

## **Unit 2 Cellular Organization**

### **Unit Map**

2.A Membrane Structure and Function

2.B Structural Organization and Function of Intracellular Organelles

2.C Organization of Genes and Chromosomes

2.D Cell Division and Cell Cycle

2.E Microbial Physiology

## 2.A Membrane Structure and Function

Q. 1. Protein that can span the lipid bilayer

- a. diffuse easily from the membrane.
- b. usually has more hydrophilic regions.
- c. usually has both hydrophobic and hydrophilic regions.
- d. Both A and C

**Correct Answer: C**

Lipid bilayer is a universal component of all cell membranes. The lipid bilayer has unique properties. They are formed in sheet-like structures that contain both a hydrophilic and a hydrophobic moiety. The membrane is composed of lipids and proteins and sometimes even carbohydrates. Two types of proteins exist in the lipid bilayer; integral and peripheral membrane proteins. Integral membrane proteins traverse the lipid bilayer. That is, they interact extensively with the hydrophobic region (hydrocarbon region) of the lipid bilayer. Integral membrane proteins interact by non-polar interactions. Peripheral membrane proteins are usually attached to surfaces of integral proteins; therefore, they are on both faces of lipid bilayer. Peripheral membrane proteins interact with the hydrophilic polar head groups of the lipid molecule.

Q. 2. The hormone which passes through the cell membrane, binds to the intracellular receptors and activates it is

- a. estrogen
- b. non-epinephrine
- c. epinephrine
- d. estradiol

**Correct Answer: A**

A lipophilic hormone, such as estrogen, that passes through the plasma membrane of a cell, binds an intracellular receptor and changes gene expression.

**Core Concept :**

**Topic Name :**

**Complexity :**

Difficulty Level : Medium

- Q. 3. "Intracellular receptors were identified and have been proposed to mediate actions of steroid hormones". In an experiment to study various estrogen actions, it was covalently coupled to albumin, a protein of 68 kD. When this protein coupled hormone was added to estrogen responsive cells, a measurable response was observed. What does this response indicates?
- a. Estrogen receptors are not found intracellularly but on the surface.
  - b. Estrogen coupled protein is taken up by the cells by passive diffusion only but not require active diffusion.
  - c. Estrogen receptors are also present on the cell membrane.
  - d. Steroid hormone coupled protein is cleave by the cells and free estrogen is taken up by the cells by passive diffusion.

**Correct Answer: D**

All steroid hormones are synthesized from cholesterol. The way in which specificity of steroid hormone action may be generated is, in large part, via the evolution of receptors that have much higher affinity for the active hormones than for metabolites or structurally similar steroids. This appears to be the case for estradiol and 1,25-dihydroxy vitamin D, the structures of which differ most from the other steroids. However, glucocorticoids, mineralocorticoids, progestogens and androgens have closer structural similarities and their specificities are markedly reduced.

Core Concept :

Topic Name :

Complexity :

Difficulty Level : Medium

- Q. 4. Which statement truly explains the fluid-mosaic model of the membrane?
- a. The lipid is arranged in layers.
  - b. The protein has no specific arrangement.
  - c. The lipid is fluid and arranged in a bilayer with functional protein embedded in them,
  - d. Both lipids and proteins are not arranged in any particular order.

**Correct Answer: C**

The fluid mosaic model proposes that a membrane is a lipid bilayer with proteins embedded in it. This model names lipids, proteins and carbohydrates as the three major components of the bilayer. Phospholipids move laterally in the membrane bilayer but are reluctant to flip across the lipid bilayer. This reluctance can contribute to asymmetry. Asymmetry is defined as different lipid compositions on each side of the bilayer. Two types of proteins can be found in membranes: integral membrane proteins and peripheral membrane proteins. Integral membrane proteins penetrate the lipid bilayer and come in two forms: transmembrane proteins and partially embedded proteins.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

- Q. 5 The process used by a cell that secretes macromolecules by fusing a vesicle to the plasma membrane is called
- endocytosis
  - exocytosis
  - endocytosis and pinocytosis
  - None of the above

**Correct Answer: B**

In exocytosis, materials are exported out of the cell via secretory vesicles. In this process, the golgi complex packages macromolecules into transport vesicles that travel to and fuse with the plasma membrane. This fusion causes the vesicle to spill its contents out of the cell. Exocytosis is important in expulsion of waste materials out of the cell and in the secretion of cellular products such as digestive enzymes or hormones.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 6 Which one of the following coat protein/s is required for receptor mediated endocytosis from plasma membrane?

- a. Clathrin
- b. SNARE protein
- c. Clathrin A protein
- d. Both A and B

**Correct Answer: A**

Clathrin-coated pits make up about 2 percent of the surface of cells such as hepatocytes and fibroblasts. Many internalized ligands have been observed in clathrin-coated pits and vesicles and researchers believe that these structures function as intermediates in the endocytosis of most (though not all) ligands bound to cell-surface receptors.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 7 The action potential leads to the

- a. increase in negative charge inside the nerve fiber.
- b. activation of the sodium-potassium pump.
- c. opening of voltage gated sodium channels.
- d. **All of the above**

**Correct Answer: C**

A nerve impulse or an action potential is a series of electrical responses that occur in the cell. With the appropriate stimulation, the voltage in the dendrite of the neuron will become somewhat less negative. This change in the membrane potential, called depolarization, will cause the voltage-gated sodium channels to open.

**Core Concept :**

**Topic Name :**

**Complexity :**

Difficulty Level : Medium

Q. 8 The oligosaccharide part of glycoproteins is either N-linked or O-linked. The amino acid residues through which these oligosaccharides are attached to polypeptide are \_\_\_\_\_.

- a. Asn and Thr
- b. Asp and Ser
- c. Ser and Lys
- d. Gin and Ser

**Correct Answer: A**

In glycoproteins, sugars are attached either to the amide nitrogen atom in the side chain of asparagine (termed an N-linkage) or to the oxygen atom in the side chain of serine or threonine (termed an O-linkage). An asparagine residue can accept an oligosaccharide only if the residue is part of an Asn-X-Ser or Asn-X-Thr sequence, in which X can be any residue. Thus, potential glycosylation sites can be detected within amino acid sequences.

Core Concept :

Topic Name :

Complexity :

Difficulty Level : Medium

Q. 9 A compound that does not act as second messenger during signaling process is

- a. arachidonic acid
- b. phosphatidate
- c. diacylglycerol
- d. triacylglycerol

**Correct Answer: D**

Phospholipases as the term suggests, are a group of enzymes that catalyze the cleavage of phospholipids. Enzymatic processing of phospholipids by phospholipases convert these molecules into lipid mediators or second messengers (such as arachidonic acid, phosphatidate and diacylglycerol) that play key roles in membrane trafficking, signal transduction, cell proliferation and apoptosis.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 10 The special class of proteins in the outer membrane that helps in the import of vitamin B<sub>12</sub> into gram-negative bacterial cells are

- a. integrins
- b. porins
- c. Both A and B
- d. None of the above

**Correct Answer: B**

A major class of outer membrane protein is the porin. These associate in triplets (trimers) to form a channel or pore across the outer membrane. They may be specific or non-specific. For example LamB is a porin in *Escherichia coli* which allows maltose and maltodextrin sugars, a nutrient, to pass from the external medium into the periplasm. The maltose binds to a specific site within the porin channel before diffusing across (essentially one-dimensional diffusion). OprB is a sugar-specific porin in *Pseudomonas aeruginosa*.

**Core Concept :**

Topic Name :

Complexity :

Difficulty Level : Medium

Q. 11 In the case of an archaebacteria, \_\_\_\_\_.

- a. T or T $\psi$ C arm of tRNA is without thymine
- b. T or T $\psi$ C arm of tRNA is with thymine
- c. cell wall contains D- amino acid
- d. cell wall contains L- amino acid

**Correct Answer: A**

The T arm is a 5 bp stem containing the sequence T $\psi$ C where  $\psi$  is a pseudouridine. Bases that have been modified, especially by methylation, occur in several positions outside the anticodon. The first anticodon base is sometimes modified to inosine (derived from adenine) or pseudouridine (derived from uracil).

Core Concept :

Topic Name :

Complexity :

Difficulty Level : Medium



Q. 12 Choose the incorrect statement/s about biological membranes from the following.

- a. They contain carbohydrates that are covalently bound to proteins and lipids.
- b. They are large sheet-like structures.
- c. They are symmetrical because of the symmetric nature of lipid bilayers.
- d. All of the above

**Correct Answer: C**

Biological membranes are heterogeneous assemblies of lipids, proteins and cholesterol that are organized as asymmetric bimolecular leaflets of lipids with embedded proteins. Modulated by the concentration of cholesterol lipids and proteins may segregate into two or more liquid phases with different physical properties that can coexist in the same membrane.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 13 Which among the following is not true about alanine?

- a. It contains a branched side chain.
- b. At pH I , it will move towards the cathode.
- c. An equimolar mixture of D and L alanine does not rotate the plane polarized light.
- d. Both A and C

**Correct Answer: A**

A branched-chain amino acid (BCAA) is an amino acid having aliphatic side-chains with a branch (a carbon atom bound to more than two other carbon atoms). Among the proteinogenic amino acids, there are three BCAAs : leucine, isoleucine and valine.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 14 Which of the following is a correct decreasing order of permeability through a lipid bilayer of the molecular ions?

- a.  $\text{Na}^+ > \text{Isoleucine} > \text{O}_2 > \text{Tyrosine}$
- b.  $\text{O}_2 > \text{Isoleucine} > \text{Tyrosine} > \text{Na}^+$
- c.  $\text{O}_2 > \text{Na}^+ > \text{Isoleucine} > \text{Tyrosine}$
- d.  $\text{Tyrosine} > \text{Isoleucine} > \text{Na}^+ > \text{O}_2$

**Correct Answer: B**

More specifically, the endothelial cells also possess transporters which show permeability characteristics and allow transport of oxygen and  $\text{CO}_2$  across the Blood Brain Barrier, but these selectively prevent other substances from crossing. The greater the lipid solubility of the diffusing particle, the more permeable the membrane will be. These are slightly permeable to the electrolytes such as sodium chloride and potassium and impermeable to plasma proteins and most non-lipid soluble large organic molecules.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 15 Choose the correct statement/s from the following.

- a. In O-linked glycosylation, sugars are attached to the protein via O-glycosidic bonds to the carboxyl groups of Ser and Thr .
- b. In O-linked glycosylation, oligo-saccharides are attached to the relevant protein.
- c. In O-linked glycosylation, N-acetyl-galactosamine is added via O-glycosidic bonds to the OH groups of Ser and Thr after which other sugars are added sequentially.
- d. Both B and C

**Correct Answer: C.** In O-linked glycosylation, N-acetyl-galactosamine is added via O-glycosidic bonds to the OH groups of Ser and Thr after which other sugars are added sequentially.

The N-glycosidic linkage is through the amide group of asparagine (Asn, N). The O-glycosidic linkage is to the hydroxyl of serine (Ser, S), threonine (Thr, T) or hydroxylysine (hLys). When attached to Ser or Thr, the sugar of O-linked glycoproteins is most often GalNAc.

This most common O- glycoprotein type is also commonly referred to as a mucin-type glycan. In N- linked glycoproteins, the sugar attached to the Asn residue is always GlcNAc.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

- Q. 16 In which one of the following does the inner surface of a closed membrane or vesicle become the outer surface of a closed membrane or vesicle?
- a. Fusion of two vesicles.
  - b. Transfer of an ER membrane into golgi membrane.
  - c. Exocytosis of a secretory vesicle.
  - d. All of the above.

**Correct Answer: C**

The small vesicle (endosome) can move into the interior of the cell, delivering its contents to another organelle bounded by a single membrane (a lysosome) by fusion of the two membranes. The inverse of endocytosis is exocytosis, in which a vesicle in the cytoplasm moves to the inside surface of the plasma membrane and fuses with it, releasing the vesicular contents outside the membrane. Many proteins destined for secretion into the extracellular space are released by exocytosis after being packaged into secretory vesicles.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

- Q. 17 Choose a correct match of the biological functions mentioned in Column A with the enzymes given in Column B.

	<b>Column A</b>	<b>Column B</b>
P.	Diacylglycerol synthesis	1 Protein kinase A
Q.	CREB phosphorylation	2 Ras
R.	GTP hydrolysis	3 Phospholipase

- 4 Phospholipase D
- 5 Protein kinase G

- a. P – 3, Q – 1, R – 5
- b. P – 4, Q – 1, R – 2
- c. P – 3, Q – 1, R – 2
- d. P – 3, Q – 5, R – 2.

**Correct Answer: C**

The diacylglycerol (DAG) signal generated from membrane phospholipids by hormone-activated phospholipases is attenuated by mechanisms that include lipolysis or phospholipid resynthesis. Hydrogen peroxide ( $H_2O_2$ ) initiates an increase in  $C_a^{2+}$ /cAMP-response element binding protein (CREB) phosphorylation in  $C_{10}$  alveolar type II cells that requires activation of extracellular regulated kinases 1/2 (ERK1/2). Application of  $H_2O_2$  increased nuclear accumulation of PKA and inhibition of PKA with H89 reduced oxidant-mediated phosphorylation of both CREB and ERK 1/2. The Ras-like GTPases regulate diverse cellular functions via the chemical cycle of binding and hydrolyzing GTP molecules.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level :Medium**

Q. 18 Which among the following is a correct statement(s) concerning  $Ca^{2+}$  ?

- a. The concentration of intracellular  $Ca^{2+}$  is higher than that of the extra-cellular fluid.
- b. The concentration of cytosolic  $Ca^{2+}$  is increased by activation of phospholipase.
- c. The effect of  $Ca^{2+}$  is most often mediated by calmodulin.
- d. Both A and C

**Correct Answer: C**

The  $Ca^{2+}$  -dependent inhibition of lens epithelial cell-to-cell communication is mediated in part by the direct association of calmodulin (CaM) with connexin43 (Cx43), the major

connexin in these cells. A peptide comprising the putative CaM binding domain (aa 129–150) of the intracellular loop region of this connexin exhibited a high affinity, stoichiometric interaction with  $\text{Ca}^{2+}$ -CaM.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 19 How do the cell walls of gram positive bacteria having two modified sugars, N-acetylglucosamine (NAG) and N-acetylmuramic acid (NAM), are covalently linked together?

