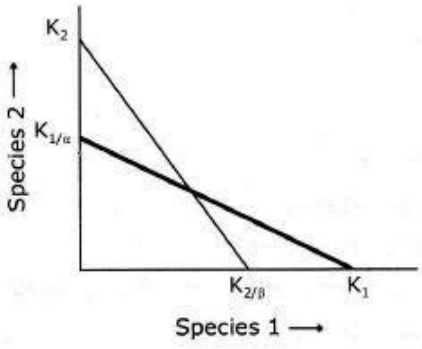


Match each graph with its corresponding statements above:

a. 1–S, 2–R, 3–Q, 4–S
b. 1–R, 2–S, 3–Q, 4–P
c. 1–P, 2–Q, 3–R, 4–S
d. 1–R, 2–P, 3–Q, 4–S

Ans: d

115. The diagram represents competition between species 1 and species 2 according to Lotka-Volterra model of competition.



Given the conditions in the diagram, the predicted outcome of competition is

a. Unstable coexistence between species 1 and 2 because $K_1 > K_2/\beta$ and $K_2 > K_1/\alpha$.
b. Unstable coexistence between species 1 and 2 because $K_1 < K_2/\beta$ and $K_2 < K_1/\alpha$.
c. Stable coexistence between species 1 and 2 because $K_1 > K_2/\beta$ and $K_2 > K_1/\alpha$.
d. Stable coexistence between species 1 and 2 because $K_1 < K_2/\beta$ and $K_2 < K_1/\alpha$.

Ans: a

June 2015

111. The following table shows selected characters used in analyzing the phylogenetic relationships of four plant taxa:

Taxon	Characters			
	Xylem or Phloem	Wood	Seed	Flowers
T_1	+	–	–	–
T_2	+	+	+	+
T_3	+	+	+	–
T_4	–	–	–	–

Taxa T_1, T_2, T_3 and T_4 are respectively:

a. Ferns, Oaks, Pines, Hornworts

b. Oaks, Pines, Hornworts, Ferns

c. Hornworts, Pines, Oaks, Ferns

d. Ferns, Pines, Oaks, Hornworts

Ans: a

112. Given below are the main characteristics of a few mammalian orders. Match the names of the animals with the characteristics of their orders:

P. Hooves with even number of toes on each foot, omnivorous	1. Tapir
Q. Teeth consisting of many thin tubes cemented together, eats ants and termites	2. Lemur
R. Opposable thumbs, forward facing eyes, well developed cerebral cortex, omnivorous	3. Aardvark
S. Hooves with an odd number of toes on each foot; herbivorous	4. Pig

Choose the *correct* combination.

a. P–3, Q–4, R–1, S–2
b. P–1, Q–4, R–2, S–3
c. P–4, Q–3, R–2, S–1
d. P–4, Q–3, R–1, S–2

Ans: c

113. Which of the following options match the plant tissue type with its *correct* function in vascular plants?

Tissue	Function
P. Tracheids	1. Chief water-conducting element in gymnosperms
Q. Vessel elements	2. Chief water-conducting element in angiosperms
R. Sieve tube element	3. Food-conducting element in gymnosperms
S. Sieve cell	4. Food-conducting element in angiosperms

a. P–1, Q–2, R–4, S–3
b. P–2, Q–1, R–3, S–4
c. P–1, Q–2, R–3, S–4
d. P–1, Q–3, R–4, S–2

Ans: a

114. Match the five (P – T) group of organisms with their *correct* taxonomic rank (1 – 5) given below:

Group	Taxonomic rank
P. Crustacea	1. Order
Q. Hominidae	2. Domain
R. Dermaptera	3. Class
S. Ctenophora	4. Phylum
T. Archaea	5. Family

a. P–3, Q–1, R–5, S–4, T–2
b. P–1, Q–2, R–3, S–4, T–5
c. P–4, Q–3, R–2, S–1, T–5
d. P–3, Q–5, R–1, S–4, T–2

Ans: d

115. For the aquaculture farming of Indian Major carps several techniques are used. Which one of the following techniques is *not* used for this purpose?

a. Induced breeding
b. Selective breeding
c. Inbreeding
d. Composite fish farming

Ans: c

116. Which one of the following is the most appropriate match for the protected areas of India?

Category	Protected area
P. Biosphere reserve	1. Chambal
Q. National park	2. Loktak
R. Ramsar site	3. Nanda Devi
S. Wildlife sanctuary	4. Rajaji
	5. Sundarbans

a. P–3, Q–4, R–2, S–1
b. P–2, Q–4, R–3, S–1
c. P–1, Q–5, R–3, S–1
d. P–3, Q–2, R–5, S–4

Ans: a

117. Given below is a matrix of possible interactions (beneficial (+), harmful (−), neutral (0)) between species 1 and 2. The names of interactions, A, B, C and D, respectively, are

Species 2 \ Species 1	+	−	0
+	C	B	
−		A	D

a. Predation, competition, mutualism, commensalism
b. Mutualism, competition, amensalism, commensalism
c. Competition, predation, mutualism, amensalism
d. Competition, mutualism, commensalism, predation

Ans: c

118. Two lakes (I and II) with a similar trophic structure of phytoplankton-zooplankton-planktivorous fish food chain were chosen. To understand the 'top-down' effects, some piscivorous fish (those that feed on planktivorous fish) were introduced into lake I, making it a system with four trophic levels. Lake II was enriched by adding large quantities of nitrates and phosphates to study the 'bottom-up' effects over a period of time. Changes in the biomasses of each trophic level were measured. The expected major changes in the two lakes are

a. In Lake I zooplankton biomass increases, phytoplankton biomass decreases.
In Lake II both phytoplankton and planktivorous fish biomasses increase.
b. In Lake I zooplankton biomass decreases, phytoplankton biomass increases.
In Lake II both phytoplankton and planktivorous fish biomasses increase.
c. In Lake I planktivorous fish biomass and phytoplankton biomass decrease.
In Lake II phytoplankton biomass increases, planktivorous fish biomass decreases.
d. In Lake I planktivorous fish and zooplankton biomasses increase.
In Lake II both phytoplankton and planktivorous fish biomasses increase.

Ans: a

119. Which of the following is *true* about the Digestion Efficiency (DE) (assimilation/consumption) and Ecological Efficiency (EE) (Production/consumption) of ectotherms and endotherms?

a. Endotherms have a high DE and ectotherms have a high EE.
b. Endotherms have a low DE and ectotherms have a high EE.
c. Endotherms have a high DE and ectotherms have a low EE.
d. Endotherms have a low DE and ectotherms have a high EE.

Ans: a

120. Which of the following is/are *not* valid explanation(s) for the observed pattern of species richness?

1. Older communities are more species-rich.
2. Large areas support more species.
3. Natural enemies promote reduced species richness at local level.
4. Communities in climatically similar habitats may themselves be similar in species richness.
5. Greater productivity permits existence of more species.

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

Ans: b

121. The following table shows the number of individuals of each species found in two communities:

Community	Species			
	A	B	C	D
C1	25	25	25	25
C2	80	05	05	10

(*Hint*: In values for 0.05, 0.10, 0.25 and 0.80 are −3.0, −2.3, −1.4 and −0.2, respectively)

The calculated Shannon diversity index (H) values for communities C1 and C2, respectively are

a. 1.4 and 0.69
b. 1.2 and 0.34
c. 2.1 and 0.43
d. 1.8 and 0.37

Ans: a

122. Compared to K-selection, r-selection favours

a. rapid development, smaller body size and early, semelparous reproduction.
b. rapid development, smaller body size and early, iteroparous reproduction.
c. slow development, larger body size and late, iteroparous reproduction.
d. slow development, smaller body size and late, iteroparous reproduction.

Ans: a

UNIT 11 & 12

Part B

June 2011

116. Recent studies on Archaea suggest that life could have originated
   a. extraterrestrially and seeded through meteorite impacts.
   b. in shallow coastal areas.
   c. in deep hydrothermal vents.
   d. in hot, terrestrial habitats.

Ans: c

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
   a. positive
   b. negative
   c. neutral
   d. random

Ans: a

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?
   a. 112
   b. 81
   c. 105
   d. 145

Ans: c

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 γ, under which condition would kin selection favour this altruistic trait?
   a. $B > C$
   b. $B > \gamma C$
   c. $\gamma B - C = 0$
   d. $\gamma B - C > 0$

Ans: d

120. The photoreceptor commonly involved in light entrainment of the biological clock in flies, moulds and plants is
   a. phytochrome
   b. rhodopsin
   c. carotenoid
   d. cryptochrome

Ans: d

121. Which of the following food crops has recently been genetically engineered to obtain edible vaccine to develop immunity against hepatitis B?
   a. Banana
   b. Maize
   c. Potato
   d. Tomato

Ans: c

122. Release of nutrients, oxidants or electron donors into the environment to stimulate naturally occurring microorganisms to degrade a contaminant, is referred to as

a. biostimulation
b. phytoremediation
c. bioaugmentation
d. bioremediation

Ans: a

123. ELISA assay uses

a. an enzyme which can react with secondary antibody
b. an enzyme which can react with the antigen
c. a substrate which gets converted into a colored product
d. a radiolabelled secondary antibody

Ans: c

124. Routinely used glucose biosensor estimates blood glucose level by sensing the concentration of

a. glucose
b. oxygen
c. δ-gluconolactone
d. H_2O_2

Ans: b

125. Which of the following methods of plant transformation can be used to introduce a gene into chloroplast genome?

a. *Agrobacterium*-mediated transformation
b. Particle delivery system
c. Permeabilization
d. Electroporation

Ans: b

December 2011

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

Ans: a

124. To keep them in a totipotent state, embryonic stem cells need to be maintained stem cells need to be maintained in a medium supplemented with

a. growth hormone
b. leukemia inhibiting factor
c. nestin
d. insulin

Ans: b

125. The peacock's tail is an example of

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

Ans: c

June 2012

116. Sexual selection results in variation in the reproductive success of males, often due to female choice with particular phenotypes. This type of sexual selection occurs because

a. males cannot compete with other males.

b. cost of breeding is higher for females as compared to males.

c. inappropriate mating results in a similar reduction in fitness of females and males.

d. males are a limiting resource for females.

Ans: b

117. Among the following events in the history of life

1. Prokaryotic cell
2. Eukaryotic cell
3. Natural selection
4. Organic molecules
5. Self-replicating molecules

Which is the *correct* chronological order?

a. 4, 5, 3, 1, 2

b. 4, 5, 1, 2, 3

c. 5, 4, 1, 3, 2

d. 4, 5, 1, 3, 2

Ans: a

118. The Hardy-Weinberg principle comes from considering what happens when Mendelian genes act in a population. The model predicts that there will be no change in allele frequencies when

a. migration into the population occurs at a steady rate.

b. the population suffers a bottleneck.

c. a rare new mutation is associated with a sharp increase in fitness.

d. no evolutionary process is at work.

Ans: d

119. Which of the following is responsible for initiation of maternal behaviour in the first-time pregnant rats after parturition?

a. Higher prolactin levels in blood.

b. Stimulation of secondary receptors during delivery.

c. Changes of uterine volume.

d. Presence of male rats.

Ans: a

120. To replace animal use in testing hepatic toxicity of a drug on trial, which one of the following would be used *in vitro* to be closest to the *in vivo* scenario?

a. Liver cells

b. Hepatic cell lines

c. Liver slices

d. Co-culture of liver parenchymal cells and kupffer cells

Ans: c

121. Which of the following *does not* represent a strategy of phytoremediation?

a. Phytodegradation

b. Phytomining

c. Continuous removal through hyper accumulators

d. Chelate-mediated extraction of pollutants

Ans: b

122. The word fermentation is used in biochemistry and microbial technology to denote different phenomena. If the former is called C and latter is called T, which of the following statements is *true*?

a. All C is T but all T is not C.

b. All T is C but all C is not T.

c. T is always a product of genetic engineering while C is not.

d. C is always anaerobic process, while T can be aerobic or anaerobic.

Ans: d

123. Which of the following statements is *not* true during the infection of plant cells with *Agrobacterium*?

a. The protein products of virulence genes virA and virG perceive acetosyringone.

b. The VirB protein forms a connection between Agrobacterium and the plant cell and facilitates T-DNA transfer into the plant.

c. The T-DNA is excised and bound to VirD2 protein.

d. The T-DNA, after becoming coated with VirF binds to phosphorylated VIPI, which, allows the complex to enter the plant's nucleus.

Ans: d

124. Which is the best method for checking mycoplasma contamination in a mammalian cell line?

a. Southern hybridization

b. ELISA

c. PCR

d. Western hybridization

Ans: c

December 2012

118. Character similarity that can be misinterpreted as common descent is called

a. symplesiomorphy
b. synapomorphy
c. homology
d. homoplasy

Ans: d

119. Which of the following evolutionary processes played an important role in the evolution of complex immune system?

a. Reproductive isolation
b. Adaptive radiation
c. Neutral evolution
d. Co-evolution

Ans: d

120. In some species of new world monkeys, only one female reproduces in a group. One or more younger females have suppressed reproduction and assist the reproductive female. This is an example of

a. sexual selection
b. group selection
c. kin selection
d. reciprocal altruism

Ans: c

121. In bird species where both parents contribute equally to parental care, generally

a. males are larger than females.
b. females are more colorful than males.
c. females are larger than males.
d. both sexes are morphologically similar.

Ans: d

122. The idea that an altruistic gene will be favored if r>C/B, where r is the coefficient of relatedness, B is the benefit to the recipient of the altruism, and C is the cost incurred to the donor, is known as

a. red queen hypothesis
b. handicap principle
c. Hamilton's rule
d. competitive exclusion principle

Ans: c

123. Use of doubled haploid in plant breeding helps to

a. reduce generation time while interogressing recessive traits.
b. reduce generation time while interogressing dominant traits.
c. develop somatic hybrids.
d. interogress transgenic traits.

Ans: a

124. For sustained expression of a transgene in the successive generation of a cell line in culture, the ideal gene transfer can be obtained using

a. lentiviral vector
b. adenoviral vector
c. plasmid DNA containing the transgene
d. only transgenic DNA

Ans: a

125. *Desulphovibrio desulfuricans* (A) and *Pseudomonas species* (B) are involved in mercury bioremediation. Which of the statements below is *correct*?

a. A converts methyl mercury to mercuric ion, B converts mercury to methyl mercury.

b. A converts mercury to methyl mercury, B converts mercury to mercuric ion.

c. A converts mercury to methyl mercury, B converts methyl mercury to mercuric ion.

d. A converts methyl mercury to mercuric ion, B converts mercury to mercuric ion.

Ans: c

June 2013

117. In pre-industrial period in England, peppered moths had light coloration which effectively camouflaged them against light coloured trees and lichens. During industrial revolution, many lichens died out and trees became blackened by soot from factories and interestingly, dark coloured moths were predominantly seen. This happened due to

a. natural selection of dark coloured moths which were initially present in fewer numbers.

b. new mutation which arose due to environmental pollution.

c. macroevolution occurring due to environmental change.

d. natural selection of the camouflaging mechanism of the moths.

Ans: a

118. The speciation in which a population splits into two geographically isolated populations experience dissimilar selective pressure and genetic drift is known as

a. sympatric speciation

b. parapatric speciation

c. peripatric speciation

d. allopatric speciation

Ans: d

119. Evolution of multi-gene family occurs by

a. only gene duplication.

b. only unequal crossing-over.

c. random mutations.

d. both duplication and unequal crossing over.

Ans: d

120. One aims to find out the role of a gene product in macrophages by using a transgenic mouse expressing the genes under a promoter. Which of the following is the most appropriate promoter?

a. Actin promoter

b. MHC Class II promoter

c. Mac-1/CD 11b promoter

d. IL-2 promoter

Ans: c

121. Which of the following genes was engineered in the "Flavr Savr" transgenic tomato variety?

a. 1-amino cyclopropane-1-carboxylic acid synthase.

b. 1-amino cyclopropane-1-carboxylic acid oxidase.

c. Expansin.

d. Polygalacturonase.