- By the formation of  $\alpha$ -1,4-glycosidic bond.
- By the formation of  $\beta$ -1,6-glycosidic bond.
- By the formation of  $\alpha$ -1,6-glycosidic bond.
- By the formation of  $\beta$ -1,4-glycosidic bond.

**Correct Answer: D**

Lysozyme is known for damaging bacterial cell walls by catalyzing the hydrolysis of  $\beta$ -(1,4)-linkages between N-acetylmuramic acid (NAM) and N-acetyl-D-glucosamine (NAG) residues in peptidoglycan and between N-acetyl-D-glucosamine residues in chitodextrins. In this way, lysozyme is efficient in lysing the cell walls of both bacteria and fungi. The location of cleavage for lysozyme on this architectural theme is the  $\beta$ (1-4) glycosidic linkage, connecting the C1 carbon of NAM to the C4 carbon of NAG.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 20 How do mycoplasmas are different from other prokaryotes?

- a. They have a chitin in cell walls.
- b. There is a presence of carbohydrates in cell walls.
- c. There is a presence of proteins in cell walls.
- d. Absence of cell wall itself.

**Correct Answer: D**

Mycoplasmas are a specific and unique species of bacteria (the smallest) free living organism known on the planet. The primary differences between mycoplasmas and other bacteria is that bacteria have a solid cell-wall structure and they can grow in the simplest culture media. Mycoplasmas however, do not have a cell wall and like a tiny jellyfish with a pliable membrane, can take on many different shapes which make them difficult to identify, even under a high powered electron microscope.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level :Medium**

Q. 21 \_\_\_\_\_ can help in identifying eukaryotes, eubacteria and archaebacterial cell types.

- a. Signature sequence
- b. Recognition sequence
- c. Oligonucleotide sequence
- d. None of the above

**Correct Answer: A**

Highly conserved sequences, which are largely the same in all bacteria but differ significantly from those of the eukaryotes and those of other large group of bacteria. On the other hand, differences for some oligonucleotide sequences are found even within genera and species. Certain “signature” sequences have been identified which seem to be characteristic four groups of organisms.

**Core Concept :**

**Topic Name :**

Complexity :

Difficulty Level : Medium

Q. 22 Archaeal cells contain pseudopeptidoglycan which is mainly composed of

- a. N-acetylmuramic acid and L- amino acids.
- b. N- acetyltalosaminuronic acid and D- amino acids.
- c. N- acetylmuramic acid and D- amino acids.
- d. N- acetyltalosaminuronic acid and L- amino acids.

**Correct Answer: D**

Archaea have various chemical compositions, including glycoprotein S- layers, pseudopeptidoglycan or polysaccharides. One type of archaeal cell wall is that composed of pseudopeptidoglycan (also called pseudomurein). However, unlike peptidoglycan, the sugar N-acetylmuramic acid is replaced by Nacetyltalosaminuronic acid and the two sugars are bonded with a  $\beta$ , 1-3 glycosidic linkage instead of  $\beta$ , 1-4 . Additionally, the cross-linking peptides are L- amino acids rather than D- amino acids as they are in bacteria.

Core Concept :

Topic Name :

Complexity :

Difficulty Level : Medium

Q. 23 Which among the following is an incorrect statement about the structures of water-soluble proteins?

- P. They contain tightly packed amino acid residues in their interior.
  - Q. Most of their non-polar residues face the aqueous solvent
  - R. In H-bonded secondary structures, the main chain NH and CO groups are often involved.
  - S. All of the water-soluble proteins contain  $\beta$  – sheet structural motifs.
- a. P, S
  - b. S, P, R

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

**Correct Answer: C**

Proteins are also linear polymers made up of a string of subunits called amino-acids. The different amino-acids differ in their side-chains of which there are 20 different kinds. Hydrophobic side-chains are found primarily in the interior for water-soluble proteins and charged residues are usually on the surface. Polar residues are good hydrogen bond donors or acceptors and are equally happy making hydrogen bonds with water as with other parts of the protein. Most membrane lipids are amphipathic, having a non-polar end and a polar end. The interior of a lipid bilayer is normally highly fluid. In the liquid crystal state, hydrocarbon chains of phospholipids are disordered and in constant motion. Some cytosolic proteins have domains that bind to polar head groups of lipids that transiently exist in a membrane. The enzymes that create or degrade these lipids are subject to signal-mediated regulation, providing a mechanism for modulating affinity of a protein for a membrane surface.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 24 Membrane proteins are synthesized on endoplasmic reticulum and transported to various organelle membranes. One hypothesis for membrane protein sorting is hydrophobicity matching i.e., the proteins with a shorter transmembrane portion into thinner membranes. You are given the following three observations.

- A. It was found that transmembrane portions of proteins in Golgi membranes are shorter than those in plasma membranes
- B. Presence of cholesterol increases the thickness of the bilayer
- C. The phospholipid composition of Golgi and plasma membranes are same

Which one of the following statements is correct?

- a. Proteins in plasma membrane have longer transmembrane portion than proteins in Golgi membranes.
- b. Proteins in Golgi membranes have longer transmembrane portion than proteins in plasma membranes.



- c. Proteins of both Golgi and plasmamembranes have same length of transmembrane portion.
- d. Cholesterol is more in Golgi membrane than in plasma membrane.

**Correct Answer: A**

As already been mentioned in the observations that golgi has shorter proteins in its membrane. Cholesterol increases the thickness of membrane. Phospholipids content is same in both the cases, so only first option is correct.

Q. 25 All among the following statements are correct regarding the  $\text{NAD}^+$  , except

- a. it is a flavin nucleotide.
- b. it is a adenine nucleotide used in metabolism.
- c. it contains a **nicotine** amide ring during reduction.
- d. None of the above

**Correct Answer: A**

Flavoproteins are enzymes that catalyze oxidation-reduction reaction using either flavin mononucleotide (FMN) or flavin adenine dinucleotide (FAD) as cofactors.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 26 Prosthetic groups in the cells are required by all enzymes because they are

- a. required by all enzymes for the activity.
- b. loosely bound to enzymes.
- c. tightly bound to enzymes and are required for their activity.
- d. Both A and B

**Correct Answer: C**

Prosthetic group is a tightly bound, specific non-polypeptide unit required for the biological function of some proteins. The prosthetic group may be organic (such as a vitamin, sugar or lipid) or inorganic (such as a metal ion), but is not composed of amino acids. Prosthetic groups are

bound tightly to proteins and may even be attached through a covalent bond, as opposed to coenzymes, which are loosely bound. In enzymes, prosthetic groups are often involved in the active site, playing an important role in the functions of enzymes.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 27 Metal cations may do all of the following except

- a. it donate electron pair to functional groups found in the primary structure of the enzyme protein.
- b. it serve lewis acid in enzyme.
- c. it serve lewis base in enzyme.
- d. it stabilize an enzyme conformation.

**Correct Answer: A**

Cations are particles with positive charge. They are formed when an atom loses electrons. Among the atoms the alkali metal and alkaline earth metals are the most reactive metals, having one and two **valence** electrons, respectively. Therefore, metal lose their electron and form cations.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 28 The polarity of water molecule is due to

- a. its secondary structure.
- b. bonding electrons being attracted more to oxygen,
- c. its more electrolytic property.
- d. its weak electrolytic property

**Correct Answer: B**

The hydrogen bond is really a special case of dipole forces. A hydrogen bond is an attractive force between the hydrogen attached to an electronegative atom of one molecule and an electronegative atom of a different molecule. Usually the electronegative atom is oxygen, nitrogen or fluorine, which has a partial negative charge. The hydrogen then has the partial positive charge.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 29 A cyclic peptide antibiotic, named as valinomycin facilitates the transport of \_\_\_\_\_ ions.

- a.  $K^+$
- b.  $Fe^{2+}$
- c.  $Ca^{2+}$
- d.  $Na^+$

**Correct Answer: A**

Facilitated diffusion of a molecule or ion is sometimes accomplished by binding to a mobile carrier. An example is the diffusion of a complex of  $K^+$  with the low- molecular mass lipid-soluble carrier or ionophore valinomycin. The  $K^+$  valinomycin complex diffuses the short distance to the other side of the membrane and discharges the bound ion.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 30 Which among the following can be inferred by the Nicholson-Sanger fluid mosaic model of biological membrane?

- a. Membrane proteins are soluble in aqueous environment.
- b. Most of the membrane form lipid bilayer.
- c. Membrane lipids are not free to diffuse laterally.
- d. Membrane proteins may be free to diffuse laterally.

**Correct Answer: D**

According to the fluid mosaic model of S. Jonathan Singer and Nicholson, the biological membranes can be considered as a two-dimensional liquid where all lipid and protein molecules diffuse more or less freely.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Medium**

Q. 31 Why do longer fatty acids make membranes less fluid?

- a. The long chains tend to get intertwined together and transform longer chain fatty acids less fluid
- b. There is an involvement of more hydrogen bonding between the methyl groups.
- c. There are more Van der **waals** interactions between the chains.
- d. Both A and C

**Correct Answer: C**

Lipid molecules are slightly soluble to insoluble in water. Lipids are hydrophobic because the molecules consist of long, 16–18 carbon, hydrocarbon backbones with only a small amount of oxygen containing groups. The fluidity of a lipid bilayer depends on both its composition and its temperature, as is readily demonstrated in studies of synthetic bilayers. The van der Waal attractive forces between neighboring fatty acid tails are not selective enough to hold groups of molecules of this sort together.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**

Q. 32 Which among the following is incorrect about an embedded segment of an integral membrane protein?

- a. An  $\alpha$ -helical segment long enough about 10–15 amino acids, to span the lipid bilayer.
- b. Typically has polar C=O and NH groups in contact with the fatty acyl chains of phospholipids.
- c. Typically has any charged residues facing the exterior of the molecule.
- d. Typically has any charged residues facing the interior of the molecule.

**Correct Answer: B**

Integral proteins containing membrane-spanning  $\alpha$ -helical domains are embedded in membranes by hydrophobic interactions with the lipid interior of the bilayer and probably also by ionic interactions with the polar head groups of the phospholipids. The hydrophobic side chains form Van der Waals interactions with the fatty acyl chains and shield the polar carbonyl (C=O) and imino (NH) groups of the peptide bond, which are all hydrogen-bonded to one another. This hydrophobic helix is prevented from slipping across the membrane by a flanking

set of positively charged amino acids (lysine and arginine) that are thought to interact with negatively charged phospholipid bead groups.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**

Q. 33 A cardiotonic steroid, digitalis enhances the contractility of cardiac muscles by increasing the intracellular level of  $\text{Ca}^{2+}$ , Digitalis inhibit the

- a sodium potassium pump
- b. sodium calcium pump
- c. passive diffusion and activate sodium potassium pump
- d. None of the above

**Correct Answer: A**

Digitalis, a mixture of cardiotonic steroids derived from the dried leaf of the foxglove plant (*Digitalis purpurea*), is of great clinical significance. Digitalis increases the force of contraction of heart muscle, which makes it a choice drug in the treatment of congestive heart failure. Inhibition of the Na-K pump by digitalis leads to a higher level of Na inside the cell. The diminished Na gradient results in slower extrusion of  $\text{Ca}^{2+}$  by the sodium-calcium exchanger. The subsequent increase in the intracellular level of  $\text{Ca}^{2+}$  enhances the contractility of cardiac muscle. It is interesting to note that digitalis was effectively used long before the discovery of the Na-K ATPase.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**

Q. 34 Why does the plasma membrane is highly impermeable lo all charged molecules?

- P. All membrane transport proteins so far known traverse the lipid bilayer and their polypeptide backbones generally extend back and forth across the membrane a number of times.

Q. Ionophores operate by shielding the charge of the transported ion so that it can penetrate the hydrophobic interior of the lipid bilayer.

R. Since the  $\text{Na}^+ - \text{K}^+$  ATPase exchanges equal number of  $\text{Na}^+$  and  $\text{K}^+$  ions in each pumping cycle, it is electrically neutral.

Choose the correct statement

- a. P, Q
- b. Q, R
- c. Only Q
- d. Only P

**Correct Answer: A**

Although the basic structure of biological membranes is provided by the lipid bilayer, membrane proteins perform most of the specific functions of membranes. Many proteins extend through the lipid bilayer, with part of their mass on either side. Like their lipid neighbors, these transmembrane proteins are amphipathic, having regions that are hydrophobic and regions that are hydrophilic. Ionophores are small hydrophobic molecules that dissolve in lipid bilayers and increase their permeability to specific inorganic ions. They are widely used by cell biologists as tools to increase the ion permeability of membranes in studies on synthetic bilayers, cells or cell organelles.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**

Q. 35 Which of the following characteristics differentiates membrane carrier proteins from membrane channel proteins?

- a. Carrier proteins are lipoproteins whereas channel proteins are glycoproteins.
- b. Carrier proteins transport molecules against their electrochemical gradient, while channel proteins transport molecules down their electrochemical gradient.
- c. Carrier proteins can mediate active transport, while channel proteins cannot.
- d. Both carrier proteins and channel proteins are synthesized on free cytoplasmic ribosomes.

**Correct Answer: C**

The integral proteins involved in facilitated transport are collectively referred to as transport proteins; they function as either channels for the material or carriers. Another type of protein embedded in the plasma membrane is a carrier protein. This protein binds a substance and, in doing so, triggers a change of its own shape, moving the bound molecule from the outside of the cell to its interior; depending on the gradient, the material may move in the opposite direction.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**

- Q. 36 The receptor cells of corti organ of hair cells are mechanoreceptors that have hair like stereocilia protruding from one end. Choose a correct statement from the following.
- Whenever the stereocilia bend, ion channels in the plasma membrane of the hair cells close and resulting ion movements repolarization of the membrane.
  - Whenever the stereocilia bend, ion channels in the plasma membrane of the hair cells close and resulting ion movements hyperpolarize the membrane.
  - Whenever the stereocilia bend, ion channels in the plasma membrane of the hair cells open and the resulting ion movements depolarize the membrane and create a receptor potential.
  - The stereocilia are in contact with the overhanging basilar membrane, which projects inward from the side of the cochlea.

**Correct Answer: C**

The stereocilia are simpler, containing only an actin cytoskeleton. Each stereocilium tapers where it inserts into the apical membrane, forming a hinge about which each stereocilium pivots. The stereocilia are graded in height and are arranged in a bilaterally symmetric fashion (in vestibular hair cells, this plane runs through the kinocilium). Displacement of the hair bundle parallel to this plane toward the tallest stereocilia depolarizes the hair cell, while movements parallel to this plane toward the shortest stereocilia cause hyperpolarization.

**Core Concept :**

**Topic Name :**



Complexity :

Difficulty Level : Difficult

- Q. 37 Which one of the following events is not known to be associated with MAP kinase (e.g. ERK) signaling?
- Cytoplasm to nucleus translocation.
  - Dephosphorylation by phosphatases.
  - Phosphorylation of downstream targets.
  - Phosphorylation of upstream receptors.

**Correct Answer: B**

The mitogen-activated protein kinases (MAPKs) have been shown to participate in a wide array of cellular functions. A role for some MAPKs (e.g., extracellular signal-regulated kinase, Erk 1/2) has been documented in response to certain physiological stimuli, such as ischemia, visceral pain and electroconvulsive shock. The effects of a different stressor, acute forced swim stress, on the phosphorylation (P) state of these MAPKs in the hippocampus, neocortex, prefrontal cortex, amygdala and striatum. In addition, effects on the phosphorylation state of the upstream activators of the MAPKs, their respective MAPK kinases (MAPKKs; PMEK1/2, P-MKK4 and P-MKK3/6), were determined. Finally, because the Erk pathway can activate c-AMP response element (CRE) binding (CREB) protein and swim stress has recently been reported to enhance CREB phosphorylation, changes in P-CREB were also examined.

Core Concept :

Topic Name :

Complexity :

Difficulty Level : Difficult

- Q. 38 How do influenza virus enters the host cell?
- By cell fusion
  - By endocytosis
  - By exocytosis
  - By phagocytosis

**Correct Answer: B**

Influenza virus has been described to enter host cells via clathrin-mediated endocytosis. However, it has also been suggested that other endocytic routes may provide additional entry pathways. Thus receptor-mediated endocytosis is known to play an important role in the entry of many viruses into host cells.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**

Q. 39 Choose the correct statement from the following for the endoplasmic reticulum ( ER ).

- a. The SER is the site for the synthesis, modifications and sorting of proteins.
- b. The RER is the site for lipid and protein biosynthesis.
- c. The RER is the site for the modifications and sorting of proteins.
- d. All of the above are true statements

**Correct Answer: C**

Ribosomes are associated with the ER membrane, and while a protein is being translated it is inserted into the ER membrane. When translation is complete, the newly synthesized protein will remain in the ER membrane if it is a membrane protein, or it will be released into the lumen of the ER if it is a secretory or soluble protein. Commonly, proteins synthesized in the rough ER are glycosylated (have short polysaccharides covalently attached). That is, enzymes in the ER add core oligosaccharides (a short-chain polysaccharide with between 4 and 20 monosaccharides) to the nascent polypeptide. Finally, if a protein is multimeric (consisting of two or more polypeptides), the subunits are assembled in the ER. Once a protein has been folded and modified in the ER, it is transported to the Golgi complex for further modification and sorting to the correct subcellular location.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**

Q. 40 Select an incorrect statement from the following.

- a. The SRP system **translocates** folded proteins into the ER .
- b. Post-translational translocation of unfolded proteins into the inner mitochondrial space requires a bipartite signal sequence.
- c. Nuclear export involves the movement of folded proteins through the nuclear pore complex.
- d. All of the above are correct statements

**Correct Answer: A**

Correct targeting requires recognition of the protein-coded signal by a specific cytoplasmic receptor. One example is the co-translational transport of proteins across the ER membrane. Briefly, the signal sequence is recognized by its cytoplasmic receptor, the signal recognition particle or SRP, which also binds to the ribosome. The SRP- ribosome-nascent chain complex is then transported to the translocation sites in the ER . Here the interaction between SRP and its membrane-bound receptor triggers release of the signal sequence, which is then recognized by its membrane receptor, a step which is essential for the following transport across the membrane.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**

Q. 41 In eukaryotic cells \_\_\_\_\_ is/ are not part of the cytoskeleton.

- a. microfilaments and microtubules
- b. mitochondria
- c. intermediate filaments
- d. microtubules

**Correct Answer: B**

The cytoskeleton is unique to eukaryotic cells. It is a dynamic three-dimensional structure that fills the cytoplasm. This structure acts as both muscle and skeleton, for movement and stability. The long fibers of the cytoskeleton are polymers of subunits. The primary types of fibers comprising the cytoskeleton are microfilaments, microtubules and intermediate filaments but not the cellular organelle like mitochondria.

Core Concept :

Topic Name :

Complexity :

Difficulty Level : Difficult

- Q. 42 The property that is common to all cytoskeletal motor proteins (such as kinesins, dynein's and myosins) is
- an actin-binding domain two
  - two globular-head domains
  - ATPase activity
  - an actin and myosin binding domain

**Correct Answer: C**

The motor proteins in the myosin and kinesin super families exhibit a remarkable diversity of motile properties, well beyond their choice of different polymer tracks. Most strikingly, a single dimer of conventional kinesin moves in a highly processive fashion, traveling for hundreds of ATPase cycles along a microtubule without dissociating.

Core Concept :

Topic Name :

Complexity :

Difficulty Level : Difficult

- Q. 43 The cell walls of plants contain \_\_\_\_\_
- glycosaminoglycan
  - pectin
  - glycans
  - peptidoglycan and fibrinogen

**Correct Answer: B**

The plant cell wall is composed of polysaccharides and proteins. In addition, some cells have walls impregnated with lignin. In all cases, the polysaccharides constitute the major part of the wall.

The wall polysaccharides are often classified into cellulose, hemicelluloses and pectin. These three types are represented in almost all cell walls in varying proportions.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**

Q. 44 \_\_\_\_\_ is/are cell adhesion molecule(s).

- a. Integrin
- b. Keratin
- c. Both A and B
- d. Fibrinogen

**Correct Answer: A**

Integrins are cell-surface receptors that mediate adhesion to the extracellular matrix (ECM) and cell-cell interactions. Most cells express several integrins that recognize a range of cell surface and ECM associated ligands. Individual integrins often bind more than one ligand. They play multiple roles in differentiation and cell communication.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**

Q. 45 In plasmodesmata

- a. ionic coupling occurs.
- b. two plasma membranes are fused.
- c. two adjacent plasma membranes are fused.
- d. Both A and C

**Correct Answer: C**

The cell wall has a limited number of pores through which the plasma membranes of two adjacent cells fuse to form channels called plasmodesmata. The plasmodesmata serve as intercellular routes for transport of cellular materials.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**

Q. 46 Choose an incorrect statement for chloroplast.

- a. It contains DNA as their genetic material.
- b. It contains a transcription apparatus.
- c. It has electron transport chain.
- d. It contains a transcription apparatus but no translational apparatus.

**Correct Answer: D**

Chloroplast transcripts from genes involved in transcription reached peak levels first, followed by transcripts from genes involved in translation and finally photosynthesis gene transcripts.

**Core Concept :**

**Topic Name :**

**Complexity :**

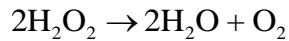
**Difficulty Level : Difficult**

Q. 47 The reaction,  $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$  is catalyzed by \_\_\_\_\_.

- a. oxidase
- b. peroxidase
- c. catalase
- d. None of the above

**Correct Answer: C**

Catalases perform their rapid destruction of hydrogen peroxide in two steps. Firstly, they bind onto a hydrogen peroxide molecule to break it apart into water and oxygen, with the latter being put together with an iron atom. A second hydrogen peroxide molecule then binds onto the catalase, where it is also broken apart into pieces which combine with the iron-bound oxygen atom to release more water and oxygen gas. Catalase disproportionate:



$\text{H}_2\text{O}_2$  is a destructive waste product that is produced in the human body when peroxides partial oxidase fatty acids. Other enzymes, such as plasma amine oxidase and xanthine oxidase, also produce hydrogen peroxide as part of their normal catalytic cycle.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**

Q. 48 The nucleosomes \_\_\_\_\_.

- a. contain about 350 base pairs of wrapped DNA
- b. contain a core of histone proteins
- c. contain a core of histone and non-histone proteins
- d. All of the above

**Correct Answer: B**

Five major families of histones exist: H1/H5, H2A, H2B, H3 and H4. Histones H2A, H2B, H3 and H4 are known as the core histones, while histones H1 and H5 are known as the linker histones. Two of each of the core histones assemble to form one octameric nucleosome core, approximately 63Å in diameter (a solenoid (DNA)-like particle).

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**

Q. 94 Which of the following two organelle's membranes are contiguous?

- a. ER and Golgi
- b. Nucleus and ER
- c. Golgi and Plasma membrane
- d. Golgi and Lysosomes

**Correct Answer: B**

The inner nuclear membrane is lined by the fibrous protein network of the nuclear lamina. The outer nuclear membrane is contiguous with the membrane of the endoplasmic reticulum ( ER ).

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**

Q. 50 It is expected that a cell with an extensive Golgi apparatus to \_\_\_\_\_.

- a. synthesize large amount of ATP
- b. secrete large amount of proteins
- c. secrete large amount of steroids
- d. synthesize more phospholipids

**Correct Answer: B**

The golgi apparatus receives proteins and lipids (fats) from the rough endoplasmic reticulum. It modifies some of them and sorts, concentrates and packs them into sealed droplets called vesicles. Depending on the contents these are dispatched to one of three destinations:

Destination 1: within the cell, to organelles called lysosomes.

Destination 2: the plasma membrane of the cell.

Destination 3: outside of the cell.

**Core Concept :**

**Topic Name :**

**Complexity :**

**Difficulty Level : Difficult**



Q. 51 What is/are the major function(s) of the golgi apparatus in eukaryotic cells?

- a. To carry out glycosylation of the proteins being transported.
- b. To act as the major protein sorting center of the cell.
- c. To form secretory vesicles in its *trans* compartment.
- d. All of the above.

**Correct Answer: D**

The Golgi apparatus is an organelle containing a double membrane and it is mainly devoted to the processing of proteins synthesized in the ER. The three primary functions of the golgi apparatus are the transport sorting and modification of both proteins and lipids. Role of the golgi apparatus is to package material for export, but its exact function varies depending upon the organism. For example, *Giardia* and *Entamoeba* utilize Golgi apparatus to form cell walls during cyst formation. It often participates in the synthesis of cell membranes and the final processing of proteins before export. The type of glycosylation that takes place is dependent upon signals contained within the protein sequence. Golgi also processes enzymes using proteases, which clip at specific amino acids sequences to form mature proteins and hormones. These mature proteins then move to their final destinations, which may be in the membrane, in lysosomes or secreted into the environment.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level: Medium**

Q. 52 Which of the following is the source of free energy ( $\Delta G$ ) for moving protons out of mitochondria against their concentration and electrical gradients?

- a. Glycolysis
- b. Calvin cycle
- c. the redox reactions of electron transport

d. Kreb's cycle

**Correct Answer: C**

The mitochondrion maximizes the production of ATP by transferring electrons from NADH and FADH<sub>2</sub> through a series of electron carriers. This step-by-step transfer of electrons via the electron transport chain (also known as the respiratory chain) allows the free energy in NADH and FADH<sub>2</sub> to be released in small increments. At several sites during electron transport from NADH to O<sub>2</sub>, protons from the mitochondrial matrix are transported uphill across the inner mitochondrial membrane and a proton concentration gradient forms across it. Thus free energy released during the oxidation of NADH or FADH<sub>2</sub> is stored both as an electric potential and a proton concentration gradient-collectively, the proton-motive force-across the inner membrane.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level: Medium**

Q. 53 The cellular organelle that is associated with photosynthesis is

a. golgi

b. mitochondria

c. endoplasmic reticulum

d. chloroplast

**Correct Answer: D**

Chloroplasts are the food producers of the cell. The organelles are only found in plant cells and some protists such as algae. Animal cells do not have chloroplasts. Chloroplasts work to convert light energy of the Sun into sugars that can be used by cells. The entire process is called photosynthesis and it all depends on the little green chlorophyll molecules in each chloroplast.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level: Medium**

Q. 54 Cellular metabolism is an example of \_\_\_\_\_.

- a. equilibrium metabolism
- b. steady-state metabolism
- c. a series of reactions
- d. None of the above

**Correct Answer: B**

The presence of cytosolic and plastidic pathways of carbohydrate oxidation is a characteristic feature of plant cell metabolism. The emergence of steady-state metabolic flux analysis (MFA) as a practicable systems biology tool for generating flux maps of the central metabolic pathways in plants offers new opportunities for analysing plant metabolic phenotypes. In this approach, substrates labeled with stable isotopes are introduced into the network and fluxes are determined by measuring the labelling of the system after it has reached an isotopic and metabolic steady state.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level: Medium**

Q.55 Which one of the following experimental results does not support Mitchell's chemiosmosis theory?