Ans: d

122. For developing transgenic mice, embryonic stem cells are engineered to express the transgene. These cells are selected by

a. novobiocin

b. neomycin

c. tetracycline

d. penicillin

Ans: b

123. Microbial leaching involves the process of dissolution of metals from ore breaking rocks using microorganisms. Which one of the following bacteria helps in leaching copper from its ore?

a. *Acidithiobacillus ferrooxidans*

b. *Pseudomonas putida*

c. *Deinococcus radiodurans*

d. *Rhodopseudomonas capsulate*

Ans: a

124. In the case of monoclonal antibody production by hybridoma technology, myeloma cells used lack the enzyme hypoxanthine-guanine phosphoriboxyl transferase (HGPRT) such that fused cells can only survive when selected on hypoxanthine-aminopterin-thymidine (HAT). What is the role of aminopterin in this medium?

a. To be used as cell cycle inhibitor of myeloma cells.

b. To block the pathway for nucleotide synthesis.

c. To facilitate fusion of myeloid B-cells and antibody producing B-cells.

d. To facilitate production of antibody producing B-cells.

Ans: b

December 2013

117. After gull nestlings hatch, the parents remove the egg-shells from the nest. This behaviour is to

a. clean the area

b. reduce infection

c. make more space in the nest

d. minimise nest detection by predators

Ans: d

118. Greater male investment in the care of offspring is most likely to lead to

a. a lek system

b. stronger female choice

c. reverse sexual dimorphism

d. run-away selection

Ans: c

119. A neuron that fires when an individual is eating by hand, also fires when he sees someone else eating with hand. Such neurons are called

a. mirror neurons

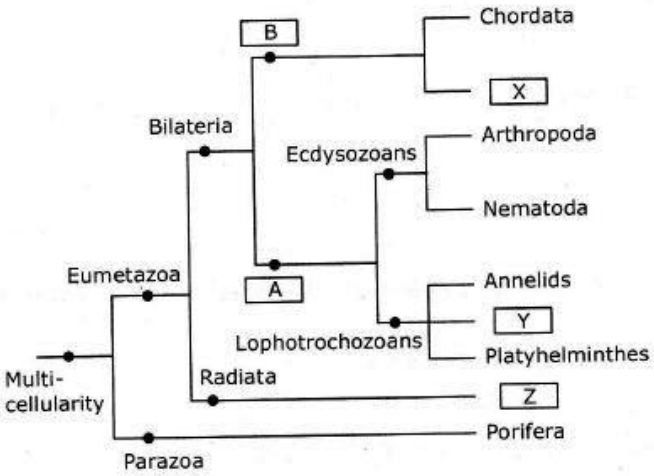
b. mimicry neurons

c. motor neurons

d. reward neurons

Ans: a

120. Given below is an evolutionary tree.



Based on the above, which one of the following combinations is *correct*?

a. A-Protostome; B-Deuterostome; X-Mollusca; Y-Cnidaria; Z-Protozoa

b. A-Protostome; B-Deuterostome; X-Echinodermata; Y-Mollusca; Z-Cnidaria

c. A-Deuterostome; B-Protostome; X-Crustacea; Y-Mollusca; Z-Cnidaria

d. A-Deuterostome; B-Protostome; X-Echinodermata; Y-Roundworm; Z-Ctenophora

Ans: b

121. Name the common Indian bird that is generally seen in groups (aggregation)

a. Bulbul

b. Warbler

c. Babbler

d. Sun bird

Ans: c

122. *Which of the following transgenic crop(s) have been approved for commercial cultivation in India?*

a. Cotton
b. Brinjal
c. Cotton and brinjal
d. Cotton, *Brassica*, brinjal

Ans: a

123. Which of the following microbial fermentations are anaerobic?

a. Ethanol and acetone-butanol
b. Citric acid and propionic acid
c. Penicillin and vitamin B_{12}
d. Streptomycin and rifampicin

Ans: a

124. Encasing of which of the following plant cells in a gelatinous matrix is referred as artificial seed?

a. Microcalli
b. Somatic embryos
c. Root tips
d. Shoot tips

Ans: b

125. Which of the following diseases does *not* leave any paleontological evidence?

a. Tuberculosis
b. Arthritis
c. Rickets
d. Cholera

Ans: d

June 2014

114. In rats, after the delivery of the offspring mother shows the following behaviors. Which one of the following behaviors is *not* maternal?

a. Licking the pups
b. Huddling above the pups to access the ventrum
c. Lordosis of mother rat
d. Bringing back to the nest pups that wander away from it

Ans: c

115. The population size of a bird increased from 600 to 645 in one year. If the per capita birth rate of this population is 0.125, what is its per capita death rate?

a. 0.25
b. 0.15
c. 0.05
d. 0.02

Ans: c

116. The long feather tail of a peacock is quoted as an example supporting

a. Hamilton's rule
b. Zahavi's handicap principle
c. The Red Queen hypothesis
d. Haldane's rule

Ans; b

117. In very small populations, genetic variation is often lost through genetic drift. If the population size of a mammal on an isolated island is 50, what percentage of its genetic variation is lost every generation?

a. 0.01
b. 0.5
c. 0.1
d. 0.05

Ans: a

118. Among the following antigens specific to a pathogen, which one is most likely to be ineligible as a vaccine with long lasting host protective effect?

a. A cell surface protein.

b. An enzyme involved in pathogen metabolism.

c. A signaling intermediate, which is a kinase.

d. A long chain fatty acid.

Ans: d

119. Which one of the following techniques is generally used to produce transgenic animals?

a. Processed mRNA containing only exons are introduced into blastocyst stage embryo.

b. Entire foreign nucleus is introduced in enucleated unfertilized egg.

c. Desired DNA is microinjected into fertilized eggs followed by implantation of embryo in a foster mother.

d. cDNA of desired gene is introduced into animal embryos and implanted in a foster mother.

Ans: c

120. Which one of the following statements is *not* correct for propagation and maintenance of mammalian cells *in vitro*?

a. Transformed cell lines do need external supply of serum to grow.

b. The cells that are obtained directly from the organism is a primary culture.

c. Trypsin is added to cell culture media to maintain cell's health.

d. HEPES buffer is generally used to maintain pH of the culture media.

Ans: c

December 2015

116. Which species concept utilizes morphological and molecular characters to distinguish between species?

a. Evolutionary
b. Ecological
c. Biological
d. Phylogenetic

Ans: d

117. Worker bees, instead of themselves reproducing, help the queen reproduce. This behaviour is explained as an example of

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

Ans: a

118. The wings of insects and the wings of bats represent a case of

a. divergent evolution
b. convergent evolution
c. parallel evolution
d. neutral evolution

Ans: b

119. The degree of genetic relatedness between the offspring and their parents is

a. higher than that between sister and brother.
b. lower than that between sister and brother.
c. the same as that between sister and brother.
d. dependent on the number of siblings.

Ans: c

120. During which geological period was there an explosive increase in the number of many marine invertebrate phyla?

a. Ordovician
b. Devonian
c. Permian
d. Cambrian

Ans: d

121. You want to purify a recombinant protein of your interest. You can use affinity chromatography to purify as you have nickel columns available in the laboratory. With what molecule will you tag the protein to purify using those columns?

a. GST
b. Histidine
c. Histamine
d. Proline

Ans: b

122. In an experiment to detect a new protein in fixed cells, no secondary antibody tagged with fluorescence dye is available. What should be the best choice out of the following to detect the protein?

a. Protein A-FITC
b. Protein A-Sepharose
c. Biotin-FITC
d. Avidin-FITC

Ans: a

123. Two 18-residue helical peptides A and B are enantiomers. They can be distinguished by

a. recording their MALDI mass spectrum
b. hydrolysis followed by amino acid analysis
c. sequencing by Edman's method
d. examining their circular dichroism spectra

Ans: d

124. Lower limits of detection by sensors is important. Which method of detection is more sensitive than glass electrode used for pH measurement?

a. Absorption spectroscopy

b. Refractive index

c. Circular dichroism

d. Fluorescence spectroscopy

Ans: d

125. If a researcher intends to identify a specific brain area activity linked to a cognitive function in human subjects, which one of the following techniques should be used?

a. CAT

b. MRI

c. fMRI

d. Patch-clamp

Ans; c

126. Which of the following statements is *incorrect* for fluorescence *in situ* hybridization (FISH) technique?

a. A fluorescence or confocal microscope is used for detection of signal.

b. A labeled sequence of nucleotides is used.

c. Specific fluorescence tagged antibodies are used.

d. A stringent washing step is essential to remove appearance of non specific signal.

Ans: c

June 2015

123. The most commonly used molecular tool for phylogenetic analysis involves sequencing of

a. mitochondrial DNA

b. mitochondrial RNA

c. ribosomal RNA

d. nuclear DNA

Ans: a,c

124. According to which evolutionary theory, there are long periods without significant evolutionary changes interrupted by short episodes of rapid evolution?

a. Punctuated equilibrium

b. Saltation

c. Mutation

d. Neutrality

Ans: a

Part C

June 2011

126. Using molecular clock, it was estimated that two species A and B must have diverged from their common ancestor about 9×10^6 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?

a. 0.0270

b. 0.0135

c. 0.00017

d. 0.0035

Ans: a

127. What will be the approximate effective population size in a panmictic population of 240 with 200 females and 40 polygamous males?

a. 160

b. 133

c. 63

d. 67

Ans: b

128. An animal was first maintained in a constant environmental condition for several days until a consistent biological rhythm (B) was established. The animal was then exposed to an experimental physical rhythm (E) which modulates the phase and period of B. However, upon withdrawal of E, the B gradually regained its pattern of pre-exposure condition. From these observations which one or more of the following should be the most logical inference?

P. E is a Zeitgeber

Q. E is a masking agent

R. E causes entrainment of B

S. B is a conditioned to E

The *correct* answer is

a. P and R

b. Q and S

c. Q only

d. S only

Ans: a

129. The following geological eras mark the advent of important events in the history of earth–origin of terrestrial plants, origin of mammals, and breakup of the land mass Pangaea;

P. early Cambrian

Q. late Devonian

R. late Cretaceous

S. late Jurassic

Identify the *correct* match of the events with the geological era.

a. Origin of terrestrial plants-(R); origin of mammals-(S); break-up of Pangaea-(P).

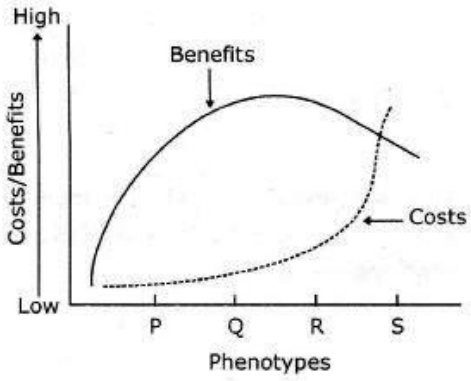
b. Origin of terrestrial plants-(Q); origin of mammals-(S); break-up of Pangaea-(R).

c. Origin of terrestrial plants-(S); origin of mammals-(R); break-up of Pangaea-(Q).

d. Origin of terrestrial plants-(Q); origin of mammals-(R); break-up of Pangaea-(S).

Ans: b

130. Shown in the graph below are the fitness costs and benefits of four alternative behavioural phenotypes (P, Q, R, S). Given sufficient evolutionary time, which phenotype(s) is likely to evolve as an adaptation?



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

Ans: b

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

I–List of products	*II–Microorganism*
P. 2,3-Butane diol	1. *Leuconostoc*
Q. Dextran	2. *Brevibacterium*
R. Glutamic acid	3. *Bacillus polymyxa*
S. Cobalamin	4. *Propionibacterium*

The *correct* combination is

a. P-3, Q-1, ; R-2, S-4
b. P-1, Q-2, ; R-3, S-4
c. P-3, Q-2, ; R-4, S-1
d. P-2, Q-3, ; R-4, S-1

Ans: a

132. A transposon carrying a promoterless β-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:

A. The virulence of the bacteria was completely lost and the *lac* Z was induced by acetosyringone.
B. The virulence of the bacteria was reduced and the *lac* Z was induced by acetosyringone.
C. 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?

a. In group A, the insertion could be in *vir* B, C, D or G; in group B the insertion could be in *vir*C or E; and in group C the insertion could be in *vir A* or *G*.
b. In group A, the insertion could be in *vir A, B, C* or *D*; in group B the insertion could be in either *vir*C or D; and in group C the insertion could be in *vir*G.
c. In group A, the insertion could be in *vir*A; in group B, the insertion could be in *vir*B: and in group C, the insertion could be in *vir*C.
d. In group A, the insertion could be in *vir*G; in group B, the insertion could be in *vir*B, D and E; in group C, the insertion could be in *virA*.

Ans: a

133. 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

Ans: b

134. ^{32}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 ^{32}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

Ans: a

December 2011

126. 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.

Ans: d

127. 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.

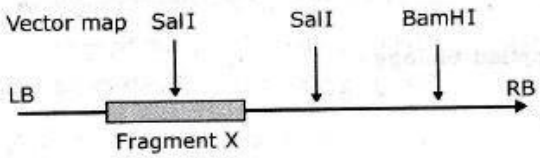
b. It will sing the song of its own species X.

c. It will not sing at all.

d. It will sing a song not sung by either X or Y.

Ans: a

128. 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:

P1		P2		P3	
BamHI	SalI	BamHI	SalI	BamHI	SalI
	—	—		—	—
—	—		—		
—	—		—		—

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 contains two and P3 contains one copy of the transgene.

Ans: c

129. 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

Ans: d

130. 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

Ans: b

131. 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

Ans: c

132. Which of the following behavioural changes are expected in a rat when its nucleus accumbens is experimentally ablated?

a. Aggressive behaviour increases

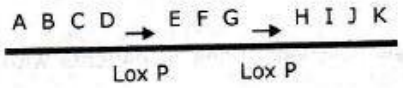
b. Exploratory behaviour decreases

c. Nest-building activity increases

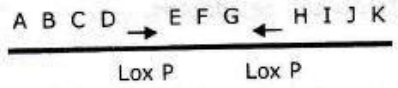
d. Level of parental care drops

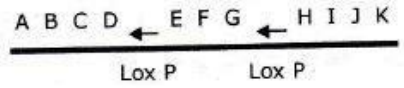
Ans: b

133. 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. 

b.

c. 

d. 

Ans: c

134. 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

Ans: c

135. Enzymes are nowadays used extensively in bioprocessing 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

Ans: c

136. 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

Ans: a

137. 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

Ans: d

June 2012

125. Northern elephant seals had been reduced to about 20 individuals in the 1800s. Biologists studied variation in proteins in the species. They found no genetic differences in the protein among different individuals. This lack of variation is due to:

a. the fact that elephant seals live in a constant environment where there is no need for genetic variation.
b. population bottleneck and genetic drift.
c. natural selection resulting in a single best genotype.
d. a very low rate of mutation.

Ans: b

126. There are 'n' number of alleles for a given locus in a diploid population. The proportion of all homozygotes in the population (i) if all alleles are equally abundant and (ii) if all alleles are not equally abundant, will be:

a. (i) $1/n$ (ii) $< 1/n$
b. (i) $1/n$ (ii) $> 1/n$
c. (i) $1/n^2$ (ii) $< 1/n^2$
d. (i) $1/n^2$ (ii) $> 1/n^2$

Ans: b

127. Which of the following is a prediction of the neutral theory of molecular evolution that is supported by data?

a. Humans and chimps differ more in DNA sequences of pseudogenes than in coding regions of functional genes.
b. Humans and chimps differ more in DNA sequences of coding regions of functional genes than of pseudogenes.
c. Humans have a faster evolution of most of their DNA sequences than chimps.
d. The more advanced species have more number of functional genes.

Ans: a

128. In a Radio-immunoassay (RIA) for glucocorticoid hormone, radioactive glucocorticoid (tritiated) is added to the RIA cocktail. When the amount of bound hormone was measured no counts were observed. The following explanation(s) were proposed:

P. the radioactive hormone was insufficient.

Q. the radioactive tag to the hormone completely dissociated during storage.

R. antibody was not added to the cocktail.

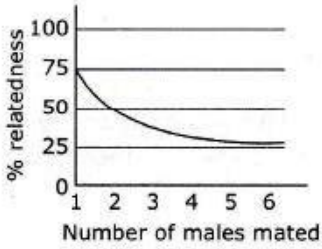
S. the specific activity of the tritium was low.

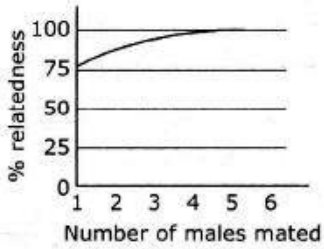
Choose the *correct* option(s):

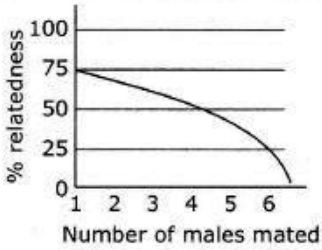
a. P only
b. R only
c. Q and R
d. P and S

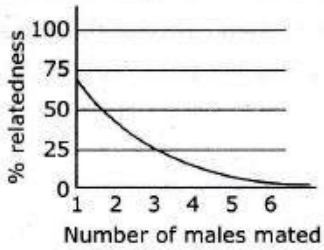
Ans: c

129. In hymenopteran insects, males are haploid and females are diploid. All fertilized eggs give rise to females and unfertilised eggs give rise to males. As a result, if a female mates with a single male, the females in the progeny are related to each other by 75%. But if the mother had mated with many males, the mean genetic relatedness of female progeny is correctly represented by:

a.


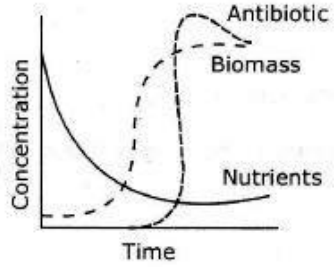
b.


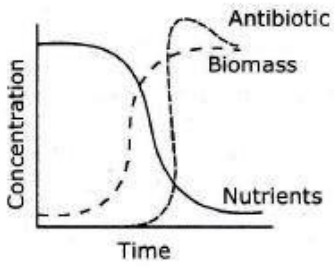
c.


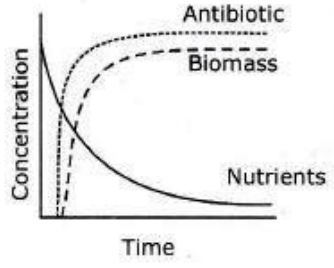
d.


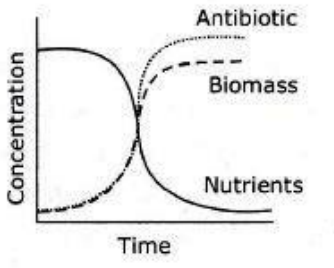
Ans: a

130. Which of the following curves *correctly* represents the process of antibiotic production by *Streptomyces* sp.?

a.


b.


c.


d.


Ans: b

131. Ten different mouse strains were primed with whole Keyhole limpet hemocyanin (KLH). KLH was broken into ten peptides for *in vitro* stimulation. The splenocytes from ten different primed mouse strains were restimulated with each of these ten peptides and the responsiveness to these peptides were measured *in vitro*. It was found that each of these mouse strains had responded to one of the peptides. When the peptide 3 responder was mated with peptide 4 responder, the splenocytes of F1 offspring responded to both the peptides. Which of the following is most appropriate?

a. Mouse strains responding to peptide 3 or peptide 4 have different MHC haplotypes.
b. Mouse strains responding to peptide 3 or peptide 4 have either of these T cell receptor.
c. Mouse strains responding to peptide 3 or peptide 4 cannot process KLH.
d. Mouse strains responding to peptide 3 or peptide 4 did not express MHC class-I molecule.

Ans: a

132. For the generation of transgenic plants in crop improvement, one important regulatory gene X was overexpressed in a crop plant. Out of 30 transgenic rice plants generated, 22 showed high levels of gene X expression. However, rest 8 lines displayed low levels of expression. One explanation of such observation may be:

a. Suppression effect of the transgene
b. Knock-down effect of the gene X
c. Gene silencing effect
d. Co-suppression effect of the transgene

Ans: c

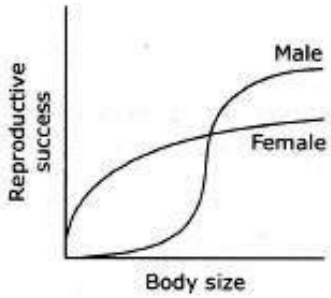
133. Stem cells are widely used for their degenerative property and capacity to differentiate into different lineages. A person with a damaged liver approaches a stem cell therapist. Which of the following therapeutic strategies would be the safest?

a. Procuring adult liver cells from a healthy donor and grafting them into the patient.
b. Transforming skin cells from the patient into iPS cells and using them for further differentiation and grafting in liver.
c. Injecting embryonic stem cells into the damaged liver.
d. Injecting cord blood cells into the liver directly.

Ans: b

December 2012

126. If the relationship between life time reproductive success and body size for males and females of a species as shown in figure below;



The species is most likely to evolve

a. sexual dimorphism

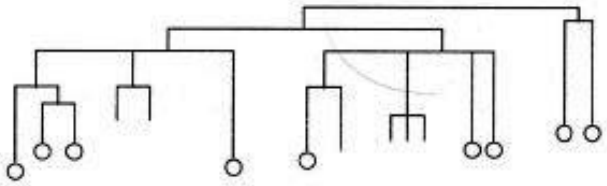
b. asexual reproduction

c. polyandry

d. obligate monogamy

Ans: a

127. Following tree represents phylogenetic relationships among species of a moth family. Circles represent species having eye spots on the wings. Other species do not have eye spots.



The following inferences were made by different researchers:

P. Eye spots were present in the ancestors and some species lost them.

Q. Eye spots were not present in the ancestors.

R. Eye spots were lost more than once in evolution of the family.

S. Eye spots were gained only once while evolving from ancestor without them.

Which of the inferences are *correct*?

a. P and Q

b. R and S

c. P and R

d. Q and S

Ans: c

128. *Wolbachia* are obligate intracellular bacteria, many different strains of which are abundantly present in insects. They induce mating incompatibility in host, i.e. males infected with one strain can only fertilize females infected with the same strain. No other pathological effects are observed in host. A possible evolutionary consequence of this phenomenon would be:

a. Extinction of many insect species.

b. Termination of sexual reproduction in many insect species.

c. Co-extinction of host and parasite.

d. Reproductive isolation leading to rapid speciation in insects.

Ans: d

129. Twenty small populations of a species, each polymorphic for a given locus (T, t) were bred in captivity. In 10 of them the population size was kept constant by random removal of individuals, while other 10 were allowed to increase their population size. After several generations it was observed that in 7 of the size restricted populations only T was present, in the remaining 3 only t was present. In the growing populations 8 retained their polymorphism and in 2 only t was observed. The experiment illustrates

a. genetic drift which is more likely in large populations.

b. genetic drift which is more likely in small populations.

c. density dependent selection against T.

d. density dependent selection against t.

Ans: b

130. Some important events in the history of life on Earth are given below:

1. First vertebrates (jawless fishes); first plants.
2. Forest of ferns and conifers; amphibians arise; insects radiate.
3. Conifers dominant; dinosaurs arise; insects radiate.
4. Flowering plants appear; climax of dinosaurs followed by extinction.
5. Radiation of flowering plants, most modern mammalian orders represented.
6. Ice Ages, Modern humans appear.

Match the above with the geological time periods and choose the *correct* combination,

a. 1 – Silurian; 2 – Permian; 3 – Triassic; 4 – Jurassic; 5 – Cretaceous; 6 – Tertiary.

b. 1 – Ordovician; 2 – Carboniferous; 3 – Triassic; 4 – Cretaceous; 5 – Tertiary; 6 – Quaternary.

c. 1 – Cambrian; 2 – Ordovician; 3 – Silurian; 4 – Devonian; 5 – Permian; 6 – Tertiary.

d. 1 – Devonian; 2 – Permian; 3 – Triassic; 4 – Cretaceous; 5 – Tertiary; 6 – Quaternary.

Ans: b

131. During transgenesis, the location of the genes and their number integrated into the genome of the transgenic animal are random. It is often necessary to determine the copy number of genes and their tissue-specific transcription. The following are the possible methods used for the determination.

P. Polymerase Chain Reaction (PCR)

Q. Southern blot hybridization

R. Reverse Transcriptase PCR

S. Western blot

Choose the correct set of combinations.

a. P and Q

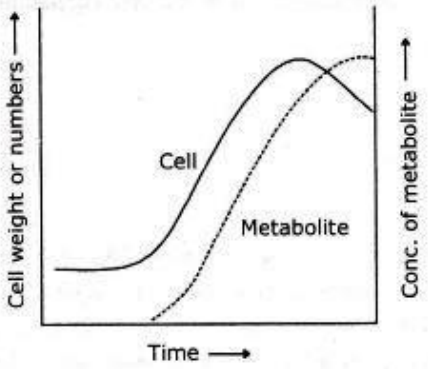
b. Q and R

c. Q and S

d. P and S

Ans: b

132. Microbes produce either primary or secondary metabolites during fermentation. A metabolite production curve is shown below:



The following statements refer to the above figure;

P. A primary metabolite has a production curve that lags behind the line showing cell growth.

Q. A primary metabolite is produced after the trophophase is completed.

R. A secondary metabolite is produced mainly during idiophase.

S. The curve shows the production of penicillin from mold.

Which of the above statements are *correct?*

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

Ans: b

133. *Agrobacterium tumefaciens*, also known as natural genetic engineers, causes crown-gall disease in plants. However, when the same bacteria are used to raise transgenic plants with improved agronomic traits, no such tumor (disease) is observed. This is due to:

P. vir D_2 gene is mutated in Ti plasmid.

Q. Disarmed Ti plasmid is generally used.

R. Heat-shock during transformation destroys virulence.

S. Oncogenes have been removed.

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

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

Ans: d

134. A student wrote following statements regarding comparison of Restriction Fragment Length Polymorphism (RFLP), Random Amplified Polymorphic DNA (RAPD), Amplified Fragment Length Polymorphism (AFLP) and Simple Sequence Repeats (SSRs) techniques used for generating molecular markers in plants:

P. All these techniques can be used for fingerprinting.

Q. Detection of allelic variation can be achieved only by RFLP and SSRs.

R. Use of radioisotopes is required in RFLP and RAPD only.

S. Polymerase chain reaction is required for all the techniques.

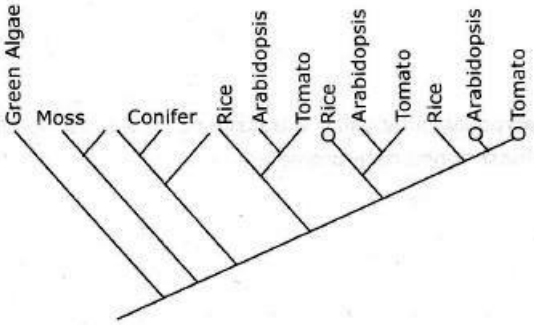
Which one of the following combination of above statements are *correct*?

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

Ans: a

June 2013

125. Knox genes code transcriptional factors important for the regulation of indeterminate growth in plant shoots. These genes also regulate patterns of development of plant organs such as leaves and flowers. The figure represents a phylogenetic tree of the multigene family in some land plants. The circles represent genes that act to maintain shoot apical meristem (equivalent to stem cells). Orthologues are genes that duplicate due to speciation and paralogues are genes that duplicate within a species.



From the figure, the following inferences were made.

P. Multiple gene duplication occurred in vascular plants.

Q. Gene duplications may have enabled shoot diversification in vascular plants.

R. Shoot apical meristems are regulated by orthologous genes in vascular plants.

S. Shoot apical meristems are regulated by paralogous genes in vascular plants.

Which of the following represents a combination of *correct* inferences?

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

Ans: a

126. In an experiment that has continued for more than 50 years, corn has been propagated by breeding only from plants with the highest amount of oil in the seeds. The average oil content is now much greater than any of the plants in the original population.

The following hypotheses were proposed as explanations for this observation.

P. Mutations occurred that increased the oil content in seeds.

Q. Plants with high oil content were stimulated to produce offspring with more oil in their seeds.

R. The breeding led to increased frequency of alleles at multiple loci, so that new combinations of genes for even higher oil content were formed.

Which of the following represents a combination of *correct* statements?

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

Ans: b

127. The Galapagos finches were an important clue to Darwin's thinking about the origin of species. These finches are believed to have descended from a single ancestral species that colonized the Galapagos archipelago, America, over a short period of time. The Galapagos finches differ in their beak shape and size. Different species feed on seeds that vary in size and hardness.

Which of the following is the most likely explanation for these patterns?

a. The finches represent an example of directional trend in beak size from small to big.

b. Beak shapes changed in response to different seed types and these changes were inherited by subsequent generations.

c. The ancestral finch already had all the beak variations and different lineages formed that were specialized to eat different seed types.

d. The finches represent an example of adaptive radiation in which beak variation was generated by mutation followed by selection by different seed types.

Ans: d

128. In order to demonstrate that the long tails of males attracted females in a bird species, experimenters captured and cut the tails of 'n' number of males and monitored the number of females mated by each male. They had two types of controls in the experiment.

P. 'n' males that were not captured

Q. 'n' males that were captured, had their tails cut and then stitched back to attain the original size.

The males with cut tails mated with a significantly smaller number of females than both the controls. Which of the following alternative explanations is not ruled out by the experiment?

a. The stress of cutting tails affected the performance of males.

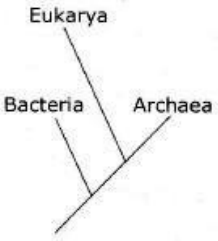
b. The time wasted in the capture reduced mating opportunities of males.

c. Females avoided any deviation from normal.

d. Females chose males randomly.

Ans: c

129.



In the phylogenetic tree above, branch-lengths are drawn proportional to the number of changes along a lineage. The following inferences were made from this tree.

P. Bacteria are more closely related to Eukarya than to Archaea.

Q. Bacteria and Archaea are more similar to each other than either is to Eukarya.

R. Archaea and Eukarya diverged from each other after their common ancestor diverged from bacteria.

Which of the following represents a combination of *correct* inferences?

a. P, Q and R

b. P and Q only

c. Q and R only

d. P and R only

Ans: c

130. Mouse erythroleukemia (MEL) cells are used as an *in vitro* cell culture model for understanding erythropoiesis. These cells are arrested at the stage of pro-erythroblast due to transformation. These cells could be induced by heme to differentiate further so as to synthesize hemoglobin. The most probable molecular mechanism for this could be that heme may suppress and/or downregulate an endogenous heme-regulated inhibitor (HRI) kinase, an inhibitor of globin synthesis. This downregulation in turn promotes differentiation. To validate this hypothesis which of the following approaches is *not* appropriate?

a. Transfect MEL cells with HRI kinase gene.

b. Knock down HRI kinase gene in MEL cells.

c. Determine the rate of protein synthesis *in situ* as a function of differentiation.

d. Measure HRI kinase activity as a function of differentiation.