- a. Electron transport in isolated mitochondria was shown to result in acidification of the medium.
- b. Addition of dinitrophenol to isolated mitochondria was shown to inhibit electron transport, but had no effect on ATP synthesis.
- c. Addition of dinitrophenol to isolated mitochondria during electron transport was shown to inhibit acidification of the medium.
- d. Both A and B

**Correct Answer: B**

Some electrons, like those from succinate, pass from the coenzyme of succinate dehydrogenase (*i.e.*, FAD) directly to Q (ubiquinone). When this happens, only two ATPs are formed per pair

of electrons transferred. A number of chemical agents uncouple oxidative phosphorylation from the electron transport system (*e.g.*, 2,4- dinitrophenol, dicumarol and the salicylanilides). The addition of these compounds has two interesting effects. First, they speed up electron transport and oxygen consumption even in the absence of ADP , but there is no synthesis of ATP . In other words, phosphorylation is uncoupled and so is energy transfer. Second, in the presence of the uncoupling agent, the hydrolysis of ATP may occur the opposite of the normal goals of mitochondrial activity.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level: Medium**

Q. 56 Both plant and animal cell possess \_\_\_\_\_.

- a. cell walls
- b. mitochondria
- c. central vacuoles
- d. All of the above

**Correct Answer: B**

Structurally, plant and animal cells are very similar because they are both eukaryotic cells. They both contain membrane-bound organelles such as the nucleus, mitochondria, endoplasmic reticulum, golgi apparatus, lysosomes and peroxisomes. Both also contain similar membrane, cytosol and cytoskeletal elements.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level: Medium**

Q. 57 Molecule/s that serves as a carrier of fatty acids in mitochondria is/are

- a. Acetyl-CoA and Palmitate
- b. Carnitine

c. Dolichol and Carnitine

d. Malonyl-CoA

**Correct Answer: B**

While short-chain fatty acids can move across the mitochondrial membrane directly and are then activated in the mitochondrial matrix, the inner mitochondrial membrane is impermeable to longer fatty acids, such as palmitate. A small molecule, carnitine, serves as a carrier across the mitochondrial membrane. This pathway requires no chemical energy supply; rather, the fact that the fatty acid in the mitochondrial matrix is being broken down by oxidation drives the process.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level: Medium**

Q. 58 If the triacylglycerol ester bonds of molecules are broken then what kind of molecule is formed which would be soluble in water?

a. Fatty acid side chains

b. Phospholipids

c. Glycogen

d. Glycerol and glycogen

**Correct Answer: D**

The exception to the monomer/polymer rule is lipids. Lipid base units are not considered monomers. One type of lipid or fat is made up of fatty acids and glycerol molecules in 3:1 ratio. The bonding of three fatty acids to one glycerol molecule creates a triglyceride. Monomers or base units are bonded together to create larger molecules via dehydration. This involves the removal of a water molecule at the bonding site. The larger molecule can be broken down by the reverse process, hydrolysis. This occurs when water is added to break the covalent bonds created during dehydration.

**Core Concept:**

**Topic:**

**Complexity:**

Difficulty level: Medium

Q. 59 The inner mitochondrial membrane composition is similar to that of

- a. the inter-mitochondrial space.
- b. the cell's plasma membrane.
- c. the bacterial cellular membrane.
- d. the nuclear membrane.

**Correct Answer: D**

The double membrane found in mitochondria and chloroplasts appears to be a relic of absorption of the prokaryotic bacteria by the eukaryotic host cells. The inner membrane is of a different chemical composition (like that of eubacteria) than the outer membrane of the organelle. Some enzymes and inner membrane systems resemble prokaryotic inner membrane systems. The outer membrane is of similar composition to the plasma membrane of the eukaryote, as is the membrane of other cellular organelles such as the nuclear membrane, endoplasmic reticulum and Golgi apparatus of eukaryotes (in support of the invagination hypothesis of their origin).

Core Concept:

Topic:

Complexity:

Difficulty level: Medium

Q. 60 In order to demonstrate the protein translocating ability, complex III was incorporated into an artificial lipid vesicle which would be an appropriate electron donor in the case?

- a. Cytochrome c oxidase
- b. Fe-S complex
- c. Ubiquinol (UQH<sub>2</sub>)
- d. Cytochrome a<sub>3</sub>

**Correct Answer: C**

Cytochrome b<sub>0</sub>3 ubiquinol oxidase (cyt-b<sub>0</sub>3) is the homolog counter part of Cytochrome c oxidase in bacterial system. Respiratory oxidases have been the object of intensive studies

during the past years. Series of reactions takes place through electron transport chain complexes to contribute ATP synthesis where membranes play a crucial role in this mechanism to maintain the proton concentration gradient via creating closed and connected architecture. It is not only important to maintain the proton gradient but also to maintain the structural and functional integrity of the proteins. UQ is a small, hydrophobic, two-electron and two-proton carrier present in the lipid bilayer. UQ is able to act between two-electron donor and one-electron acceptor system. UQ is a small, hydrophobic, two-electron and two-proton carrier present in the lipid bilayer. UQ is able to act between two-electron donor and one-electron acceptor system.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level: Medium**

Q. 61 Which among the following is an incorrect statement about the outer mitochondrial membrane?

- a. The outer membrane is impermeable to hydrogen ions.
- b. The outer membrane is highly permeable to substances of small molecular weight.
- c. The outer membrane is about 50% lipid and 50% protein by weight.
- d. Both A and C

**Correct Answer: A**

The outer membrane contains a large number of proteins that form pores or channels through the membrane allowing small molecules to pass freely between the intermembrane space and the cytoplasm. These pores make the outer membrane permeable to most ions and small molecules; therefore, the intermembrane space has the same ionic composition as the cytoplasm surrounding the mitochondrion.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level: Medium**

Q. 62 In certain plants, specialized type of peroxisome and the site of glyoxylate pathway is called as \_\_\_\_\_.

- a. glyperoxisome
- b. lysosome
- c. glyoxysome
- d. None of the above

**Correct Answer: C**

A specialized form of peroxisome, that contains the enzymes of the glyoxylate pathway. The glyoxysome is found in some plant cells, notably the cells of germinating seeds.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level: Medium**

Q. 63 Which among the following observations is not used as evidence to support the concept of endosymbiotic origin of chloroplasts and mitochondria?

- a. Chloroplasts and mitochondria both have their own DNA.
- b. Chloroplasts and mitochondria both have their own ribosomes.
- c. Chloroplasts and mitochondria both strongly resemble prokaryotes.
- d. Chloroplasts and mitochondria both can live and function independently of the cell.

**Correct Answer: D**

When one organism actually lives inside the other it's called endosymbiosis. The endosymbiotic theory describes how a large host cell and ingested bacteria could easily become dependent on one another for survival, resulting in a permanent relationship. Over millions of years of evolution, mitochondria and chloroplasts have become more specialized and today they cannot live outside the cell.

**Core Concept:**

**Topic:**

**Complexity:**



Difficulty level: Medium

Q. 64 The fluid matrix of a cell is

- a. nucleus
- b. cytosol
- c. Both A and B
- d. None of the above

**Correct Answer: B**

The cytosol or intracellular fluid is the liquid found inside cells. It is the liquid of a cell, that is parted from other parts of the cell by cell walls, such as the mitochondrial matrix inside the mitochondrion. The entire contents of a eukaryotic cell within cell membrane, minus the contents of the cell nucleus, are referred to as the cytoplasm.

Core Concept:

Topic:

Complexity:

Difficulty level: Medium

Q. 65 Choose the correct statement (s).

P. Due to the pKa of imidazole group, histidine acts as a buffer at pH 6.

Q. The molecular mass of polypeptide with 23 amino acid residues is 44,000 Da approximately.

R. 20L amino acids can give 400 different dipeptides.

S. Ninhydrin is a strong oxidizing agent.

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

**Correct Answer: D**

Histidine acts as a buffer because of presence of imidazole group. It has a pK value of 6.0 which is close to the physiological pH. A signal peptide 22 amino acids would result in an N-terminal glutamine. Which of cyclized to pyroglutamate, would account for our inability to determine the N-terminal amino acid of the secreted protein. This would result in a protein with a molecular weight of 43,943 which is in close accord with the reported 44,000 Da molecular weight of the secreted protein. The amino acids composition calculates the relative frequency of occurrence for each of the 20 amino acids in a protein sequence. Similar to the amino acid composition, the dipeptide composition calculates the relative frequency of occurrence of each of the 400 possible dipeptides in a protein sequence. Ninhydrin is a strong oxidizing agent and causes the oxidative deamination of the amino function. The products of the reaction are the resulting aldehyde, ammonia, carbon dioxide and hybrindantin, a reduced derivative of ninhydrin.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level: Medium**

Q. 66 C-terminal peptide sequence with four amino acids, Lys-Asp-Glu-Leu (KDEL) directs proteins to

- a. endoplasmic reticulum
- b. mitochondria
- c. nucleus
- d. peroxisomes

**Correct Answer: A**

Proteins such as chaperones and protein disulphide isomerase that function in the endoplasmic reticulum (ER) may not be initially retained there, after synthesis. They are moved to the Golgi and then returned to the ER in transport vesicles. The 'return address label' that distinguishes these proteins is a C-terminal peptide sequence of four amino acids, Lys-Asp-Glu-Leu (KDEL in the single-letter abbreviation system for amino acids), which is recognized by specific receptors in the Golgi membrane.

**Core Concept:**

**Topic:**

**Complexity:**

Difficulty level: Medium

Q. 67 Proteins that cross the mitochondrial membranes are

- a. bound to an importin protein via a signal sequence.
- b. present in fully folded form.
- c. present in unfolded extended form attached to Hsp 70 chaperones.
- d. present in unfolded extended form without chaperones.

**Correct Answer: D**

Mitochondrial proteins are not folded when they are synthesized in the cytosol instead they are attached to Hsp 70 chaperone proteins which hold them in extended form for delivery to the mitochondria. On reaching a mitochondrion the protein binds to an outer membrane translocase (TOM) protein. This binding is helped by Hsp 70, but as the protein translocates across the membrane the chaperones are removed and do not enter the mitochondrion.

Core Concept:

Topic:

Complexity:

Difficulty level: Medium

Q. 68 How do proteins enter peroxisomes?

- a. Folded, using a C- terminal or internal signal sequence.
- b. Folded, using an N- terminal or internal signal sequence.
- c. Unfolded, using a C- terminal or internal signal sequence.
- d. Unfolded, using an N- terminal or internal signal sequence.

**Correct Answer: A**

Peroxisomal proteins are fully folded in the cytoplasm and enter the organelle in folded form. The most common signal sequence which directs proteins to peroxisomes is a C- terminal Ser-Lys-Leu tripeptide but less commonly a nonapeptide (nine amino acid residues), located internally near the N- terminus can also be used as an 'address' directing proteins to peroxisomes.

Core Concept:

Topic:

Complexity:

Difficulty level: Medium

Q. 69 Choose the covalent bond types from the following that are found in the structure of ATP .

- a. Ester, N- glycosidic, Phosphoanhydride, Thioester, Phosphodiester.
- b. Phosphoanhydride, Phosphomonoester, N- glycosidic.
- c. Ester, Ether, Phosphoanhydride, Hydrogen bond.
- d. Ether, Thioester. Phosphomonoester, Phosphodiester

**Correct Answer: B**

Nucleotides represent energy rich compounds that drive metabolic process, especially biosynthetic, in all cells. Hydrolysis of nucleoside triphosphate provides the chemical energy to drive a wide variety of cellular reactions. ATP is the most widely used for this purpose. The useful free energy in an ATP molecule is contained in phosphoanhydride bonds, which are formed from the condensation of two molecules of phosphate by the loss of water. RNA 2',3' cyclic phosphate ends play important roles in RNA metabolism, especially as intermediates in tRNA splicing and repair. There are two enzymatic routes to generate RNA 2',3' cyclic phosphate termini. The first is via transesterification, wherein an internal ribose 2'-OH attacks the adjacent 3'-5' phosphodiester and expels a 5'-OH terminated RNA leaving strand. The second pathway entails *de novo* cyclization of RNA 3'- phosphomonoester in a three-step reaction that consumes ATP . A "nucleoside" results from the linking of one of these 2 sugars with one of the purine or pyrimidine-derived bases through an N- glycosidic linkage. The chemical bond linking them in an " N- glycosidic bond".

Core Concept:

Topic:

Complexity:

Difficulty level: Medium

Q. 70 Nuclear Localization Signals are rich in

- a. acidic amino acid residues and are located at the C- terminus of the protein.
- b. basic amino acid residues and are located at the C- terminus of the protein.
- c. acidic amino acid residues and may be located anywhere in the protein sequence.
- d. basic amino acid residues and may be located anywhere in the protein sequence.