Ans: c

131. While attempting to create a disease model of poliomyelitis in mice, it was found that mice cannot be infected with the said virus. Since human beings are susceptible to this viral infection, which kind of transgenic mice should be generated to have a transgenic mouse model that can be infected with polio virus? Select the right approach from below:

a. A mouse expressing surface protein of polio virus.

b. A mouse expressing human receptor gene which makes cell surface protein for docking and internalization of polio virus.

c. A mouse expressing human MHC class II invariant chain.

d. A mouse expressing human receptor gene which makes cell surface protein for docking and internalization of polio virus along with a gene designed to express surface protein of this virus at puberty.

Ans: b

132. Protoplast fusion is used in plant tissue culture for various applications. In protoplast fusion:

P. naked plant cells are used.

Q. transfer of organelles is not possible.

R. partial genome transfer is involved.

S. cells from two different plants can be mixed together and forced to fuse.

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

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

Ans: b

133. Which of the following is a mismatch between the plant drug and its source?

a. Codeine - *Papaver somniferum*

b. Vinblastine - *Catharanthus roseus*

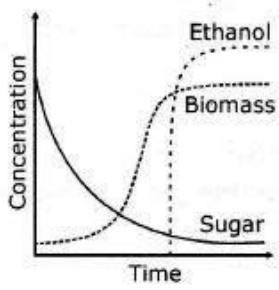
c. Quinine - *Cinchona ledgeriana*

d. Digitaline - *Artemisia annua*

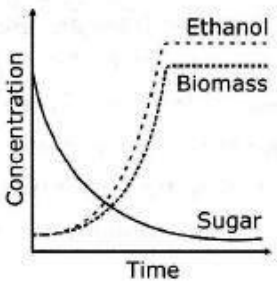
Ans: d

134. Which of the following curves *correctly* represents the process of ethanol production by yeast?

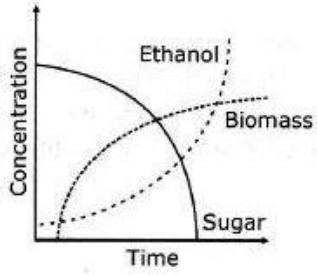
a.



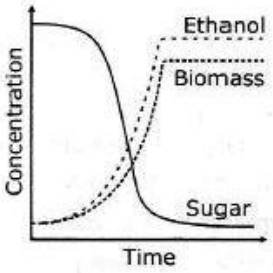
b.



c.



d.



Ans: d

135. Inbreeding for 5 generations led to production of homozygous transgenic mice. However, these homozygous males or females were infertile. Which of the following approach is most preferable and economical to obtain heterozygous transgenic animals continuously?

a. More transgenic founder (1st animal) should be generated.

b. Crossing (breeding) of transgenic mice with wild type mice in earlier generations should be done for continued production of transgenic heterozygous offspring.

c. Inbreeding should be avoided after 5th generation.

d. Homozygous transgenic mice should be mated with wild type mice for continued production of transgenic heterozygous offspring.

Ans: b

136. Following are few statements for regeneration of plants from explants/tissues.

P. Cytokinin is required for shoot development.

Q. Auxin is required for shoot development.

R. Auxin to cytokinin ratio is very important.

S. Jasmonic acid is required for both root and shoot development.

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

a. P and R

b. Q and S

c. P and S

d. Q and R

Ans: a

December 2013

126. Microevolution is the term used for changes in allele frequencies that occur over time. This occurs

P. Within a population at species level.

Q. Within a community at genus level.

R. Due to appearance of new genes from infections.

S. Due to mutation, natural selection, gene flow and genetic drift.

Which of the following combinations is *not* appropriate?

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

Ans: b

127. The following genotypes were observed in a population

Genotype	Number
HH	90
Hh	60
hh	50

Which of the following is the *correct* frequency of H allele and what will be the expected number of HH in the given population?

a. 0.60 and 72
b. 0.80 and 96
c. 0.50 and 32
d. 0.30 and 90

Ans: a

128. The first vertebrate animal appeared in which of the following geological ages?

1. Paleozoic era
2. Mesozoic era
3. Ordovician period
4. Cretaceous period
5. Mississippian epoch
6. Paleocene epoch

Which of the following combinations give the best answer?

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

Ans: d

129. Foster pups were presented to a primiparous rat at the mid gestation period. Which of the following behaviour will be found in the pregnant rat?

a. The rat shows maternal behaviour after a few days of presentation of pups.

b. The rat attacks and kills the pups every time they are presented.

c. The rat rejects the pups after repeated presentation.

d. The rat shows fear response for a few days.

Ans: a

130. Electrons are transferred from reduced co-enzymes like NADH, NADPH to pyruvic acid or its derivatives during fermentation. Those final electron acceptors are reduced to the end-products for example lactic acid, propionic acid, etc. The end products depend on the particular microorganism and the substrate.

Organism	End product(s)
P. *Streptococcus*	1. Butanediol, formic acid
Q. *Clostridium*	2. Lactic acid
R. *Salmonella*	3. Butyric acid, isopropanol
S. *Enterobacter*	4. Succinic acid, acetic acid

a. P–1, Q–2, R–3, S–4

b. P–4, Q–3, R–1, S–3

c. P–2, Q–3, R–4, S–1

d. P–3, Q–4, R–1, S–2

Ans: c

131. While designing an experiment for *Agrobacterium* mediated plant transformation, a student noted down the following points:

P. Ti and Ri plasmids induce crown gall and hairy root disease, respectively.

Q. Enzymes octopine synthase and nopaline synthase involved in the synthesis of octopine and nopaline, respectively are encoded by T-DNA.

R. All the six vir genes, virA, virB, virC, virD, virE and virG are absolutely required for virulence.

S. Almost perfect 25 bp direct repeat sequences flanking all Ti and Ri plasmids in the T-DNA region is essential for T-DNA transfer.

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

a. P, Q and R

b. Q, R and S

c. P, R and S

d. P, Q and S

Ans: d

132. *The following are certain facts regarding bioremediation:*

P. Biodegradable plastics are made using polyhydroxyalkanoates (PHAs) such as polyhydroxybutyrate (PHB).

Q. *Pseudomonas putida* F1 bacterial strain is involved in degradation of aromatic hydrocarbons.

R. The bacterium *Deinococcus radiodurans* consume and digest toluene and ionic mercury from highly radioactive nuclear waste.

S. Bioaugmentation is a process of improving the microorganisms already existing in the system for degradation *of xenobiotic compound.*

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

a. P, Q and R

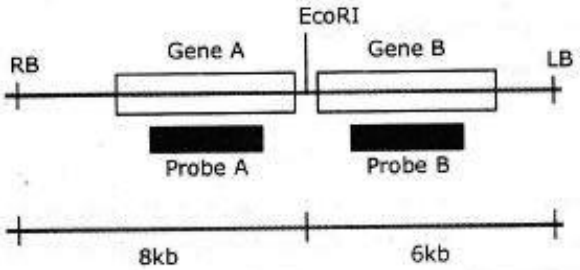
b. P, Q and S

c. P, R and S

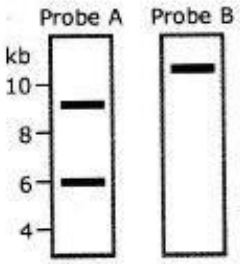
d. Q, R and S

Ans: a

133. A transgenic plant is developed with the following T-DNA construct

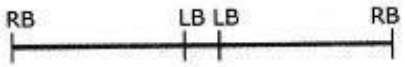


In order to analyze the nature of integration, genomic DNA digested with EcoRI was used for Southern hybridization using either probe A or B. The result obtained is as

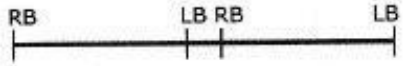


The following conclusions were made:

1. There are two copies of the T-DNA cassette integrated at one loci and a third copy at another loci.
2. There are two copies of the T-DNA cassette integrated at one loci.
3. Complete T-DNA cassette has been integrated in all cases.
4. In one T-DNA cassette there is a truncation towards the RB.
5. In one T-DNA cassette there is a truncation towards the LB.
6. The arrangement of the T-DNA cassettes integrated at the same loci is



7. The arrangement of the T-DNA cassette integrated at the same loci is



Which of the above are *correct*?

a. 2, 5 and 7
b. 2, 4 and 6
c. 1, 4 and 6
d. 2, 3 and 5

Ans: b

June 2014

121. Assume that in terms of 'genetic fitness' the 'benefit' of performing an altruistic act to a relative is 500 units and the 'cost' involved is 150 units. Following Hamilton's rule, the act should be performed if the relative is a

a. only brother
b. nephew or niece
c. brother or step-sister
d. only step-sister

Ans: a

122. The following situations might lead to the evolution of monogyny in birds:

P. Male has to assist the female in rearing the offspring.

Q. Male guards the female against other male trying to mate with her.

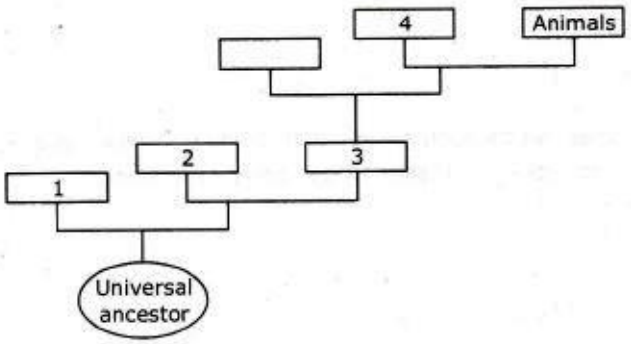
R. One male may not produce enough sperm required to fertilize all the eggs produced by the female.

Which of the above is/are *correct*?

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

Ans: c

123. The diagram below depicts a simplified Tree of Life with three domains and one of the domains including Whittaker's three major kingdoms.



Which of the following is the *correct* naming of the numbered boxes?

a. 1–Bacteria 2–Archaea 3–Eukarya 4–Fungi
b. 1–Archaea 2–Bacteria 3–Eukarya 4–Plants
c. 1–Eukarya 2–Bacteria 3–Archaea 4–Plants
d. 1–Archaea 2–Bacteria 3–Eukarya 4–Fungi

Ans; a

124. A few events in the history of life on earth are given below:

1. Radiation of mammals and birds; Flourishing of insects and angiosperms.
2. Primitive plants and fungi colonize land; Diversification of echinoderms.
3. Seed plants appear; Fishes and trilobites abundant; Earliest amphibians and insects.
4. Earliest birds and Angiosperms appear; Gymnosperms dominant.
5. Invasion of land by primitive land plants and Arthropods.
6. Mass marine extinctions; Reptiles radiate; Amphibians decline.

Which of the following is a *correct* match of the above events with the geological period during which they had occurred?

a. 1: Ordovician; 2: Tertiary; 3: Permian; 4: Silurian; 5: Devonian; 6: Jurassic.
b. 1: Permian; 2: Devonian; 3: Silurian; 4: Ordovician; 5: Tertiary; 6: Jurassic.
c. 1: Tertiary; 2: Ordovician; 3: Devonian; 4: Jurassic; 5: Silurian; 6: Permian.
d. 1: Permian; 2: Devonian; 3: Jurassic; 4: Tertiary; 5: Silurian; 6: Ordovician.

Ans: c

125. Following are certain statements regarding the use of *Agrobacterium* in plant transformation.

P. *A. tumefaciens* causes crown gall disease and *A. rhizogenes* causes hairy root disease.

Q. Region A in *Ti* plasmid is responsible for replication.

R. Region D in *Ti* plasmid is responsible for virulence.

S. Oncogenic (*onc*) region in T-DNA is responsible for unusual amino acid synthesis.

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

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

Ans: c

126. Four different species concepts are given below:

P. Species separate based on their use of different ecological niches and their presence in different habitats and environments.

Q. Differences in physical characteristics or molecular characteristics are used to distinguish species.

R. Species are distinct if they are reproductively isolated.

S. Phylogenetic trees and analyses of ancestry serve to differentiate species.

Which of the following gives the *correct* names of the above concepts?

a. P: Biological; Q: Phylogenetic; R: Evolutionary; S: Ecological
b. P: Ecological; Q: Phylogenetic; R: Biological; S: Evolutionary
c. P: Evolutionary; Q: Ecological; R: Biological; S: Phylogenetic
d. P: Phylogenetic; Q: Evolutionary; R: Ecological; S: Biological

Ans: b

127. Cultured animal cells were transfected with expression vector encoding either β-galactosidase (β-gal) alone or expressing a fusion protein of β-gal glucocorticoid receptor (GR). After transfection, cells were kept in presence or absence of Dexamethasone. Immunofluorescence with a labeled antibody specific for β-gal was used to detect the expressed protein in cytoplasm or nucleus of transfected cells. Possible results of the experiments are:

1. Expression of β-gal alone in the cytoplasm in both absence or presence of Dexamethasone.
2. Expression of β-gal-GR in the cytoplasm in the absence of Dexamethasone.
3. Expression of β-gal alone in the nucleus both in the presence or absence of Dexamethasone.
4. Expression of β-gal-GR in the nucleus in presence of Dexamethasone.
5. Expression of β-gal alone in both cytoplasm and nucleus in presence or absence of Dexamethasone.
6. Expression of β-gal-GR in both cytoplasm and nucleus in presence of Dexamethasone.

Choose the *correct* combination of results from the following options.

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

Ans: b

128. Marker-assisted selection (MAS) defined as selection based on molecular markers should have some important criterion for plant breeding activities. Some statements about these criteria are mentioned below:

P. Marker should co-segregate with the desired trait of interest.

Q. Marker should not co-segregate with the desired trait of interest.

R. Marker should be un-linked with the desired trait of interest.

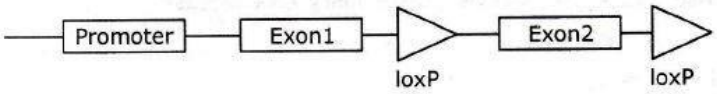
S. Marker is used for indirect selection of a genetic determinant or determinants of a trait of interest.

Which one of the above combinations is *correct*?

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

Ans: d

129. In a transgenic mice line, lox P sites are introduced in the target gene A in the following manner



This transgenic mice line was mated with another transgenic mice line where Cre recombinase is expressed only in B-cells. What will be the expression profile of gene A in Cre/lox recombinant mice?

a. Gene will not be expressed in B-cells, as orientation of exon 1 will be inverted by Cre.

b. Gene will not be expressed in B-cells, as exon 2 will be deleted by Cre.

c. Gene will only be expressed in B-cells of the recombinant mice where Cre removes the two lox P sites.

d. Gene will not be expressed in B-cells as orientation of exon 2 will be inverted.

Ans: b

December 2014

127. In life history evolution there is generally a trade-off between the size and number of offspring produced. Some conditions are listed below:

P. Scarcity of food during the early stages of life

Q. Provision of parental care

R. High mortality during early stages of life

S. Predator's preference for large sized prey

What are the above two conditions that would favour the production of a small number of large-sized offspring?

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

Ans: c

128. In a random sample of 400 individuals from a population with alleles of a trait in Hardy-Weinberg equilibrium, 36 individuals are homozygous for allele a. How many individuals in the sample are expected to carry at least one allele A?

a. 36
b. 168
c. 364
d. 196

Ans: c

129. Which of the following statements is *not* correct regarding effect of genetic drift?

a. It alters allele frequency substantially only in small populations.

b. It can cause allele frequencies to change at random.

c. It can lead to a loss of genetic variation within populations.

d. It can cause harmful alleles to become eliminated.

Ans: d

130 Which of the following is *not* a benefit for the female adopting polyandry?

a. Greater probability of getting all her eggs fertilized.

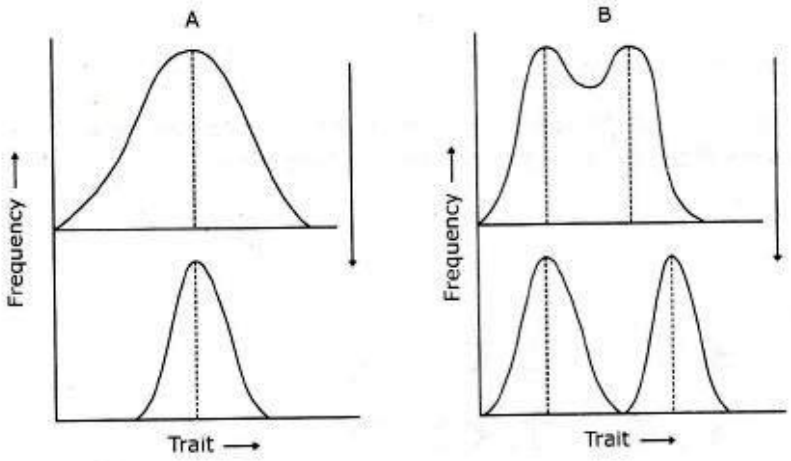
b. Ability to receive more resources from the males.

c. Ability to produce more offspring than normal.

d. Improved chances of genetic compatibility with her own DNA.

Ans: c

131. Two kinds of natural selection (A and B) acting on a trait are shown in the figure below. In each, the top graph shows the trait frequency before and the bottom graph frequency after the action of natural selection.



The kind of natural selection in A and B are

a. A-Directional, B-Disruptive

b. A-Neutral, B-Disruptive

c. A-Stabilizing, B-Disruptive

d. A-Disruptive, B-Stabilizing

Ans: c

132. You have isolated a short chain polypeptide from a bacteria which upon administering to animal cells in culture is demonstrated to get transported to mitochondria and to cause mitochondrial membrane disruption. This peptide is being considered for its therapeutic effects on cancer and is to be tested for its anticancer properties in the following models of the disease.

P. Cancer with Apaf-1 mutation.

Q. Cancer where *Bax* genes are inactivated.

R. Cancer where *Bak* genes are inactivated.

Which of the following is likely to provide best effect (i.e. induce apoptosis)?

a. Only P

b. Q and R

c. P and Q

d. P and R

Ans: b

133. A transgenic lettuce plant was generated by over-expressing isopentenyl transferase (IPT) gene under the control of the promoter of senescence activator gene (SAG12).

Following are some statements regarding this transgenic plant. The transgenic plants

P. exhibit delayed senescence.

Q. exhibit fast senescence.

R. have higher amount of cytokinin during senescence.

S. have higher amount of gibberellins during senescence.

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

a. P and Q

b. P and R

c. Q and S

d. R and S

Ans: b

134. During the production of alcohol by fermentation using budding yeast, oxygen supply is kept limited. Why?

a. Budding yeasts are obligate anaerobes and cannot tolerate oxygen.

b. Budding yeasts lose mitochondria in the absence of oxygen.

c. Budding yeasts are facultative anaerobes.

d. Alcohol is oxidized further in the presence of oxygen.

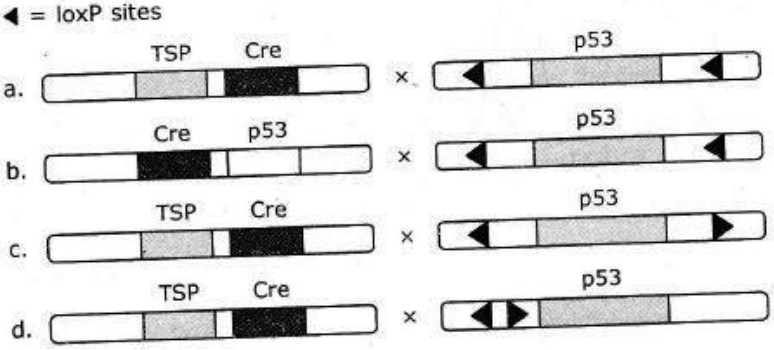
Ans: c

135. A student was asked to design a knockout cassette for specifically deleting the p53 gene from the prostate gland of mice. Which one of the following pairs of cassettes will ensure deletion of the gene?

TSP = Tissue-specific promoter

Cre = Cre recombinase

◀ = loxP sites



Ans: a

136. Individual A performs to another individual a behavioral act which has a fitness consequence. Match the behavioral acts (P to T) with the *correct* fitness consequence (1 to 4).

Behavioral act	Fitness consequence to A
P. Cooperation	1. Gains direct fitness but after delay
Q. Adaptive altruism	2. Loses inclusive fitness
R. Spite	3. Gain indirect fitness
S. Deceit and manipulation	4. Gains direct fitness but immediately
T. Reciprocity	

a. P–4, Q–3, R–2, S–2, T–1

b. P–1, Q–2, R–2, S–3, T–4

c. P–1, Q–3, R–2, S–2, T–4

d. P–2, Q–2, R–3, S–1, T–4

Ans: a

137. Assume that individual A wants to do an altruistic act to individual B and that the benefit and cost of doing this act are, in 'fitness' units, 40 and 12, respectively. According to Hamilton's Rule, A should perform the altruistic act only if B is his

a. nephew

b. niece

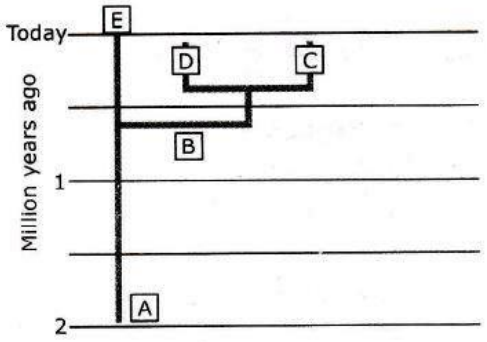
c. grandson or granddaughter

d. daughter or son

Ans: d

June 2015

125. In the evolutionary tree given below, terms A, B, C, D and E, represent respectively



a. *Homo erectus*, *Homo heidelbergensis*, Neanderthal, Denisovan and *Homo sapiens*.

b. *Homo heidelbergensis, Homo erectus*, Denisovan, Neanderthal and *Homo sapiens*.

c. *Homo erectus, Homo heidelbergensis,* Denisovan, Neanderthal and *Homo sapiens*.

d. *Homo heidelbergensis*, *Homo sapiens*, Denisovan, Neanderthal, and *Homo erectus*.

Ans: a

126. Homing pigeons, when released at a place far away from their home, use earth's magnetic field or the sun as navigational cues and choose the right direction to fly. To test the hypotheses, two experiments were conducted. In experiment I, one group of pigeons (Test) were equipped with Helmholtz coils (which disrupt magnetic field detection), while the second group (control) were not. Both groups were released on a sunny day. Experiment II used the same Control and Test groups of pigeons, but they were released on a cloudy, overcast day. The expected results, if the hypotheses is true, would be

a. In experiment I, both Control and Test groups fly in the right direction, but in experiment II, only Control group does.

b. In both experiments, Test groups fail to choose the right direction.

c. In experiments I and II, test groups fly in the right direction.

d. In experiment I both groups fly in the right direction but in experiment II both groups fail to choose the right direction.

Ans: a

127. Brothers A and B have the same father but different mothers. B wants A to help him which involves both benefits (b) and costs (c) for A. If A incurs a cost of 30 'Darwinian fitness units' in that act, under what condition should he help B, following Hamilton's rule?

a. only if b > 30

b. only if b > 60

c. only if b > 120

d. only if b > 240

Ans: c

128. In a population at Hardy-Weinberg equilibrium, the genotype frequencies are: $f(A_1A_1) = 0.59$; $f(A_1A_2) = 0.16$; $f(A_2A_2) = 0.25$. What are the frequencies of the two alleles at this locus?

a. $A_1=0.59$; $A_2=0.41$

b. $A_1=0.75$; $A_2=0.25$

c. $A_1=0.67$; $A_2=0.33$

d. $A_1=0.55$; $A_2=0.44$

Ans: *

129. Following are the main types of defense employed by prey species against predators.

Types of defense	Prey Species
P. Chemical with aposematic coloration	1. Grasshoppers and seahorses
Q. Cryptic coloration	2. Hoverflies and wasps
R. Batesian mimicry	3. Bombardier beetles, ladybird beetles, many butterflies
S. Intimidation display	4. Frilled lizard, Porcupine fish

a. P–1, Q–3, R–2, S–4
b. P–4, Q–2, R–1, S–3
c. P–3, Q–1, R–2, S–4
d. P–2, Q–3, R–1, S–4

Ans: c

130. Following is the list of some important events in the history of life and the names of the epochs of Cenozoic era.

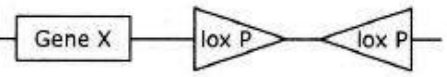
Events	Epochs
P. Angiosperm dominance increases; continued radiation of most present day mammalian orders	1. Paleocene
Q. Major radiation of mammals, birds and pollinating insects	2. Pleistocene
R. Origins of many primate groups	3. Oligocene
S. Origin of genus Homo	4. Pliocene
T. Appearance of bipedal human ancestors	5. Eocene
U. Continued radiation of mammals and angiosperms, earliest direct human ancestors	6. Miocene

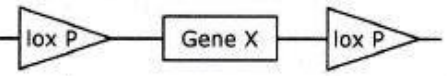
Which one of the following is the *correct* match of events with the epochs?

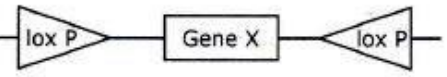
a. P–5, Q–2, R–1, S–3, T–4, U–6
b. P–6, Q–1, R–2, S–4, T–3, U–5
c. P–5, Q–1, R–3, S–2, T–4, U–6
d. P–4, Q–1, R–2, S–3, T–5, U–6

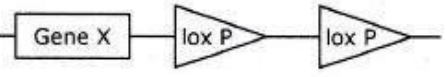
Ans: c

131. In transgenic mice, the orientation and location of the loxP sites determine whether *Cre* recombinase induces a deletion, an inversion or a chromosomal translocation. If a researcher wants to put the loxP sites in such a manner that only inversion will take place, which one of the following construct best justifies their intention? Gene X is the target gene.

a. 

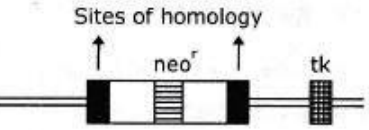
b. 

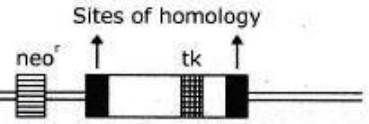
c. 

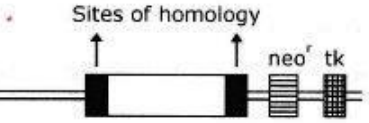
d. 

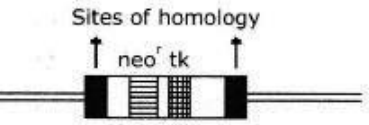
Ans: c

132. A student, while constructing knock-out mice, isolated mouse embryonic stem cells and introduced an engineered DNA into the cells. However, none of the mice were transgenic. On checking the cells containing DNA construct, he found that he had made a mistake in constructing the DNA since the cells were resistant to ganciclovir but sensitive to G418. Which one of the following, constructs had he designed?

a.


b.


c.


d.


Ans: c

133. Somatic embryogenesis is an important exercise in micropropagation and genetic engineering of plants. The following steps are considered as critical for achieving somatic embryogenesis:

P. Reducing the concentration of sucrose in the medium by half.

Q. Addition of the hormone, 2, 4–dichlorophenoxyacetic acid, to induce somatic embryos.

R. Reduce agar concentration to 0.6% (w/v).

S. Use maltose in place of sucrose as a carbon source.

Which one of the following combinations is *correct*?

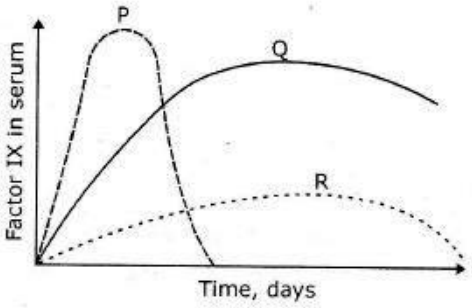
a. P and R
b. Q and S
c. P and Q
d. R and S

Ans: b

134. Factor IX is essential for blood clotting. Deficiency of Factor IX could be corrected by delivering factor IX gene using viral vectors. In an experiment the gene for Factor IX was cloned appropriately into Adenovirus (AV), Adeno-associated virus (AAV) and Retrovirus (RV). Retrovirus integrates the gene into the dividing cells. AAV integrates partially into non-dividing cells. AV does not integrate the gene but transfects both dividing and non-dividing cells.

Following expression profile for factor IX was observed when the three vectors were injected intra-muscularly into three groups of experimental mice.

Which one of the following outcomes is *correct*?



a. P by RV; Q by AV; R by AAV
b. P by AV; Q by AAV; R by RV
c. P by AAV; Q by RV; R by AV
d. P by AV; Q by RV; R by AAV

Ans: d

135. The following genes have been genetically engineered to develop herbicide resistance in plants.

P. Resistance to glyphosate using the 5-enolpyruvyl shikimate-3-phosphate synthase gene.

Q. Bialaphos resistance using the bar gene.

R. Sulfonyl urea resistance using the acetolactate synthase gene.

S. Atrazine resistance using the glutathione S-transferase gene.

In which of the above two cases the mechanism is based on abolition of herbicide binding to the enzyme?

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

Ans: d

UNIT 13

Part B

June 2011

135. 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?

a. TRP1
b. SUP4
c. URA3
d. CEN

Ans: b

136. The μ and σ 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?

a. 20
b. 64
c. 10
d. 336

Ans: a

December 2011

138. 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

Ans: b

139. 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

Ans: a

140. 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

Ans: -

June 2012

134. Among existing technologies, which of the following vector systems would you prefer to use for generating a library for 140 kb eukaryotic genomic DNA fragments, while giving due consideration to size as well as stability of the insert?

a. Phage
b. Cosmid
c. Bacterial artificial chromosome (BAC)
d. Yeast artificial chromosome (YAC)

Ans: c

135. If r denotes the correlation coefficient and m denotes the slope of regression line, inter-changing X and Y axes would

a. change m but not r
b. change r but not m
c. change both r and m
d. not change r or m

Ans: a

136. The use of biotinylated secondary antibody in ELISA

a. increases the sensitivity of the assay but compromises the specificity.
b. increases the sensitivity of the assay without compromising the specificity.
c. does not alter either sensitivity or specificity.
d. decreases both sensitivity and specificity.