**Correct Answer: D**

Large (> 40,000 Daltons). nuclear-localized proteins need a nuclear localization signal (NLS). Many nuclear proteins contain NLSs that are rich in basic arginine and lysine residues, which may be located anywhere in the polypeptide chain.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level: Medium**

Q. 71 The proteins that are inserted into the inner mitochondrial membrane originate in the

- a. cytosol using outer and inner membrane translocases (TOMs and TIMs) and in the matrix using TIMs
- b. cytosol, using outer membrane translocases (TOMs) and inner membrane translocases (TIMs).
- c. matrix using inner membrane translocases (TIMs).
- d. Both A and B

**Correct Answer: A**

Most mitochondrial proteins are synthesized in the cytosol and are transferred into the mitochondrion using membrane translocases. Proteins destined for the inner membrane are inserted in three slightly different ways, but all involve the use of outer and inner membrane translocases (TOMs and TIMs). However, the mitochondrion has its own DNA and protein synthesis apparatus. In humans, the mitochondrial DNA codes for just thirteen separate

peptides, but all these are subunits of inner membrane proteins. These are synthesized in the matrix and inserted into the inner membrane using TIMs.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Difficult

Q. 72 Signal pathways activate transcription factors, so that they are transported into the nucleus, by the

- a. detachment of the transcription factor from a complexing protein that will unmask a nuclear localisation signal.
- b. phosphorylation of the transcription factor that will increase its importin binding affinity.
- c. dephosphorylation of the transcription factor that will increase its importin binding affinity.
- d. All of the above

**Correct Answer: D**

Many signal mechanisms work by stimulating transcription factors present in the cytosol to move into the nucleus where they cause transcription of specific genes. There are several ways in which this can be achieved. Some signal molecules bind to the transcription factor causing it to be released from binding to another cytosolic protein and uncovering a nuclear localisation signal. Other transcription factors can be phosphorylated, increasing the affinity of their nuclear localization signal for binding to importin. Yet others can achieve the same increase in binding affinity by having phosphate groups removed by protein phosphatases. However, the change always involves the transcription factor itself. The import in carrier molecule is not activated.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Difficult

Q. 73 Which of the following is a correct pair of amino-acid sequence and the corresponding target organelle?

- a. KDEL – peroxisomes
- b. K-K/R-X-K/R – Lysosomes
- c. SKL – Peroxisome
- d. NPVY – Mitochondria

**Correct Answer: C**

The carboxyl-terminal amino acid sequence serine-lysine-leucine (SKL) is the consensus peroxisomal targeting sequence 1 (PTS 1) and is sufficient to direct a polypeptide to peroxisomes *in vivo* in plants, animals and yeasts.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Difficult

Q. 74 What is the term used for the basic microtubular structure of cilia and flagella?

- a. Axial spoke
- b. Radial spoke
- c. Axoneme
- d. All of the above

**Correct Answer: C**

Virtually all eukaryotic cilia and flagella are remarkably similar in their organization, possessing a central bundle of microtubules, called the axoneme, in which nine outer doublet microtubules surround a central pair of singlet microtubules. This characteristic "9+2" arrangement of microtubules is seen when the axoneme is viewed in cross section with the electron microscope.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Difficult

Q. 75 The intracellular protein synthesis occurs in \_\_\_\_\_.

- I. rough ER
  - II. endoplasmic reticulum
  - III. polysomes
  - IV. microsomes
- a. I, II
  - b. I, III
  - c. I, IV
  - d. III, IV

**Correct Answer: B**

Proteins that become part of the endomembrane system, the plasma membrane or that are secreted out of the cell are synthesized on the rough ER. Ribosomes are associated with the ER membrane and while a protein is being translated it is inserted into the ER membrane. When translation is complete, the newly synthesized protein will remain in the ER membrane if it is a membrane protein or it will be released into the lumen of the ER if it is a secretory or soluble protein. It is engaged in protein secretion, such as the liver, in which the synthesis of albumin, a serum protein, has been reported to occur on membrane-bound ribosomes, whereas the synthesis of ferritin, an intracellular iron storage protein, occurs on free polysomes.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Difficult

Q. 76 Which one of the following statements correctly applies to proteins which are translated on a rough endoplasmic reticulum?



- a. Cytoplasmic proteins which are targeted to the nucleus in response to hormone stimuli.
- b. Proteins targeted to lysosomes, plasma membrane and cell exterior.
- c. Proteins which are targeted to the nucleus through endoplasmic reticulum lumen as the lumen is in direct connection with the inner membrane space of the nucleus.
- d. All proteins which get targeted peroxisomes.

**Correct Answer: C**

Proteins for plasma membrane, lysosome and cell exterior are synthesized by RER. After that it is transported in vesicles. Proteins that are destined for the ER, the Golgi apparatus, lysosomes, the plasma membrane and secretion from the cell, are synthesized on ribosomes which are bound to the membrane of ER. On the other hand, proteins synthesized on free ribosomes either remain in the cytosol or are transported to the nucleus, mitochondria, chloroplasts, or peroxisomes.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Difficult

Q. 77 How the acidic pH in the lysosome is maintained?

- a. By the GTP-dependent proton pump in the lumen.
- b. By the ATP-dependent proton pump on the membrane.
- c. By HCl in lysosome.
- d. All of these

**Correct Answer: B**

It is universally recognized that lysosomes, the intracellular digestive organelles, show an internal pH approximately 2 units below that of their environment. This not only provides favourable conditions for the activity of lysosomal enzymes, which have acidic pH optima, but also assists directly in the digestive process by denaturing ingested proteins to make them more susceptible to enzymatic proteolysis. The transmembrane pH gradient in these organelles is generated and maintained by an ATP-dependent proton pump residing in the organelle membrane.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Difficult

Q. 78 Ribosomes are present in \_\_\_\_\_.

- a. higher forms
- b. bacteria
- c. Both A and B
- d. None of the above

**Correct Answer: C**

Ribosomes are found in prokaryotic and eukaryotic cells; in mitochondria, chloroplasts and bacteria. Those found in prokaryotes are generally smaller than those in eukaryotes. Ribosomes in mitochondria and chloroplasts are similar in size to those in bacteria. There are about 10 billion protein molecules in a mammalian cell and ribosomes produce most of them. A rapidly growing mammalian cell can contain about 10 million ribosomes.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Difficult

Q. 79 In mitochondria, elongation of medium chain fatty acids occurs that mostly

- a. requires acetyl CoA .
- b. requires malonyl CoA .
- c. requires malonyl CoA and acetyl CoA .
- d. requires malonyl CoA , palmitate and acetyl CoA .

**Correct Answer: B**

The pathway for fatty acid synthesis occurs in the cytoplasm, whereas, oxidation occurs in the mitochondria. Oxidation of fats involves the reduction of  $\text{FADH}^+$  and  $\text{NAD}^+$  . Synthesis of fats

involves the oxidation of NADPH. However, the essential chemistry of the two processes are reversals of each other. Both oxidation and synthesis of fats utilize an activated two carbon intermediate, acetyl- CoA . However, the acetyl- CoA in fat synthesis exists temporarily bound to the enzyme complex as malonyl- CoA . The synthesis of malonyl- CoA is the first committed step of fatty acid synthesis and the enzyme that catalyzes this reaction, acetyl- CoA carboxylase (ACC), is the major site of regulation of fatty acid synthesis.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Difficult

Q. 80 Only in \_\_\_\_\_, golgi apparatus is present.

- a. higher forms
- b. bacteria
- c. Both A and B
- d. all living organisms

**Correct Answer: A**

Golgi apparatus is present in eukaryotic cells as one or more groups of flattened, membrane-bounded compartments or sacs. They are located very near the rough endoplasmic reticulum and hence near the nucleus.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Difficult

Q. 81 The disease that is not associated with lysosomal malfunctioning is

- a. Tay-Sachs disease
- b. I-cell disease
- c. Pompe's disease

d. Marfan syndrome

**Correct Answer: D**

Marfan syndrome is a genetic disorder that affects the body's connective tissue. Connective tissue holds all the body's cells, organs and tissue together. It also plays an important role in helping the body grow and develop properly. Marfan syndrome is caused by a defect (or mutation) in the gene that tells the body how to make fibrillin -1. This mutation results in an increase in a protein called transforming growth factor  $\beta$  or TGF- $\beta$ .

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Difficult

Q. 82 Where do the enzymes of electron transport and energy conversion are located?

- a. Outer membrane of mitochondria
- b. Inner membrane of mitochondria
- c. Intermitochondrial space
- d. Mitochondrial matrix

**Correct Answer: B**

Mitochondria occupy a substantial portion of the cytoplasmic volume of eukaryotic cells and they have been essential for the evolution of complex animals. The inner membrane is highly specialized. Its lipid bilayer contains a high proportion of the "double" phospholipid cardiolipin, which has four fatty acids rather than two and may help to make the membrane especially impermeable to ions. This membrane also contains a variety of transport proteins that make it selectively permeable to those small molecules that are metabolized or required by the many mitochondrial enzymes concentrated in the matrix. The matrix enzymes include those that metabolize pyruvate and fatty acids to produce acetyl CoA and those that oxidize acetyl CoA in the citric acid cycle. The principal end-products of this oxidation are  $\text{CO}_2$ , which is released from the cell as waste and NADH, which is the main source of electrons for transport along the respiratory chain-the name given to the electron-transport chain in mitochondria. The enzymes of the respiratory chain are embedded in the inner mitochondrial membrane and they

are essential to the process of oxidative phosphorylation, which generates most of the animal's ATP.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Medium

Q. 83 Plant cells differ from animal cells with respect to

I. Cell membrane

II. Cell wall

III. Golgi bodies

IV. Mitochondria

V. Chloroplast

VI. Endoplasmic reticulum

VII. Large vacuoles

a. I, III, VI

b. II, V, VII

c. I, II, V

d. II, III, VI

**Correct Answer: B**

Plant cells can be larger than animal cells. The normal range for an animal cell varies from 10 to 30 micrometers while that for a plant cell stretches from 10 to 100 micrometers. Beyond size, the main structural differences between plant and animal cells lie in a few additional structures found in plant cells. These structures include: chloroplasts, the cell wall and vacuoles.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Medium

Q. 84 Choose an incorrect statement about the lysosomes.

- a. Lysosome is a unit membrane bound vesicles.
- b. Lysosome contain a complement of hydrolytic enzymes.
- c. Lysosomes are called cellular house-keepers.
- d. Lysosome are involved in burning fuel of molecules such as carbohydrates.

**Correct Answer: D**

Food is the fuel for the body. The mitochondria are the converters; they convert the fuel into useable energy. When food is digested or broken down into its smallest molecules and nutrients and air is taken in or inspired, the smallest molecules and nutrients cross into the bloodstream. These molecules and nutrients include things such as glucose (a sugar molecule derived from carbohydrates) and oxygen.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Medium

Q. 85 Which of the following is facilitated by plasmodesmata?

- a. Free exchange of substances between cells.
- b. Protein modifications.
- c. Exchange of material between different parts of cell.
- d. None of the above

**Correct Answer: A**

Plasmodesmata are numerous channels that pass between cell walls of adjacent plant cells and connect their cytoplasm; thereby, enabling materials to be transported from cell to cell, and thus throughout the plant.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Medium

Q. 86 Where does an intracellular protein synthesis occur?

- a. Rough ER , polysome
- b. Endoplasmic reticulum, Microsomes
- c. Golgi apparatus, Rough ER
- d. Endoplasmic reticulum, Golgi apparatus

**Correct Answer: A**

Translating ribosomes in eukaryotes are located in different places in the cell depending on the fate of their proteins. Free polysomes are in the cytoplasm and synthesize cytoplasmic proteins and those that are bound for most intracellular organelles, for example, the nucleus. Members of the second class of polysomes, membrane-bound polysomes, are attached to the endoplasmic reticulum (forming the rough ER ) and synthesize exported proteins. In cells that are actively secreting enzymes or hormones (for example, those in the pancreas), most of the protein synthesis occurs on the rough ER .

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Medium

Q. 87 In the process of protein targeting, lysosomal proteins are tagged with

- a. glucose –6– phosphate
- b. KDEL sequence
- c. mannose –6– phosphate
- d. phospholipids

**Correct Answer: C**

Protein tagged for lysosomes are tagged with mannose –6– P in the *cis* cisterene. A vesicle destined for the lysosome is assembled in the following way: Proteins to be sent to the lysosome have phosphorylated mannose attached to them. This is recognized by the mannose phosphate receptor in the membrane of the *trans*-Golgi network. The receptor is a protein that spans the membrane, one part being inside the lumen of the Golgi, where it binds the lysosomal protein and the other end in the cytosol.

Core Concept:

Topic:

Complexity:

Difficulty level: Medium



Q. 88 Why do glycolipids exist almost exclusively on the exterior side, but not the cytoplasmic side, of the cell membrane?

- a. The membrane inner layer is not thick enough to accommodate carbohydrates and lipids.
- b. Carbohydrates are added only to lipids on the lumen side of the ER and Golgi membranes.
- c. Flippases move the glycolipids to this side of the membrane.
- d. The removal of carbohydrates from the cytoplasmic side are done by glycosylase enzymes.