Ans: b

December 2012

135. Optical density of a 400 base pair long 1 ml DNA solution was found to be 0·052. How many DNA molecules are present in the solution? [1 base pair = 650 dalton, optical density of 1·0 D corresponds to 50 µg DNA/ml]

a. $6{\cdot}023 \times 10^{12}$ b. $6{\cdot}023 \times 10^{18}$

c. $4{\cdot}633 \times 10^{18}$ d. $5{\cdot}2 \times 10^{13}$

Ans: a

136. In which of the following techniques does molecular fragmentation offer clues to the covalent chemical structures of biomolecules?

a. MALDI-TOF MS mass spectrometry

b. MALDI-TOF MS/MS mass spectrometry

c. ESI-TOF MS mass spectrometry

d. LC-coupled ESI-TOF MS mass spectrometry

Ans: b

137. The movement of a single cell was required to be continually monitored during development. This cell was marked with a reporter gene. To visualize this movement one would use

a. phase contrast microscopy b. bright field microscopy

c. fluorescence microscopy d. atomic force microscopy

Ans: c

June 2013

137. Molar absorption coefficient of phenylalanine is 200 M^{-1} cm^{-1} at 257 nm. What concentration (g/L) of this amino acid will give an absorption of 1 in a cell of 0.5 cm path length at 257 nm?

a. 3.30 b. 0.33

c. 1.65 d. 0.17

Ans: c

138. Which of the following atomic nuclei cannot be probed by nuclear magnetic resonance spectroscopy?

a. ^{1}H b. ^{31}P

c. $^{18}0$ d. ^{15}N

Ans: c

139. $t_{1/2}$ of an irreversible first order reaction, $S \longrightarrow P$ is 1 hour. The time (in hours) required to reach 75% completion is

a. 1.5 b. 2.0

c. 2.5 d. 3.0

Ans: b

December 2013

134. Co-localization of two fluorescently labelled proteins in an organelle in cells is usually visualised by

a. interference-contrast microscopy

b. scanning electron microscopy

c. confocal microscopy

d. atomic force microscopy

Ans: c

135. Haemoglobin has characteristic circular dichroism (CD) peaks C in the far-UV, near UV and Soret regions. Contribution to near-UV CD comes entirely from

a. aromatic amino acid residues.

b. heme group.

c. heme and aromatic amino acid residues.

d. peptide bonds and aromatic amino acid residues.

Ans: c

136. A weed is assumed to be dispersed randomly in a meadow. What statistical distribution will describe the dispersion *correctly*?

a. Binomial

b. Negative Binomial

c. Poisson

d. Normal

Ans: c

137. Which of the following are the most appropriate spectral bands for vegetation analysis using remote sensing platforms?

a. Red, Near Infrared

b. Infrared, Visible

c. Red, Microwave

d. Visible, Microwave

Ans: a

June 2014

130. In isoelectric focusing experiments, proteins are separated on the basis of their

a. relative content of only positively charged residues.

b. relative content of only charged residues.

c. relative content of positively and negatively charged residues.

d. mass to charge ratios.

Ans: c

131. Which one of the following molecular marker types uses combination of both restriction enzyme and PCR techniques?

a. SSR

b. AFLP

c. SNP

d. RAPD

Ans: b

132. An ant moving straight, upon encountering an obstacle, may turn either right or left and continue moving. To test the hypothesis that the direction chosen by the ant is random, the most appropriate statistical test is

a. Student's t-test

b. χ^2-test of independence

c. χ^2-test of goodness of fit

d. correlation test

Ans: c

133. A bioinformatics tool used to find the sequence similarity in the subunits of hemoglobin is

a. FASTA

b. BLAST

c. HUMMER

d. PSI:PLOT

Ans: b

134. Electron microscopes have much higher resolution than any type of light microscope because

a. of their higher magnification.

b. the lenses used are of much higher quality.

c. of very short wavelength of electrons.

d. the images are viewed on screen rather than directly using an eye-piece or ocular lens.

Ans: c

135. The average energy absorbed by 10 gm of tissue from ^{32}P radiation is 14.9 Jkg^{-1}. The average dose in rads is

a. 1490

b. 1.49

c. 14900

d. 149

Ans: a

136. The electrospray ionization spectrum of a highly purified protein shows multiple closely spaced peaks. This most likely arises due to

a. degradation of the protein during recording of the spectrum.

b. the presence of multiple conformations.

c. multiple charged species of the protein.

d. extensive aggregation of the protein.

Ans: c

June 2015

136. Which one of the methods listed below is the most sensitive label-free quantification method for proteins?

a. UV spectroscopy

b. Infra-red spectroscopy

c. Raman spectroscopy

d. ^{13}C content of protein

Ans: a

137. Two groups (Control, Treated) are to be compared to test the effect of a treatment. Since individual variability is high in both groups, the appropriate statistical test to use is

a. analysis of variance

b. Kendall's test

c. Student's t-test

d. Mann-Whitney U-test.

Ans: d

138. A protein has one tryptophan and one tyrosine in its sequence. Assume molar extinction coefficients at 280 nm of tryptophan and tyrosine as 3000 and 1500 M^{-1} cm^{-1}, respectively. What would be the molar concentration of that protein if its absorption at 280 nm is 0.90?

a. 2 mM

b. 0.4 mM

c. 0.2 mM

d. 0.02 mM

Ans: c

139. The mean (μ) and standard deviation (σ) of body size in a *Drosophila* population are 8.5 and 2.2 mm, respectively. Under natural selection over many generations the μ and σ of body size change to 8.5 and 0.8 mm, respectively. The type of natural selection responsible for the change is called

a. directional

b. neutral

c. disruptive

d. Stabilizing

Ans: d

Part C

June 2011

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 rational 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.

Ans: b

138. A researcher has isolated a restriction endonuclease that cleaves at only one specific 10 base pair site.

P. Would this enzyme be useful in protecting cells from viral infections, given that a typical viral genome is 5×10^4 base pairs long?

Q. Restriction endonucleases are slow enzymes with turnover number of $1s^{-1}$. Suppose the isolated endonuclease was faster with turnover numbers similar to those for carbonic anhydrase ($10^6\ s^{-1}$), would this increased rate be beneficial to host cells, assuming that the fast enzymes have similar levels of specificity?

The *correct* combination of answer is

a. P : No Q : Yes

b. P : No Q : No

c. P : Yes Q : No

d. P : Yes Q : Yes

Ans: a

139. Bacteria often acquire genes by the process of lateral or horizontal transfer. Such *foreign* genes, if acquired in recent past, may be identified by their atypical GC content, as compared to native genes. Suppose the genomic GC content of a bacterium is 40%. Gene A of this organism contains 1000 bases with 225 G and 215 C. Another gene B of length 800 bases contains 160 G and 140 C. Which one of the following would be the most acceptable hypothesis (given that $\chi^2 = 3.841$ at 0.05 significance level)?

a. A: native, B: foreign

b. A: foreign, B: native

c. A: foreign, B: foreign

d. A: native, B: native

Ans: b

140. The MALDI spectrum of a peptide shows a peak at m/z corresponding to 3600. When the ESI spectrum is recorded, peaks at m/z corresponding to 721,904 and 1801 were obtained. When the MALDI MS/MS spectrum was recorded, large number of peaks with m/z less than 3600 were observed. The spectral data indicate that the peptide is

a. highly impure.

b. pure with molecular mass of 3600 and partial sequence of the peptide can be determined.

c. highly unstable and degrades rapidly.

d. degraded under condition employed for recording ESI spectrum.

Ans: b

141. In one study, a group of 5 day rat pups were fed for 3 weeks a diet A and the pups gained weight by 300%. In a second study, when the same diet fed for 3 weeks to rats of 350 gms, they did not gain weight significantly. In a third study, a diet B was fed to 250-350 gms rats and it was observed that they delivered normal pups after five weeks. Based on these observations which of the following statements is *correct*?

a. Diet A facilitates weight gain than diet B.

b. Diet B facilitates pregnancy and child-bearing.

c. More control experiments are to be conducted for definitive conclusion.

d. Diet A is more energy containing than diet 'B'. Hence, its quantity should be reduced.

Ans: c

142. Proteins in cells can be visualized by the following methods:

P. Express the gene (coding for the said protein) as a fusion with the green fluorescence protein (GFP) and directly visualize under a fluorescence microscope.

Q. Express the gene (coding for the said protein) as a fusion with the β-galactosidase gene (lac Z) and directly visualize under a phase contrast bright field microscope.

R. A fluorescence tagged antibody raised against the said protein could be used for visualization in a fluorescence microscope.

S. Overexpress the protein and directly visualize it under a scanning electron microscope.

Which of the following methods you would choose to visualize a protein in a living cell?

a. P only

b. P and Q only

c. P and R only

d. S only

Ans; a

143. Insertion lambda vectors are used to create cDNA libraries. In some insertion vectors, the site of insertion is within the cI gene. The recombinants which are cI can then be screened by plating on *E. coli* hfl. The gene hfl encodes a protease that controls lytic-lysogeny decision through which mechanism?

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.

Ans: c

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. AEKCEPGYRCEHFRWCSPPKCGGKCEAFAC

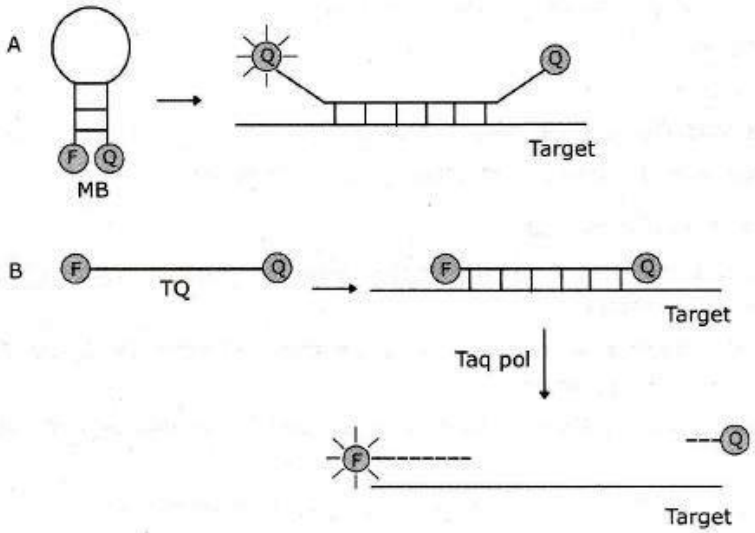
b. AEKCEPGYRCEHFRWCSPPKCGGKCEAFACL

c. AEKCEPGYRCEHFRWCSPPKCGGKCEAFACL

d. AEKCEPGYRCEHFRWCSPPKCGGKCEAFACL

Ans: c

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.

Ans: c

December 2011

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.

Ans: d

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

Ans: b

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.

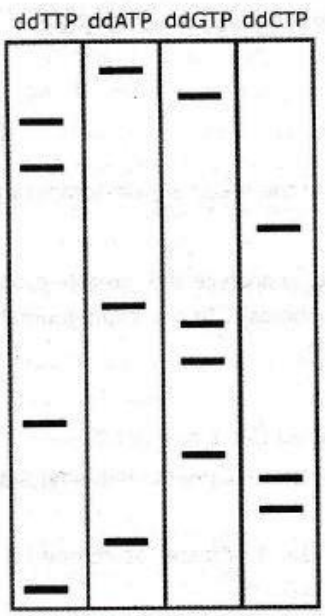
b. Individual II is homozygous for variant allele.

c. Individual II is homozygous for wild type allele.

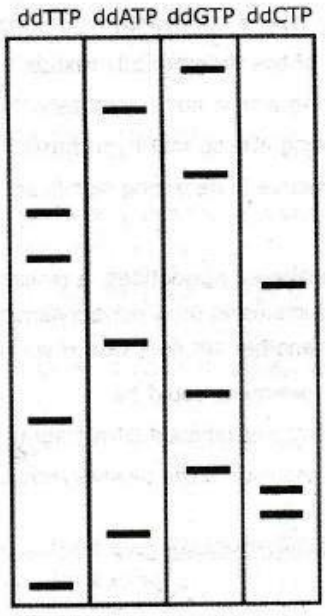
d. Individual III is homozygous for wild type allele.

Ans: b

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

Ans: c

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

Ans; a

June 2012

137. Phosphorylation of ADP to ATP occurs through energy metabolism, comprising oxidative phosphorylation or substrate-level phosphorylation or photo-phosphorylation (in plants). ATP can also be formed from ADP through the action of adenylate kinase. Crystal structure determination of adenylate kinase shows that the C-terminal region has the sequence

-Val-Asp-Asp-Val-Phe-Ser-Gln-Val-Cys-Thr-His-Leu-Asp-Thr-Leu-Lys

What can be a possible conformation of the sequence?

a. A helix that is not amphipathic
b. Amphipathic helix
c. Leucine zipper helix
d. β-hairpin

Ans: b

138. A reporter cell line with stably integrated retroviral promoter-luciferase construct was transfected with an expression vector for a cellular protein. The protein seems to regulate the activation of the retroviral promoter as analyzed by luciferase activity assay. Which one of the following techniques will you use to show *in vivo* recruitment of the cellular protein on the integrated retroviral promoter?

a. Electrophoretic mobility shift assay
b. RNAse protection assay
c. DNAse hypersensitivity assay
d. Chromatin immunoprecipitation assay

Ans: d

139. For 5′ end labeling of DNA, the following reactions are carried out sequentially as indicated.

5′-dephosphorylated DNA +[γ^{32}P] dATP + T4 polynucleotide kinase (T4PNK) and incubated for 2 hours ⟶ Ammonium acetate ⟶ Tris-EDTA ⟶ ethanol.

If trace amount of NH_4^+ is present in the initial DNA mix, which of the following statements would most likely be *true*?

a. NH_4^+ ion activates T4PNK, thereby increasing the labeling efficiency.
b. NH_4^+ ion inhibits T4PNK, therefore should not be present in the DNA mix.
c. NH_4^+ ion does not have any effect on T4PNK.
d. NH_4^+ ion dephosphorylates DNA, thereby increasing the labeling efficiency.

Ans: b

140. A researcher collected information from four forest areas using a sensor to assess their green cover, observed average spectral values for each of the forests are given in the table below:

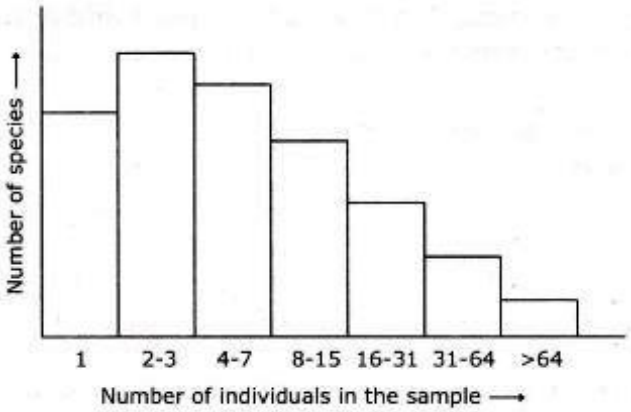
Forest	Spectral value	
	NIR	VIS
A	0.50	0.08
B	0.40	0.30
C	0.50	0.20
D	0.60	0.20

The forest green cover in the order of highest to lowest is

a. A > C > B > D
b. A > D > C > B
c. B > C > D > A
d. D > A > B > C

Ans: b

141. Biologists randomly sampled about 3000 insects from a newly found island. The distribution of their abundance in the sample was as in the figure given below.



Which of the following can be *correctly* inferred from the graph?

a. Many species have only one individual each on the island.

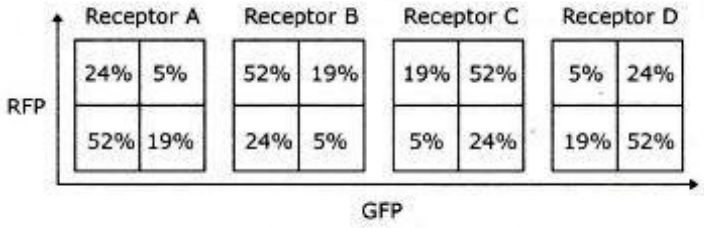
b. The bar on the extreme right represents a large number of species with very few individuals.

c. Summation of the heights of all columns will be exactly equal to the total number of species present on the island.

d. All species from the island may not be represented in the sample.

Ans: d

142. Four different receptors viz, A, B, C and D bind to the same ligand X. In order to determine which receptor has the highest ligand binding affinity following experiment was carried out. Cells were transfected with green fluorescence protein (GFP)-tagged receptors (A, B, C and D) individually, then incubated with red fluorescence protein (RFP) tagged –'X' and subjected to FACS analysis. Following are the results



Which receptor has the highest ligand binding affinity?

a. A

b. B

c. C

d. D

Ans: c

143. If one wishes to design a microarray chip for whole genome expression analysis of an eukaryotic system, which region of the gene should be preferred for selection of unique target sequences?

a. Any region of the coding DNA sequence (CDS).

b. 3' region of the CDS and 3' untranslated region (UTR).

c. 5' region of the CDS and 5' UTR.

d. 1st intron only.

Ans; b

144. During line transect sampling of two solitary species of ground mammals the following observations were made:

	Smaller species	*Larger species*
P. Transect length	100 km	100 km
Q. Number of animals sighted	30	36
R. Mean perpendicular distance form transect line	10 m	40 m

Which of the following can be inferred from the data?

a. The smaller species is more abundant but seen less frequently.

b. The smaller species is less abundant and seen less frequently.

c. The larger species is more abundant but seen less frequently.

d. The larger species is seen more frequently, but its abundance cannot be compared with the smaller species.

Ans: a

145. A protein contains 2 Trp and 4 Tyr residues. The molecular mass of the protein is 17000 D and that of Trp and Tyr are 204 and 180 D respectively. Values of $E^{1\%}_{1cm}$ the absorption coefficient of 1% (g/v) solution of Trp and Tyr in 1-cm cell at 280 nm, are 269.60 and 83.33, respectively. The absorption of 1 mg/ml protein solution in 1-cm cell at 280 nm will be

a. 0.1 b. 1.0

c. 0.7 d. 1.7

Ans: b

December 2012

138. The molecular mass of a protein determined by gel filtration is 120 kDa. When its mass is determined by SDS-PAGE with and without β-mercaptoethanol, it is only 60 kDa. What is the most probable explanation for these observations?

a. Protein is a dimer in which two identical chains are cross-linked by disulphide bond(s).

b. Protein is a monomer of molecular mass 60 kDa but it is excluded from the gel matrix due to strong repulsion between the gel matrix and the protein.

c. Protein is most likely to be composed of two sub-units having identical molecular mass.

d. Protein is a monomer but it is nicked into half its size by SDS.

Ans: c

139. In a census for a lake fish, 10 individuals were marked and released. In second sampling after a few days 15 individuals were caught, of which 5 individuals were found marked. The estimated population of the fish in the lake will be

a. 20 b. 30

c. 25 d. 35

Ans: b

140. In order to clone an eukaryotic gene in pBR322 plasmid vector, the desired DNA fragment was produced by PstI cleavage and incubated with PstI digested pBR322 (PstI cleavage site lies within the ampicillin resistant gene) and ligated. Mixture of ligated cells were used to transform *E. coli* and plasmid containing bacteria were selected by their growth in tetracycline containing medium. Which type of plasmid/s will be found?

a. Circular pBR322 plasmid containing the target gene and resistant to only tetracycline.

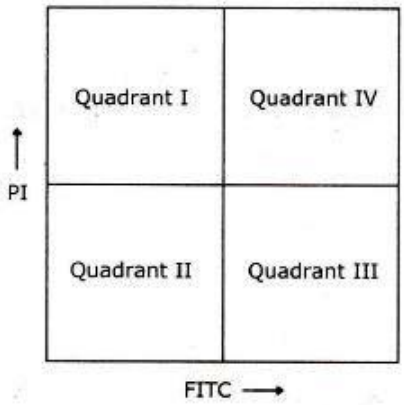
b. Circular pBR322 plasmid containing the target gene and resistant to tetracycline only and recircularized pBR322 plasmid resistant to both ampicillin and tetracycline.

c. Circular pBR322 plasmid containing the target gene and resistant to only tetracycline, recircularized pBR322 resistant to both ampicillin and tetracycline and concatemerized pBR322 resistant to both ampicillin and tetracycline.

d. Circular pBR322 plasmid containing the target gene and resistant to both ampicillin and tetracycline.

Ans: c

141. During apoptosis, phosphatidyl serine (PS) usually present in the inner leaflet of the plasma membrane flips to the outer membrane. Annexin V is a protein that binds to PS. Using this as a tool, we identify the apoptotic cells from necrotic and normal cell populations by FACS using FITC-tagged Annexin V. Propidium iodide (PI) is used to stain the nucleus which generally identifies necrotic and late apoptotic cells. In which area of the plot you should get early apoptotic cells by FACS analysis?



a. Quadrant I
b. Quadrant II
c. Quadrant III
d. Quadrant IV

Ans: c

142. The muscle tone was increased after electrolytic lesion of the caudate nucleus in a cat. The muscle tone decreased within seven days. The following explanations were given by the researcher

P. The functional recovery was due to plastic changes of nervous system.

Q. The brain tissue surrounding the lesioned area was non- functional due to circulatory insufficiency immediately after surgery which led to greater functional loss.

R. The circulatory status in surrounding tissue recovered with time resulting in partial functional recovery.

S. The degenerating nerve fibres were regenerated which underlie functional recovery.

Which one of the following is *correct*?

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

Ans: b

143. A fluorophore when transferred from solvent A to solvent B results in an increase in the number of vibrational states in the ground state without any change in the mean energies of either the ground or excited state. What would be the change seen in the fluorophore's emission spectrum?

a. An increase in emission intensity.
b. An increase in emission bandwidth.
c. An increase in emission wavelength.
d. A decrease in emission wavelength.

Ans: b

144. You wish to localize a given gene product at subcellular levels following immunofluorescence staining. Routine microscopy could not resolve whether the gene product is localized inside the nucleus or on the nuclear membrane. Which of the following will resolve this unambiguously?

P. Sectioning of cell followed by phase contrast microscopy.

Q. A simulation of 3D picture following confocal microscopy.

R. Optical sectioning and observing each section.

S. Freeze fracturing followed by Scanning Electron Microscopy.

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

Ans: b

145. The Triver-Willard hypothesis states that the physiological state of a female can bias the sex ratio of offspring. In an experiment in the bird species a group of females were fed a diet 30% lower in calories than the control females. After allowing both the groups to mate and breed freely, the offspring of control 1 group were 22 males and 18 females. The diet restricted females laid a total of 40 eggs. What should be the minimum deviation from the control to conclude that they have significantly female biased offspring sex ratio? (Chi sq [0.05] df = 1 is 3.84)

a. 18 male 22 female
b. 20 male 20 female
c. 15 male 25 female
d. 10 male 30 female

Ans: c

June 2013

140. A set of neonatal mice are divided into four groups. Group 1 neonates were not primed with any antigen. Group 2 neonates were primed with KLH. Group 3 neonates were primed with KLH but thymectomized. Group 4 neonates were KLH-primed, thymectomized, but reconstituted with KLH- specific $CD4^+$ T cells. All these mice, when grown adult, were challenged with KLH and the anti-KLH IgG antibody was measured in sera. Which of the following is the *correct* order of magnitude of antibody response?

[> = greater than, ≥ = greater than or equal to]

a. Group 1 > Group 2 > Group 3 > Group 4.
b. Group 2 > Group 1 > Group 3 ≥ Group 4.
c. Group 2 > Group 3 > Group 1 > Group 4.
d. Group 4 > Group 1 > Group 2 ≥ Group 3.

Ans: d

141. Choose the *correct* sequence of events in a next generation sequencing technology-based whole genome sequencing project.

a. DNA extraction → shearing → library preparation → sequencing → assembly → finishing → annotation → submission to Genbank.
b. DNA extraction → library preparation → sequencing → assembly → annotation → finishing → submission to Genbank.
c. DNA extraction → shearing → adapter ligation → library amplification → sequencing → assembly → finishing → annotation → submission to Genbank.
d. DNA extraction → adapter ligation → library amplification → shearing → sequencing → finishing → assembly → annotation → submission to Genbank

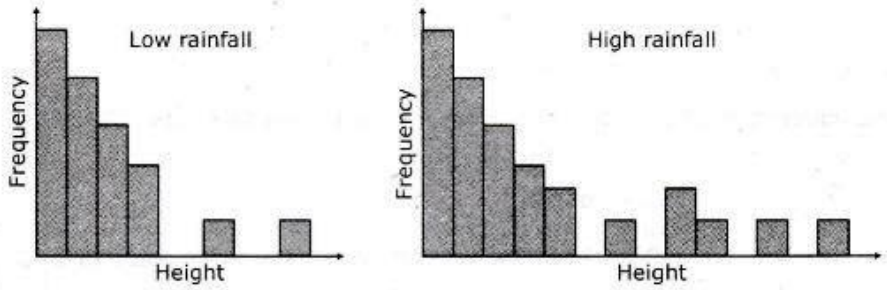
Ans: c

142. An investigator discovers a new receptor for a known ligand and wanted to identify the binding partner of the receptor i.e. its co- receptor. The antireceptor antibody is not available but anti GFP-antibody is available. Which one of the following strategies is most likely to identify the co-receptor?

a. The GFP-receptor fusion protein is expressed in a cell line and analyzed by LC-MS/MS.
b. The GFP-receptor fusion protein is expressed in a cell line and the cells positive for GFP were sorted out, lysed and run on a polyacrylamide gel.
c. The GFP-receptor protein is coated on ELISA plate, followed by ELISA with anti-GFP antibody.
d. The receptor is cloned as a fusion protein of GFP and expressed in stimulated cells. The immuno-precipitated complex obtained by anti-GFP antibody was analyzed by LC-MS/MS.

Ans: d

143. The frequency distribution of tree heights in two forest areas with different annual rainfall are given



Which of the following statistical analysis will you choose to test whether rainfall has an effect on tree heights?

a. t-test for comparison of means.

b. A non-parametric comparison of the two groups.

c. Correlation analysis of rainfall and mean tree heights.

d. Regression of tree heights on rainfall.

Ans: b

144. Two species of plants were sampled in 32 quadrats in a forest. The mean and variance for the occurrence of species 1 were 16.2 and 48 and species 2 were 3.6 and 3.2 respectively. Which of the following statements about the distribution of the two species in these quadrats is supported by these findings?

a. Both species are distributed randomly.

b. Species 1 is distributed randomly and species 2 is clustered.

c. Species 1 is clustered and species 2 is distributed randomly.

d. Both species are clustered.

Ans: c

145. Poly-L-lysine exists in pure α-helix, β-sheet and random coiled conformations depending upon the solvent conditions. The values of mean residue ellipticity at 220 nm ($[\theta]_{220}$) are −35,700, −13,800 and +3,900 deg cm^2dmol^{-1} for α-helix, β-sheet and random coil conformations of this polypeptide, respectively. The polypeptide exists in α-helix conformation at pH 10.8 and 25°C. Addition of urea leads to a two state transition between α-helix and random coil conformation. It has been observed that $[\theta]_{220}$ of the polypeptide is −14800 deg cm^2dmol^{-1} in the presence of 6M urea. The percentage of the polypeptide in α-helix conformation is:

a. 37 b. 41

c. 47 d. 50

Ans: c

December 2013

138. An unknown peptide was isolated from the leaf of a medicinal plant and purified to homogeneity. The peptide did not yield any sequence when subjected to Edman degradation. However, tryptic digest of the peptide produced a unique sequence. The mass of the intact peptide was found to be 18 Da less than that obtained from the trypsin treated sample. The possible interpretation of the above experimental results could be that

P. the N-terminus of the peptide was blocked by acetylation or methylation.

Q. the peptide was cyclic and contained at least one internal arginine or lysine residue.

R. the peptide was cyclic and contained a lysine or arginine residue at the C-terminus.

S. the peptide was cyclized by peptide bond formation between α-amino group and α-carboxyl group.

Which of the above statements is *true*?

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

Ans: d

139. A gene is regulated by a novel transcription factor. The following techniques may be used to identify the *cis*-regulatory element in the 1 kb promoter sequence of the gene where the novel transcription factor binds:

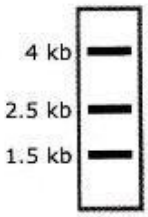
1. Bioinformatics analysis
2. Cell based reporter assay
3. S1 nuclease assay
4. Electrophoretic mobility shift assay
5. DNAse-1 foot-printing analysis

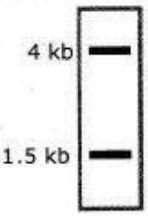
Which one of the following can help to identify the *cis* element?

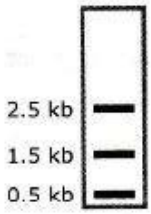
a. 1 and 2
b. 3 and 5
c. 4 only
d. 5 only

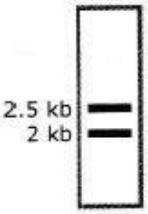
Ans: d

140. A protein D is encoded by a gene, which is 5 kb long and has three HindIII restriction enzyme sites. The first one is 0.5 kb from the transcription start site, the second one is 2.5 kb from the first site and the third one is 0.5 kb internal to the stop codon. The second site is polymorphic. In order to find out whether fetal cells contain the normal or the mutated gene, total genomic DNA from fetal cells was isolated, completely digested with HindIII, separated in an agarose gel, transferred to membrane and detected by a probe against the region between the second and third restriction site. Which one of the following band patterns will be obtained if the fetal cell is heterozygous?

a. 

b. 

c. 

d. 

Ans: b

141. Given below are the experimental protocols to find out the exact location of repetitive DNA sequence in mitotic chromosome by FISH (fluorescence in situ hybridization). Which one of the protocols will give the *correct* result?

a. Mitotic chromosomes were fixed on glass slide → incubated with biotinylated telomeric DNA → denatured → incubated with fluorescently labeled avidin → localization observed under fluorescence microscope.

b. Mitotic chromosomes were fixed on glass slide → denatured → incubated with FITC labeled unrelated non-repetitive DNA sequence → counterstained with propidium iodide → localization observed under fluorescence microscope.

c. Mitotic chromosomes were fixed on glass slide → denatured → incubated with biotinylated satellite DNA → incubated with fluorescently labeled avidin → localization observed under fluorescence microscope.

d. Mitotic chromosomes were fixed on glass slide → incubated with repetitive DNA sequence binding protein → denatured → FITC labeled antibody against the protein → localization observed under fluorescence microscope.

Ans; c

142. At 25°C values of $[\theta]_{222}$, the mean residue ellipticity at 222 nm, are −33000 and −3000 deg cm^2 $dmol^{-1}$ for a polypeptide existing in α-helical (α) and β-structure (β), respectively. If this polypeptide undergoes a two-state heat-induced α → β transition, and a value of $[\theta]_{222}$ = −18000 deg cm^2 $dmol^{-1}$ is observed at 60°C, then this observation leads to the conclusion that the α-helix conversion to β-structure is

a. 40%
b. 50%
c. 55%
d. 60%

Ans: b

143. An EEG was recorded and its power spectrum analyses were done in rats with implanted electrode for a long time. The power of the EEG waves decreased two months after electrode implantation.

This observation may be due to the following:

P. Glial cells accumulate surrounding the exposed tips of electrodes.

Q. Degeneration of neurons occur surrounding the electrode tips due to metal ion deposition.

R. Coating of electrodes are destroyed with time.

S. The microsocket becomes loose with time.

Which one of the following is *true*?