**Correct Answer: B**

Sphingomyelin is synthesized on the luminal surface of the Golgi, but glucose is added to ceramide on the cytosolic side. Glucosylceramide then apparently flips, however and additional carbohydrates are added on the luminal side of the membrane. Neither sphingomyelin nor the glycolipids are then able to translocate across the Golgi membrane, so they are found only in the luminal half of the Golgi bilayer. Following vesicular transport, they are correspondingly localized to the exterior half of the plasma membrane, with their polar head groups exposed on the cell surface.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Medium

Q. 89 A characteristic domain that is found in eukaryotic proteins that enable them to enter the Endoplasmic reticulum is

- a. Signature sequence
- b. Signal sequence
- c. Sequence receptor
- d. Recognition sequence

**Correct Answer: B**

The signal sequence consists of the first portion of the elongating polypeptide chain (so the signal sequence occurs at the amino terminal of the polypeptide). Typical signal sequences contain 15–30 amino acids. The precise amino acid sequence varies surprisingly from one protein to the next, but all signal sequences include many hydrophobic amino acids. The signal recognition particle (SRP). The complex of ribosome with its nascent polypeptide and the SRP

binds to a receptor on the surface (facing the cytosol) of the ER . The SRP leaves and translation recommences. The growing polypeptide chain is extruded through a pore in the ER membrane and into the lumen of the ER .

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Medium

Q. 90 During the formation of the tertiary structure of some secretory proteins, multiple disulphide bonds are possible but only the correct secreted products are formed. This happens due to the fact that

- a. lysosomes degrade incorrectly folded.
- b. modifications are continued in endosomes.
- c. a protein facilitates the formation of correct disulphide bonds in the ER .
- d. only correctly folded proteins are translated in the ER .

**Correct Answer: C**

Several studies have shown that glycosylation and oligosaccharide trimming in the endoplasmic reticulum ( ER ) are required for proper folding and assembly of secretory protein. Without oligosaccharides, many glycoproteins misfold, aggregate and are degraded without transport from the ER to the Golgi complex and beyond. The formation of native disulfide bonds is an essential event in the folding and maturation of proteins entering the secretory pathway.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Medium

Q. 91 Which among the following statement is incorrect about the secreted proteins?

- a. Secreted proteins are all present in one type of vesicle.
- b. Secreted proteins are often synthesized as a precursor to undergo reaction.
- c. May be continuously phagocytosed.
- d. Both A and B

**Correct Answer: A**

Regulated exocytosis is a process in which the membranes of cytoplasmic organelles fuse with the plasma membrane in response to stimulation. In many cases (secretory exocytoses) the process functions to secrete specific products that are segregated in the organelle lumen (for example, neurotransmitters, hormones and enzymes) to the extracellular space.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Medium

Q. 92 Enzyme targeting to lysosomes involve which of the following steps?

- 1. Ligand dissociation from receptor.
  - 2. Binding to a mannose –6– phosphate receptor.
  - 3. pH decrease.
  - 4. Late endosome fusion.
  - 5. Phosphate addition to mannose.
- a. 2 and 4
  - b. 1, 2, 3 and 4
  - c. 2, 4 and 5
  - d. 1, 2, 3, 4 and 5

**Correct Answer: D**

Lysosomal enzymes are synthesized on membrane-bound ribosomes and translocated to the lumen of the endoplasmic reticulum, where N-linked oligosaccharide chains are added. After transfer to the Golgi apparatus, mannose 6-phosphate residues are added to acid hydrolases in a process that requires the sequential action of 2 enzymes. The first catalyzes the addition of an  $\alpha$ -N-acetylglucosamine 1-phosphate residue to the 6 position of mannoses on high-mannose oligosaccharide chains. The second enzyme removes N-acetylglucosamine to expose the mannose 6-phosphate. The receptor-lysosomal enzyme complex is transported from the *trans*-Golgi network to an acidified prelysosomal compartment where the low pH causes the complex to dissociate. In addition to the limiting membrane, lysosomes contain intralysosomal membranes, which represent the main site of membrane degradation within this organelle. The inner membranes are rich in the phospholipid bis(monoacylglycero)-phosphate (BMP), also known as lyso-bis-phosphatidic acid (LBPA), which is exclusively found in lysosomes and late endosomes.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Medium

Q. 93 Which of the following explain the common pathway of entry into the ER of secretory, lysosomal and plasma membrane proteins?

- a. Presence of a signal sequence that targets each type of protein to the ER during synthesis.
- b. Addition of a common sorting signal to each type of protein.
- c. Addition of oligosaccharides to the proteins.
- d. Both A and C

**Correct Answer: A**

Most of the proteins destined to cell organelles and those to be cytosol resident proteins are synthesized free from ER. The rest of the proteins, few thousands required for the nucleus and glyoxysomes or peroxisomes are coded for by nuclear genes. They are translated free from ER and translated products are transported to their destinations. Each of these organelles is bound by outer and inner membranes except peroxisomes, glyoxysomes and lysosomes which are enveloped by only one unit membrane. The said membranes are structurally and functionally distinct from one another. Majority of all cell organelle proteins contain 12 to 70 amino acid signal sequences one at their N-terminal and at the other at adjacent regions. They can use two signal sequences one for the transport into the matrix and the other to transport into periplasmic or internal membranes of the organelles.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Medium

Q. 94 The KDEL sequence, found on luminal proteins of the Endoplasmic Reticulum, is mainly responsible for

- a. translocation of proteins into lumen of ER .
- b. modification of proteins into the membrane of ER .
- c. recognition of the signal sequence.
- d. retrieval of ER luminal proteins from the golgi.

**Correct Answer: D**

KDEL is a target peptide sequence in the amino acid structure of a protein which keeps it from secreting from the endoplasmic reticulum ( ER ) and is responsible for retrieval of ER luminal proteins from the Golgi apparatus by retrograde transport. It also targets proteins from other locations (such as the cytoplasm) to the ER . Proteins can only leave the ER after this sequence has been cleaved off.

**Core Concept:**

**Topic:**

**Complexity:**

**Difficulty level:** Medium

Q. 95 Which among the following statements are true for steroid hormones?

- a. Steroid hormones increase the enzymatic activity of preexisting target enzyme.
- b. Steroid hormones act at cell nucleus.
- c. Steroid hormones decrease the molecular activity of pre-existing target enzyme.
- d. Both A and B

**Correct Answer: B**

Steroids exert a wide variety of effects mediate by show genomic as well as by rapid non-genomic mechanisms. They bind to nuclear receptors in the cell nucleus for genomic actions. Steroid hormone such as estradiol and progesterone have their receptors localized to a large extent in the target cell nucleus.

**Core Concept:**

Topic:

Difficulty Level:

Complexity: Medium

Q. 96. Choose the statements from the following that does not correctly describe G-Proteins.

- a. Energy for their activity comes from GTP molecules.
- b. G- Protein activation always increase the concentration of c-AMP.
- c. G- Proteins are membranes associated proteins.
- d. Both B and C

**Correct Answer: B**

G proteins transduce signals from activated G protein- coupled receptors (GPCRs) via second messengers to regulate numerous downstream signaling target in the cell. The intracellular domain of the receptor is bound to an intracellular heterotrimeric G protein (since it binds GDP/GTP) in the cell. The G protein dissociates and one subunit interacts with the activates an enzyme – adenylate cyclase- which converts ATP into a second messenger – cyclic AMP (cAMP) – in the cell. cAMP activates protein kinase A (PKA) which phosphorylates proteins at specific Ser or Thr side chains.

**Core Concept:**

**Topic:**

**Difficulty Level:**

**Complexity:** Medium

Q. 97. What would be the first event that happens after interacting with the cell surface receptor that signals activation of a trimeric G- protein?

- a. GTP is hydrolysed to produce GDP.
- b. Amino acid present on the G- protein become phosphorylated.
- c. The G- protein dissociates into a  $\beta$  – and  $\alpha$ - subunits.
- d. GTP replaces GDP in the  $\alpha$  – subunit.

**Correct Answer: D**

The trimeric G- proteins (GTP binding proteins) play a pivotal role in the signal transduction pathways for numerous hormones and neurotransmitters. The three subunits of the protein are labelled  $\alpha$ ,  $\beta$  and  $\gamma$ . Both the  $\alpha$  and  $\gamma$  subunits are bound to the membrane via attached lipid molecules (related to fatty acids and cholesterol). The receptors are proteins with seven transmembrane  $\alpha$  – helices. The binding of the hormone or neurotransmitter to the receptor causes GTP to replace GDP on the  $\alpha$  subunit. As a result,  $\alpha$  subunit dissociates from the other two.

**Core Concept:**

**Topic:**

**Difficulty Level:**

**Complexity:** Medium

Q. 98. How does a cholera toxin exert its harmful effects in gut cells?

- a. By inhibiting CFTR protein.
- b. By inducing apoptosis.

- c. By stimulating the production of cyclic AMP.
- d. All of the above

**Correct Answer: C**

*Cholera toxin*, which is produced by the bacterium that causes cholera, is an enzyme that catalyzes the transfer of ADP ribose from intracellular  $\text{NAD}^+$  to the  $\alpha$  subunit of Gs. This ADP ribosylation alters the  $\alpha$  subunit so that it can no longer hydrolyze its bound GTP, causing it to remain in an active state that stimulates adenylyl cyclase indefinitely. In most cells, activation of adenylyl cyclase, the enzyme which catalyses synthesis of cyclic AMP, is only triggered by one or two specific hormones. The remarkable discovery about the cholera toxin was that, in the test tube, it affects not just intestinal cells, but many other kinds of cells also.

**Core Concept:**

**Topic:**

**Difficulty Level:**

**Complexity:** Medium

Q. 99 Select the incorrect statement about Nitric Oxide.

- a. It acts as intracellular signaling molecule.
- b. It acts as a neurotransmitter.
- c. It regulates the protein production.
- d. It induces adenylyl cyclase, which catalyzes cAMP formation.

**Correct Answer: D**

Secretin receptors to the class of G protein-coupled receptor that activates adenylyl cyclase to increase cAMP formation.

**Core Concept:**

**Topic:**

**Difficulty Level:**

**Complexity:** Medium

Q.100. IP<sub>3</sub> initially causes  $\text{Ca}^{2+}$  to be released into the cytoplasm from \_\_\_\_\_.

- a. mitochondria
- b. golgi apparatus
- c. the endoplasmic reticulum
- d. cell cytoplasm

**Correct Answer: C**

IP<sub>3</sub> activates IP<sub>3</sub>Rs, causing  $\text{Ca}^{2+}$  release from the ER. As a consequence, the ER store is depleted, leading to SOC activation. As phospholipase C, generating inositol trisphosphate (IP<sub>3</sub>); IP<sub>3</sub> release  $\text{Ca}^{2+}$  from the ER and raises cytoplasmic  $\text{Ca}^{2+}$ . Eventually, stromal interaction molecules (STIMs) in the ER membrane sense ER  $\text{Ca}^{2+}$  depletion, oligomerize and become active. They aggregate in the ER membrane just under the plasma membrane, promoting clustering and activation of Orai channels on the plasma membrane, initiating SOCE in membrane patches.



**Core Concept:**

**Topic:**

**Difficulty Level:**

**Complexity:** Medium

Q. 101. Choose the correct match from the following as the biological functions mentioned in column A with the Enzymes given in column B.

Column A	Column B
P. Diacylglycerol synthesis	1. Protein kinase A
Q. CREB phosphorylation	2. Ras
R. GTP hydrolysis	3. Phospholipase
	4. Phospholipase C
	5. Protein kinase D

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

**Correct Answer: C**

The increase in phosphoinositide synthesis occurs at the step proximal to diacylglycerol synthesis through the phospholipase C-catalyzed hydrolysis of phosphoinositides and not through the *de novo* synthetic pathway. The utility of the Human Phosphokinase array for monitoring off target inhibitor responses on interdependent pathways. The dose response of inhibitors on ERK and CREB phosphorylation was measured using arrays and confirmed using ELISA with excellent correlation. The Ras-like GTPases regulate diverse cellular functions via the chemical cycle of binding and hydrolyzing GTP molecules. They alternate between GTP- and GDP-bound conformations. The GDP-bound conformation is biologically active and promotes a cellular function, such as signal transduction, cytoskeleton organization, protein synthesis/translocation or a membrane budding/fusion event.

**Core Concept:**

**Topic:**

**Difficulty Level:**

**Complexity:** Medium

Q. 102. The major pathways involved in terpene synthesis are

- a. Malonic acid and Shikimic acid pathway
- b. Mevalonic acid and MEP pathway
- c. Shikimic acid and Mevalonic acid pathway
- d. MEP pathway and Mevalonic pathway

**Correct Answer: B**

The 5-carbon isomers isopentenyl pyrophosphate (IPP) and dimethylallyl pyrophosphate (DMAPP) are the fundamental building blocks used to synthesize key biological isoprenoids (terpenoids) including cholesterol and other steroids, carotenoids, saponins and limonoids. Two metabolic pathways exist for the biosynthesis of isopentenyl pyrophosphate and dimethylallyl pyrophosphate. The mevalonate pathway, predominantly used by plants and in a few insect species. The non-mevalonate pathway or methyl D- erythritol 4 -phosphate (MEP) pathway, which occurs in plant chloroplasts, algae, cyanobacteria, eubacteria and important pathogens such as *Mycobacterium tuberculosis* and malaria parasites.

**Core Concept:**

**Topic:**

**Difficulty Level:**

**Complexity:** Medium

Q. 103. If the nerve transmission activation is done by the nicotinic acid acetylcholine receptor on the post-synaptic neuron, what would be the effect on the receptor if the pre-synaptic neuron is continuously depolarized?