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

Ans: b

144. Using FRAP (Fluorescence Recovery After Photo-bleaching) techniques, diffusion coefficient of three integral membranes proteins M1, M2 and M3 in a kidney cell is calculated as 1 μm/s, 0.05 μm/s and 0.005 μm/s, respectively. Considering fluid-mosaic nature of biological membrane and relationship of structural organization of integral membrane protein with diffusion coefficient, which protein(s) will have highest number of integral membrane domain?

a. M2 and M3
b. M2 only
c. M3 only
d. M1 and M3

Ans: c

145. In resting cells, proteins X and Y are localized in the cytosol. Upon stimulation with lipopolysaccharide (LPS), both of them are phosphorylated and translocate to the nucleus. You have used antibodies against phosphorylated forms of proteins X and Y which are conjugated to either red, or green or blue dye. Keeping optical aberration of light in mind, which one of the following will be the best for visualizing X and Y in the nucleus by fluorescence microscopy?

a. Anti green X and anti red Y
b. Anti red X and anti green Y
c. Anti red X and anti blue Y
d. Anti blue X and anti green Y

Ans; c

June 2014

137. A small fraction of clear cellular lysate was run on an isoelectric focusing gel (IEF) to purify a particular protein, which showed a number of sharp bands corresponding to different pI values. The protein of interest has a pI of 5.2. Therefore, the band corresponding to pI 5.2 was cut, eluted with appropriate buffer and subjected to SDS-PAGE, which showed 3 distinct bands. Which one of the following inferences *cannot* be drawn from the above observations?

a. Several different proteins having same pI may be present at the single band on IEF gel.

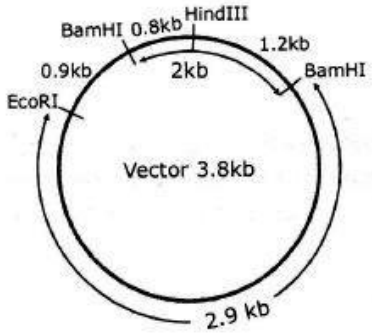
b. SDS-PAGE showed 3 distinct bands which may represent molecular mass of different proteins.

c. The protein of interest may be composed of 3 subunits.

d. As the IEF gel showed a distinct band corresponding to pI 5.2, which is the pI of the protein of interest, the protein is composed of a single subunit.

Ans: d

138. The diagram below represents a 2 kb insert successfully introduced in between two BamHI sites of a 3.8 kb vector in desired orientation. The HindIII site on the insert and EcoRI site on the vector is also indicated. If the insert was introduced in the opposite orientation, which one of the following statements is *incorrect*?



a. Digestion with EcoRI will linearize the 5.8 kb plasmid.

b. Digestion with BamHI will yield one 3.8 and one 2.0 kb fragment.

c. Double digestion with EcoRI and HindIII will produce 1.7 kb and 4.1 kb fragments.

d. Double digestion with EcoRI and HindIII will produce 2.1 kb and 3.7 kb fragments.

Ans: c

139. Given below are some of the methods used to assess evolutionary phylogenetic relationships among plant taxa.

P. 16S rRNA sequence

Q. Mitochondrial microsatellite

R. Biochemical characterization

S. Morphology

Which two of the above methods can best reveal the evolutionary phylogenetic relationships?

a. P and Q

b. Q and R

c. R and S

d. P and S

Ans: a

140. The hydrogen atoms in the δ (delta) methylene group of lysine will give the following splitting pattern in the ^{1}HNMR spectra of lysine.

a. Triplet of triplets

b. Quintet

c. Doublet of triplets

d. Triplet of a doublet

Ans; a

141. Combination of molecular markers with their classification based on either dominant or co-dominant types are shown below:

P. SSR and RFLP: co-dominant.

Q. SSR and RAPD: co-dominant.

R. RAPD and RFLP: dominant.

S. AFLP and RAPD: dominant.

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

a. P and Q

b. Q and R

c. R and S

d. P and S

Ans: d

142. Cytochrome-c has only one tryptophan residue (W) which is buried. The protein in cacodylate buffer (pH 6.0) is excited at 280 nm, and its emission spectrum measured in the range of 300-450 nm. The same measurement was repeated on the protein in the buffer containing 6M guanidine hydrochloride. It was observed that there is an increase in the intensity of the emission spectrum of the guanidine hydrochloride treated cytochrome-c. The most probable reason for this increase is:

a. W is near a hydrophobic patch present in the unfolded protein.

b. W is near the heme in the native protein.

c. W is near carboxylate amino acid side chains in the native protein.

d. W is in a polar pocket in the native protein.

Ans: b

143. The body weight of adult female of a strain of *Drosophila* is 1.8 ± 0.45 mg (mean ± standard deviation). In a laboratory experiment, each of the 3 groups (A, B, C) of this strain was subjected to a different type of selection pressure having influence on the female body weight. After many generations of experimental selection pressure, the body weight changed as follows:

Group A: Body weight distribution – Normal, 1.8 ± 0.08 mg

Group B: Body weight distribution – Bimodal at 1.4 and 2.2 mg

Group C: Body weight distribution – Normal, 2.2 ± 0.08 mg

Which of the following *correctly* gives the types of selection that have occurred in the three groups?

a. Group A: Directional; Group B: Stabilizing; Group C: Disruptive.

b. Group A: Disruptive; Group B: Directional; Group C: Stabilizing.

c. Group A: Stabilizing; Group B: Disruptive; Group C: Directional.

d. Group A: Directional; Group B: Disruptive; Group C: Stabilizing.

Ans: c

144. A protein is composed of leucine, isoleucine, alanine, glycine, proline, one lysine, one arginine and two cysteines connected by a disulfide bond. Conformational analysis indicates that the protein has elements of helix and beta structure. The protein is most likely

a. a non-specific protease

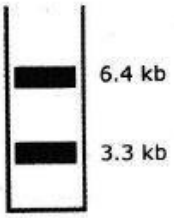
b. not an enzyme

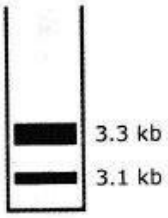
c. a lipase

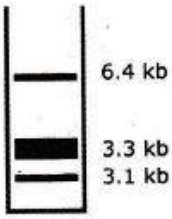
d. a flippase

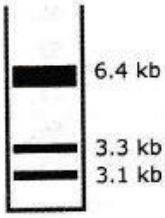
Ans: b

145. A 6.4 kb plasmid DNA has two restriction endonuclease sites, HindIII and EcoRI. Complete double digestion of the plasmid with both the enzymes yields two fragments of 3.1 and 3.3 kb. In order to study DNA repair process, a G:T mismatch was introduced in one strand of HindIII site and the damaged plasmid was incubated in a reconstituted repair system containing all the factors and enzymes required for repair. If the efficiency of the repair system is 50%, which one of the following band patterns on agarose gel will be obtained after treating the repaired plasmid with both HindIII and EcoRI?

a.


b.


c.


d.


Ans: d

December 2014

138. Two homologous proteins were isolated from a psychrophile (P) and a thermophile (T). The purified proteins were subjected to denaturation, protease digestion and circular dichroism (CD). Following observations were made:

P. The CD spectra of P and T proteins are identical.

Q. Their amino acid composition is 95% identical.

R. T and P are equally susceptible to proteolysis in the presence or absence of reducing agent.

S. T has higher midpoint of thermal denaturation than P.

The reason for enhanced stability in T is due to

a. altered secondary structure.

b. increased number of disulfides in T.

c. increase in water of hydration.

d. increase in number of salt bridges.

Ans: d

139. In an attempt to detect protein expression profile in a cell, Western blot technique is employed. Expression of two new proteins is to be followed by probing with respective high affinity antibodies (raised in rabbit). Unfortunately, the two proteins were found to co-migrate in SDS-PAGE profile. Under this situation, using one dimensional SDS-PAGE and by Western blot, which one of the following is the best way to demonstrate the presence of both the proteins?

a. Develop Western blots with their antibodies in the same gel.

b. Prior to doing SDS-PAGE/Western blot, one protein could be removed by immunoprecipitating in the cell extracts.

c. Silencing the expression of one protein at a time by siRNA and performing Western blotting.

d. Subjecting the technique of stripping/reprobing of the gel after transferring to nitrocellulose membrane while doing Western blotting.

Ans: d

140. Nichrome coated stainless steel electrodes were implanted in a rat brain for chronically recording the electrical activity of deep brain structures. During a study of 3 months the intensity of electrical signals gradually decreased. The following statements may explain the cause of this observation.

P. The deposition of metallic iron from the electrode tips caused degeneration of some neurons.

Q. The gradual accumulation of microglia at the electrode tips increased the resistance of electrodes.

R. The neurons at the electrode tips were hyperpolarized gradually.

S. The threshold for firing action potential in the neurons at the electrode tips was increased due to prolonged presence of electrodes.

Which one of the following is *correct*?

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

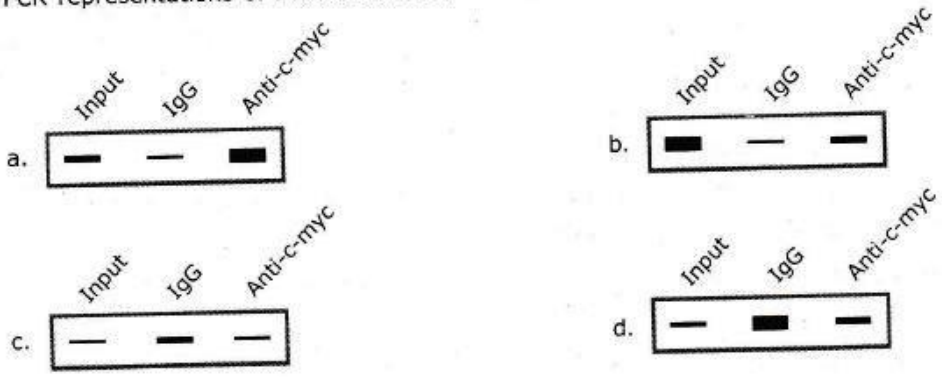
Ans: b

141. The number of seeds in the fruit of a plant species, $H_0 : \mu = 30$. A random sample of 9 fruits gives the mean number of seeds as 24 with a standard deviation of 6.12. (a) What are the confidence limits for the sample mean? (b) Would you reject or accept the null hypothesis at 95% confidence level?

a. (a) 18 and 30, (b) reject the hypothesis.
b. (a) 20 and 28, (b) reject the hypothesis.
c. (a) 20 and 28, (b) accept the hypothesis.
d. (a) 18 and 30, (b) accept the hypothesis.

Ans: b

142. A chromatin immunoprecipitation (ChIP) assay was performed to determine specific transcription factor binding sites on the promoter of a gene. Pull down was done using either IgG or antibodies against c-myc. A DNA containing c-myc binding regions was used as a control for PCR amplification (input). Which one of the following PCR representations of DNA is *correct*?



Ans: b

143. Following are certain statements regarding somatic hybridization, a technique used for plant improvement.

P. Protoplasts of only sexually compatible plant species can be fused.

Q. Hybrids are produced with variable and asymmetric amounts of genetic material of parental species.

R. Protoplast fusion permits transfer of gene block or chromosomes.

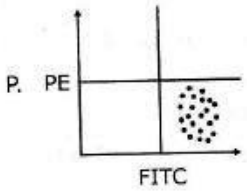
S. Genes to be transferred need to be identified and isolated.

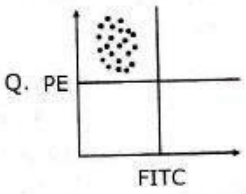
Which one of the following combinations of the above statements is *correct*?

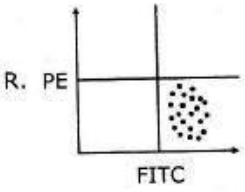
a. P and R
b. Q and R
c. P and S
d. Q and S

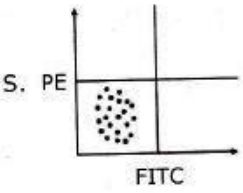
Ans: b

144. A researcher was repeating a FACS experiment but somehow got confused with the labeling of the tubes. There are four tubes, one control, C (with no fluorescent label), one standard 1, S1 (with FITC label), one standard 2, S2 (with PE label) and the last one test, T (which should be FITC positive). Given below is the result of the FACS experiment.







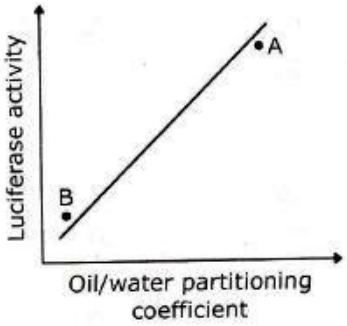


What should be the *correct* labeling?

a. P–S2; Q–S1; R–T; S–C
b. P–S1; Q–T; R–C; S–S2
c. P–S2; Q–S1/T; R–C; S–S1/T
d. P–S1/T; Q–S2; R–S1/T; S–C

Ans: d

145. Small molecular weight compounds affect the activity of luciferase differently. The oil/water solubility of various compounds is one property important for its effect on luciferase. The straight line in the graph was obtained by plotting the activity data with 50 different compounds. The luciferase activity of two new derivatives of benzene (A and B) are shown below?



Which of the following statements is *correct*?

a. A is phosphate and B is amine.
b. A is methyl and B is amine.
c. A is methyl and B is propyl.
d. A is amine and B is phosphate.

Ans: b

June 2015

140. In a confirmatory test for HIV, one or more viral antigens are detected in the blood of patients. Following are the steps to be performed for the experiment:

P. Transfer of viral antigens to nitrocellulose paper.

Q. Incubation with the buffer containing antibodies specific for viral antigens.

R. Separation of viral antigens by SDS-PAGE.

S. Detection of bands by enzyme-linked secondary antibody.

Identify the *correct* sequence steps to be performed for the experiment.

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

Ans: c

141. A protein undergoes post-translational modification. In an experiment to identify the nature of modification, following experimental results were obtained.

P. Protein moved more slowly in an SDS-PAGE.

Q. Isoelectric focusing [IEF] showed that there was no change in the pI.

R. Mass spectrometric analysis showed that the modification was on serine.

The modification that the protein undergoes is likely to be

a. phosphorylation
b. glycosylation
c. ubiquitination
d. ADP-ribosylation

Ans: b

142. A gene from genomic library is screened by using hybridization technique. After hybridizing the probe, usually a stringent washing step is given. The following statements are given to explain the stringent washing step:

1. Stringent washing takes care of removing unincorporated and non-specifically hybridized probe molecules.
2. Stringent washing is done is solution having high salt concentration and lower temperature.
3. Stringent washing is done in solution having low salt concentration keeping higher temperature.
4. Salt present in washing solution supports hybrids to stay intact by shielding the interference of water molecules.
5. Salt reacts with DNA molecules and allows easy dissociation of hybrids.
6. Stability of hybrid is directly proportional to the temperature.

Which combination of the above statements is most appropriate for stringent washing step?

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

Ans; b

143. In response to a drug, changes in protein levels were examined in a cell line. A pulse chase experiment was performed using ^{35}S labeled methionine. In comparison to untreated samples, the following observations were made: few minutes after stimulation, protein X accumulates and this was followed by reduction in protein Y and Z. The *correct* interpretation of these observations would be:

a. Protein X is a protease which degrades Y and Z.

b. Protein X is a transcriptional repressor that controls expression of Y and Z.

c. Expression of protein X and loss of Y and Z are unrelated.

d. Information is not sufficient to distinguish between the three possibilities stated above.

Ans: d

144. The most important property of any microscope is its resolution (D) and can be calculated from the formula $D = \frac{0.61\lambda}{N \sin\alpha}$; where D is minimum distance between two distinguishable objects, λ is the wavelength of incident light, α is the angular aperture and N is the refractive index of the medium. Given below are several suggestions to improve the resolution of a microscope:

P. decrease the wavelength of incident light

Q. increase the wavelength of incident light

R. use oil which has a higher refractive index

S. use oil because of its lower refractive index

Which one is the *correct* suggestion?

a. P and R

b. Only Q

c. Only S

d. Q and S

Ans; a

145. The mean and standard deviation of serum cholesterol in a population of senior citizens are assumed to be 200 and 24 mg/dl, respectively. In a random sample of 36 senior citizens, what value of cholesterol (to the nearest whole number) should lead to rejection of the null hypothesis at 95% confidence level?

a. Above 224

b. Above 248

c. Below 176 and above 224

d. Below 192 and above 208

Ans: d