- In pre-synaptic neuron more  $\text{Ca}^+$  released, on post neuron receptor is sensitized and inhibition of acetylcholine esterase takes place.
- In pre-synaptic neuron less  $\text{Ca}^+$  released, on post neuron receptor is sensitized and activation of acetylcholine esterase takes place.
- Less  $\text{Ca}^+$  released in pre-synaptic neuron, receptor on post neuron is desensitized and activation of acetylcholine esterase.
- No  $\text{Ca}^+$  released in pre-synaptic neuron, on post neuron receptor there is no sensitization and inhibition of acetylcholine esterase receptor occurs.

**Correct Answer: C**

Acetylcholine release in sensory neocortex contributes to higher-order sensory function, in part by activating nicotinic acetylcholine receptors (nAChRs). It acts as an agonist to activate and desensitize nicotinic acetylcholine receptors (nAChRs). The neuronal nAChR is a pentamer that can include a combination of  $\alpha$  and  $\beta$  subunits as a heteromeric receptor or five  $\alpha$  subunits as a homomeric receptor. Notably,  $\alpha 7$ -containing receptors are known for rapid desensitization in the presence of agonist and high  $\text{Ca}^{2+}$  permeability whereas  $\alpha 4\beta 2$ -containing receptors have higher affinity to nicotine and slower rates of desensitization.

**Core Concept:**

**Topic:**

**Difficulty Level:**

**Complexity:** Medium

Q. 104. At the neuro muscular junction, the following sequence of events occurs. Nerve impulse-release of V- end plate potential-W produced in muscle fibre -X released from sarcoplasmic reticulum-formation of Y- muscle contraction. Which among the following shows the correct sequence from V-Y ?

- a. Acetylcholine, action potential, Ca , actomyosin
- b. Action potential, actomyosin, Ca , acetylcholine
- c. Actomyosin, Ca , acetylcholine, action potential
- d. Ca , acetylcholine, actomyosin, action potential

**Correct Answer: A**

Motion produced by the integrated actions of the bones, joints and muscles. Acetylcholine is the sole chemical messenger used at the neuromuscular junction of skeletal muscle. A muscle action potential is a rapid change in the resting membrane potential, called a depolarization, that can be propagated along the cell membrane, in this case the sarcolemma. It is produced by the release of acetylcholine from the innervating motor neuron. Calcium concentrations in the sarcoplasm are responsible for the movement of the filaments. The release of calcium for the ST occurs as the muscle action potential is propagated along the sarcolemma and into the T-tubule system, opening voltage-gated calcium channels in the SR membrane. The calcium binds to troponin, altering the shape (denaturing) the troponin-tropomyosin complex. This uncovers the binding sites on the actin molecules to allow for the chemical bonding with the globular heads of the myosin molecules producing actomyosin.

**Core Concept:**

**Topic:**

**Difficulty Level:**

**Complexity:** Medium

- Q. 105 In an aerobically respiring cell, most of the ATP is produced from
- a. Krebs cycle
  - b. Oxidative electron transport
  - c. Glycolysis
  - d. Both A and B

**Correct Answer: B**

An electron transport chain (ETC) is a series of compounds that transfer electrons from electron donors to electron acceptors via redox reaction and couples this electron transfer with the transfer of protons ( $H^+$  ions) across a membrane. This creates an electrochemical proton gradient that drives. ATP synthesis, or the generation of chemical energy in the form of adenosine triphosphate (ATP).

**Core Concept:**

**Topic:**

**Difficulty Level:**

**Complexity:** Difficult

- Q. 106 Carbon monoxide inhibits electron transport chain in human mitochondria by binding to
- a. cytochrome a<sub>3</sub>

- b. cytochrome c oxidase
- c. cytochrome a
- d. cytochrome b complex

**Correct Answer: B**

Mitochondria, specially the electron transport chain, seem to be the target for CO at a subcellular level. However, the direct effect of CO in individual complexes of the human mitochondrial respiratory chain has not been completely elucidated. CO inhibits cytochrome c oxidase, while maintaining cellular ATP levels and increasing mitochondrial membrane potential.

**Core Concept:**

**Topic:**

**Difficulty Level:**

**Complexity: Difficult**

Q. 107 Which of the following pairs of subcellular compartments is likely to have same pH and electrolyte composition?

- a. Cytosol and lysosome.
- b. Cytosol and mitochondrial inter membrane space.
- c. Cytosol and endosome.
- d. Mitochondrial matrix and inter membrane space.

**Correct Answer: B**

The outer membrane contains many copies of a transport protein called porin which forms large aqueous channels through the lipid bilayer. This membrane thus resembles a sieve that is permeable to all molecules of 5000 daltons or less, including small proteins. Such molecules can enter the intermembrane space, but most of them cannot pass the impermeable inner membrane. Thus, whereas the intermembrane space is chemically equivalent to the cytosol with respect to the small molecules it contains, the matrix contains a highly selected set of these molecules.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 108 Choose the correct match from the following, where organelle or cellular components of a bacterium cell are placed in group I and the constituents and functionalities in group II

Group I	Group II
P. Cytoplasmic membrane	1. Protein synthesis

Q. Flagellum	2. Peptidoglycan
R. Cell wall	3. Phospholipid bilayer
S. Ribosome	4. Motility of cell

Choose the correct answer

- P-4, Q-2, R-4, S-1
- P-3, Q-2, R-1, S-4
- P-3, Q-4, R-2, S-1
- P-1, Q-3, R-4, S-2

**Correct Answer: C**

The lipid bilayer (phospholipid bilayer/cell membrane) is a structural component of the cell that isolates the cell components (organelles, cytoplasm) from the extracellular environment. Most motile bacteria move by the use of flagella (singular, flagellum), rigid structures 20 nm in diameter and 15–20  $\mu\text{m}$  long which protrude from the cell surface (*e.g. Chromatium*). The material in the cell wall varies between species, and can also differ depending on cell type and developmental stage. In bacteria, peptidoglycan forms the cell wall. Ribosomes contain about 80 proteins and 3–5 ribosomal RNAs (rRNAs) which interact to form a specific structure. The ribosomes are the “factory” for protein synthesis.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 109 Choose the mechanism from the following that is used by the viral movement proteins to facilitate virus movement within plants.

- Decrease the size exclusion limit of plasmodesmata.
- Increase the size exclusion limit of plasmodesmata.
- Rupture the of plasmodesmata.
- Degrade the of cell wall using secretory enzymes.

**Correct Answer: B**

A size exclusion limits vary between species and even cell types during passive transport. The varying size exclusion limits may also be due to the specific spoke molecules allowing passive transport through the neck region of plasmodesmata; different species of planta may have different neck region compositions, accounting for the discrepancies in size exclusion limits for passive transport. It has recently been shown that size exclusion limits vary between species and even cell type during passive transport.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

- Q. 110 The principle for formation of image in phase contrast microscopy involves
- interference of light waves.
  - negative staining of object.
  - use of fluorescent probes.
  - enhancing contrast by differentiating the change in phase of light pass through specimen coming from half angle of cone of light entering through objective lens.

**Correct Answer: D**

Phase contrast is basically a method of illumination in which a portion of the light is treated differently from the rest and subsequently caused to interfere with the rest, in such a manner as to produce a visible image of an otherwise invisible transparent specimen. The arrangement necessary for phase contrast. A clear annulus in the focal plane of the condenser is imaged at infinity by the condenser and then reimaged by the objective in its rear focal plane. The undiffracted energy all passes through this image and is both reduced in intensity and given a quarter-wave phase shift with reference to the diffracted energy, by means of an annular phase pattern in the rear focal plane of the objective. The end effect of these two changes in the undiffracted portion of the beam is to simulate the phase and intensity distribution which would be present in the objective focal plane if the specimen had density variations rather than refractive index variations and as a consequence the image formed by this beam interfering with the diffracted beam stimulates that of a specimen having density variations.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

- Q. 111 Choose a drug that is obtained from the capsule of *Papaver somniferum*.
- Cocaine
  - Codeine
  - Digoxin
  - Both A and C

**Correct Answer: B**

Opium is obtained from the opium poppy (*Papaver somniferum*) by scraping the unripe seed capsule and then collecting and drying the rubbery exudate. Morphine is isolated from opium in large quantities (over 1000 tons per year), although most commercial opium is converted into codeine by methylation. Morphine acts as an anesthetic without decreasing consciousness and it is one of the most powerful analgesics known.

**Core Concept:**

**Topic:**

Difficulty Level: Difficult

Complexity:

Q. 112. The reassociation of amylose and formation of crystalline structure upon cooling of cooked starch solution is called

- a. anterogradation
- b. gelatinization
- c. retrogradation
- d. crystallization

**Correct Answer: C**

Retrogradation is the realignment of amylose and amylopectin chains after gelatinisation occurs. It occurs at lower temperatures of onset of gelatinisation. Linear molecules of amylose and linear parts of amylopectin form hydrogen bonds which produces a crystalline structure. Retrogradation causes liquid to turn into a form of gel. In the retrogradation process, syneresis occurs where water is expelled from the liquid to form a gel.

Core Concept:

Topic:

Difficulty Level: Difficult

Complexity:

Q. 113 Match the Phylum in Group I with their characteristic motility appendage listed in Group II.

Group I	Group II
P. Archaezoa	I. Flagella
Q. Amoebozoa	II. Fimbriae
R. Ciliophora	III. Pseudopods
S. Apicomplexa	IV. Cilia
	V. Pili

- a. P – IV, Q – III, R – V, S – I
- b. P – III, Q – I, R – IV, S – II
- c. P – I, Q – III, R – IV, S – I
- d. P – II, Q – III, R – IV, S – V

**Correct Answer: C**

Archaezoa are unique flagellated (with tail) unicellular eukaryotes. They are unique because they lack mitochondria and plastids (manufacturing and storing of important chemicals).

Amoebozoa are characterized by the presence of pseudopodia, which are extensions that can

be either tube-like or flat lobes and are used for locomotion and feeding. Ciliophora get their name based on their method of locomotion: they swim with cilia. Cilia are short, hairlike projections of cytoplasm composed of pairs of microtubules surrounded by cell membrane. *Chromera velia* has attracted keen interest as the closest free-living relative of parasitic Apicomplexa. The life cycle of this unicellular alga is complex and involves a motile biflagellate form. Flagella are thought to be formed in the cytoplasm, a rare phenomenon shared with plasmodium in which the canonical mode of flagellar assembly, intraflagellar transport, is dispensed with. IN Apicomplexa, motile such as flagella are present only in certain gamet stage.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 114 During anaerobic respiration, \_\_\_\_\_ is an electron acceptor.

- a. lactate
- b. carbonate
- c. nitrate
- d. sulphate

**Correct Answer: A**

Anaerobic Respiration uses molecules other than oxygen as terminal electron acceptors; the most commonly used alternative electron acceptors are nitrate, sulfate and  $\text{CO}_2$ . Dissimilatory nitrate reduction occurs when nitrate is used as the terminal electron acceptor; if the nitrate is reduced to nitrogen gas, the process is called denitrification.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 115 Which cell structure store calcium ions?

- a. Rough endoplasmic reticulum
- b. Smooth endoplasmic reticulum
- c. Chloroplast
- d. Golgi vacuoles

**Correct Answer: B**

The main function of the smooth ER is to make cellular products like hormones and lipids. It also distributes those products throughout the cell and to other places in the organism. Smooth ER also regulates and releases calcium ions and processes toxins. It is described as smooth to distinguish it from rough ER, which has ribosomes for protein synthesis on its surface.

**Core Concept:**



Topic:

Difficulty Level: Difficult

Complexity:

Q. 116 The protein that is synthesized in bound ribosomes includes

- a. myoglobin
- b. enzymes
- c. haemoglobin
- d. insulin

**Correct Answer: D**

Examples of protein synthesis by the rough endoplasmic reticulum are the proteins produced in secretory cells. These include the digestive enzymes produced in the stomach and the protein hormones like insulin produced in the pancreas. Organ systems which produce many proteins have cells with a large amount of rough endoplasmic reticulum.

Core Concept:

Topic:

Difficulty Level: Difficult

Complexity:

Q. 117 *Mycobacterium tuberculosis* infects mainly \_\_\_\_\_.

- a. macrophages
- b. endothelial cells
- c. epithelial cells
- d. cardiac cells

**Correct Answer: A**

*Mycobacteria* which escape the initial intracellular destruction will multiply and this will lead to disruption of the macrophage. When this happens, blood monocytes and other inflammatory cells are attracted to the lung (second stage). These monocytes will differentiate into macrophages which again readily ingest but do not destroy the *mycobacteria*.

Core Concept:

Topic:

Difficulty Level: Difficult

Complexity:

Q. 118. Choose the mismatch from the following.

- a. SRP- Bring proteins and the ribosomes that are translating them from the cytosol to the rough ER .
- b. KDEL sequence–Targets proteins emerging from the golgi apparatus to rough ER .
- c. Chaperones-Assist in protein folding

d. eIFs-Help in translocation of ribosome on mRNA.

**Correct Answer: D**

The factors eIF-1 , eIF-1A and eIF-3 bind to the 20S ribosomal subunit and eIF-2 (in a complex with GTP) associates with the initiator methionyl tRNA .

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

**Complexity:**

- Q. 119 It is evidenced that mitochondria originated from an endosymbiotic relationship between aerobic bacteria and ancestral eukaryotic cells includes all of the following, except
- a. that the DNA in mitochondria is not packaged by histones.
  - b. that the Ribosomal RNAs in mitochondria code for prokaryotic like ribosomal proteins.
  - c. that the protein synthesis in mitochondria is inhibited by antibiotics as in bacterial protein synthesis.
  - d. Both A and B

**Correct Answer: B**

Ribosomal ribonucleic acid (rRNA) is the RNA component of the ribosome and is essential for protein synthesis in all living organisms. In prokaryotes a small 30S ribosomal subunit contains the 16S ribosomal RNA. The large 50S ribosomal subunit contains two rRNA species (the 5S and 23S ribosomal RNAs). Bacterial 16S ribosomal RNA, 23S ribosomal RNA and 5S rRNA genes are typically organized as a co-transcribed operon. The 3' end of the 16S ribosomal RNA (in a ribosome) binds to a sequence on the 5' end of mRNA called the Shine-Dalgarno sequence.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

- Q. 120 During receptor-mediated endocytosis, where LDL bound to its receptor
- a. both receptor and ligand are degraded.
  - b. the receptor is degraded and the ligand is recycled.
  - c. both receptor and ligand are recycled.
  - d. the ligand is degraded and the receptor is recycled.

**Correct Answer: D**

1. In receptor-mediated endocytosis, a specific receptor on the cell surface binds tightly to the extracellular macromolecule (the ligand) that it recognizes; the plasma-membrane region

containing the receptor-ligand complex then undergoes endocytosis, becoming a transport vesicles. Receptor ligand complex are selectively incorporated into the intracellular transport vesicles; most other plasma-membrane proteins are excluded.

2. *Tran*-membrane receptor protein that are internalized from the cell surf during endocytosis are sorted and recycled back to the cell surface.

3. The same pathway is followed by other ligands, such as insulin and other protein hormones that are internalized by receptor-mediated endocytosis and degraded in the Lysosome. After an LDL particle binds to an LDL receptor on the plasma membrane, the receptor-ligand complex is internalized in a clathrin-coated pit that pinches off to become a coated vesicle. The clathrin coat then depolymerizes to triskelions, resulting in an early endosome. This endosome fuses with a sorting vesicle, known as a late endosome, where the low pH ( $\approx 5$ ) causes the LDL particles to dissociate from the LDL receptors. A receptor-rich region buds off to form a separate vesicle that recycles the LDL receptors back to the plasma membrane. A vesicle containing an LDL particle may fuse with another late endosome but ultimately fuses with a lysosome to form a larger lysosome. There, the apo-B protein of the LDL particle is degraded to amino acids and the cholesterol esters are hydrolyzed to fatty acids and cholesterol. Abundant imported cholesterol inhibits synthesis by the cell of both cholesterol and LDL receptor protein.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 121 The following is a list of subcellular structures and their functions. Choose the option that correctly matches the subcellular structures to their functions.

Group I	Group II
P. Tonoplast	A. Lipid biosynthesis
Q. Peroxisomes	B. Protein degradation
R. Lysosome	C. Storage of starch
S. Cytoplasm	D. Fatty acid breakdown

- a. P-B, Q-A, R-C, S-D
- b. P-C, Q-A, R-D, S-B
- c. P-C, Q-D, R-B, S-A
- d. P-A, Q-C, R-D, S-B

**Correct Answer: C**

Plant cell vacuoles are distinct and characteristic in having a single unit membrane called tonoplast, which separates the vacuolar content from the rest of the cytoplasmic fluid. Sugars can also be stored in soluble forms by compartmentation into vacuoles. In this case, the tonoplast provides a physical barrier to protect stored sugars from molecular interconversion by cytoplasmic sugar-metabolizing enzymes. The other major pathway of protein degradation

in eukaryotic cells involves the uptake of proteins by lysosomes. A major function of the peroxisome is the breakdown of fatty acid molecules, in a process called  $\beta$  – oxidation. Synthesis of fatty acids takes place in the cytoplasm and involves initiation of synthesis by the formation of acetoacetyl-ACP and then an elongation cycle where 2 carbon units are successively added to the growing chain.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

- Q. 122 All of the following statements about actin and myosin are true, except
- a. the globular head section of myosin has domain for binding ATP and actin.
  - b. actin is the major protein of the thick filament.
  - c. binding of ATP to the actin-myosin complex promotes dissociation of actin and myosin.
  - d. Both A and B

**Correct Answer: B**

Two of the important proteins are myosin, which forms the thick filament and actin which forms the thin filament.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

- Q. 123 Which of the following statements is true about intermediate filaments?
- a. Rather than consisting of a single type of protein, they can be made up of number of different proteins.
  - b. They can involved in cell movement.
  - c. Both A and B
  - d. Like microfilaments, they exhibit treadmilling.

**Correct Answer: A**

Intermediate filaments have a diameter of about 10 nm, which is intermediate between the diameters of the two other principal elements of the cytoskeleton, actin filaments (about 7 nm) and microtubules (about 25 nm). In contrast to actin filaments and microtubules, the intermediate filaments are not directly involved in cell movements and are constructed from a number of different subunit protein. They appear to play basically a structural role by providing mechanical strength to cells and tissues.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 124 An event that can induce a transient arrest in the translation of a secretory protein involved the

- a. binding of a polysome to an ribosome.
- b. binding of SRP to an N-terminal signal sequence.
- c. binding of SRP to the small ribosomal subunit.
- d. binding of SRP to an C-terminal signal sequence.

**Correct Answer: B**

An ER signal sequence typically is located at the N-terminus of the protein and contains one or more positively charged amino acids followed by a continuous stretch of 6–12 hydrophobic residues; except for these features, the signal sequences of different secretory proteins have little in common. Since secretory proteins are synthesized in association with the ER membrane but not with any other cellular membrane, some signal-sequence recognition mechanism must target them there. The two key components in this targeting are the signal-recognition particle (SRP) and the SR receptor. SRP is a cytosolic particle that transiently binds to the ER signal sequence in a nascent protein, to the large ribosomal unit and to the SRP receptor in the ER membrane.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 125 Choose the incorrect statement about chloroplasts.

- a. Grana are membrane components of the thylakoids.
- b. The membranes that are stacked in the thylakoid are called stroma.
- c. Photo-harvesting apparatus are embedded in the thylakoid membrane.
- d. None of the above

**Correct Answer: B**

Inside the chloroplasts are stacks of discs called thylakoids. They are compared to stacks of coins within the walls of the chloroplast and they act to trap the energy from sunlight. The stacks of thylakoids are called grana.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 126 In cancer chemotherapy, drugs that either stabilize or depolymerize microtubules can be used. Which among the following is correct concerning such drugs?

- a. They extend the immune system action.
- b. They prevent chromatin condensation.
- c. They prevent mitosis.
- d. They interfere with mitosis.

**Correct Answer: D**

A mitotic inhibitor is a drug that inhibits mitosis or cell division. These drugs disrupt microtubules, which are structures that pull the cell apart when it divides. Mitotic inhibitors are used in cancer treatment, because cancer cells are able to grow and eventually spread through the body (metastasize) through continuous mitotic division and so are more sensitive to inhibition of mitosis than normal cells.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 127 Ionophores are \_\_\_\_\_.

- a. gating mechanisms associated with the ions transport
- b. intrinsic proteins that helps in transport of ions passively
- c. chemicals that form pores in the plasma membrane and allow ions to cross
- d. Both A and C

**Correct Answer: C**

Ionophores are molecules that help transport ions from a hydrophilic environment into a hydrophobic environment. In other words, ionophores are ion carriers that help transport hydrophilic ions across lipid bilayer membranes. There are two broad mechanisms by which ionophores transport ions across cell membranes: carrier and channel forming.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 128 Which among the following cell structure is attached to the rough areas of endoplasmic reticulum?

- a. Golgi complex
- b. Mitochondrion
- c. Nucleolus
- d. Ribosomes

**Correct Answer: D**

The endoplasmic reticulum is a multifold membranous structure within eukaryotic cells which plays a major role in the synthesis of the complex molecules required by the cell and the organism as a whole. Often the membranes of these structures are lined with ribosomes on their outer surfaces, giving them a rough appearance. These parts are called the rough endoplasmic reticulum to contrast them with the smooth endoplasmic reticulum where there are no attached ribosomes.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 129 Signal hypothesis refers to

- a. the hormonal control of prokaryotic protein synthesis.
- b. the synthesis of secreted proteins by membrane bound ribosomes.
- c. the hormonal control of eukaryotic protein synthesis.
- d. the sequence of aminoacids of a secretory proteins.

**Correct Answer: B**

A signal sequence is a short peptide that is part of the original translation product of proteins targeted to the ER, often at the *N*-terminus of the protein and is frequently removed proteolytically after translocation of the nascent polypeptide through the ER membrane. The signal hypothesis, which describes how secretory and membrane proteins are targeted to the endoplasmic reticulum. These experiments defined a pathway taken by secreted proteins, the secretory pathway; rough ER → Golgi → Secretory vesicles → Cell exterior.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 130 A microtubule can shrink or grow. This can be determined by

- a. the rate of GTP-bound tubulin addition relative to the rate of tubulin GTP hydrolysis.
- b. the phosphorylation state of microtubule.
- c. the rate of ATP hydrolysis.
- d. the presence or absence of  $\gamma$ -tubulin.

**Correct Answer: A**

Whether a microtubule grows or shrinks is determined by the rate of tubulin addition relative to the rate of GTP hydrolysis. As long as new GTP-bound tubulin molecules are added more rapidly than GTP is hydrolyzed, the microtubule retains a GTP cap at its plus end and microtubule growth continues. However, if the rate of polymerization slows, the GTP bound to tubulin at the plus end of the microtubule will be hydrolyzed to GDP. If this occurs, the GDP-

bound tubulin will dissociate, resulting in rapid depolymerization and shrinkage of the microtubule.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 131 On secreted glycoproteins, N-linked oligosaccharides are attached to \_\_\_\_\_.

- a. the nitrogen atoms in the polypeptide backbone
- b. the serine in the sequence Asn-X-Ser/Thr
- c. the threonine in the sequence Asn-X-Ser/Thr
- d. the asparagine in the sequence Asn-X-Ser/Thr

**Correct Answer: D**

In glycoproteins, sugars are attached either to the amide nitrogen atom in the side chain of asparagine (termed an *N-linkage*) or to the oxygen atom in the side chain of serine or threonine (termed an *O-linkage*). An asparagine residue can accept an oligosaccharide only if the residue is part of an Asn-X-Ser or Asn-X-Thr sequence, in which X can be any residue. Thus, potential glycosylation sites can be detected within amino acid sequences.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 132 Choose a false statement about mitochondrial genome.

- a. Mitochondrial genome with few exceptions is circular.
- b. Mitochondrial genome codes for some nuclear proteins.
- c. Mutation rate is high in mitochondrial genome.
- d. Both A and C

**Correct Answer: B**

Most mitochondrial proteins are translated on free cytosolic ribosomes and imported into the organelle by specific targeting signals. In addition, mitochondria are unique among the cytoplasmic organelles in that they contain their own DNA, which encodes tRNA, rRNAs and some mitochondrial proteins. The assembly of mitochondria thus involves proteins encoded by their own genomes and translated within the organelle, as well as proteins encoded by the nuclear genome and imported from the cytosol.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**



Complexity:

- Q. 133 The rotatory motion of bacterial flagellum is driven by
- energy obtained through ATP hydrolysis.
  - trans-membrane electrochemical potential linked to proton pumping.
  - Both A and B
  - concentration gradient of nutrients.

**Correct Answer: B**

Most bacteria that swim are propelled by flagella filaments, which are driven by a rotary motor powered by proton flux. The motor is powered by proton flux (or in some species, sodium ion flux). Protein molecules are structurally polar and thus there should be an interaction between an electric field and the mechanical deformation of protein molecules, as usually discussed in material physics. This means that theoretically the flagella rotary motor should be treated as a four-variable system, *i.e.*, as a system in which strain, stress, electric field and polarization are interacting with each other.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

- Q. 134. How do protein transportation takes place into mitochondria?
- Co-translationally
  - Post-translationally
  - Both A and B
  - Via* peroxisomes

**Correct Answer: B**

Proteins imported into the matrix of mitochondria are usually taken up from the cytosol within seconds or minutes of their release from ribosomes. Thus, in contrast to the protein translocation into the ER, mitochondrial proteins are first fully synthesized as precursor proteins in the cytosol and then translocated into mitochondria by a post-translational mechanism.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

- Q. 135 Except \_\_\_\_\_, SNARE proteins are found in the membranes of all of the following compartments.
- mitochondria
  - golgi complex
  - early endosome

d. endoplasmic reticulum

**Correct Answer: A**

SNARE are twin membrane proteins (referred to as v-SNARE [vesicle] and t-SNARE [target]), that act as anchors when two vesicles decide to fuse into one. This process is important because it participate in molecular transport in the cell. Membrane and secretory proteins pass through several membrane-bounded organelles. Simple pathway of protein can be described as Nucleus → ER → Golgi apparatus (or complex) → Plasma membrane OR endosome (pro-lysosome) OR exterior. Origin of vesicles plays its role in synaptic signal transduction. The reason why there are no SNARE proteins in the mitochondria membrane is described while talking about mitochondria itself.

Vesicles are essential for proteins movement so-called co-translational translocation of proteins. Proteins are translated by ribosomes only when they are bound to ER membrane. Thus proteins are translated into the ER, because if they were translated into cytoplasm, they could fold improperly (by the way, about 80% of all membrane proteins fold improperly even inside ER). But mitochondrial proteins that are imported (because mitochondria have its own gene translation machinery and so produce many essential proteins by itself) are translocated post-translationally, after ribosomes actually detach from polypeptide. After that so-called precursor proteins are imported into mitochondrial matrix through TOM and TIM complexes led by signal polypeptide chain (note that there are two membranes! that complexes act like gateway, really fascinating structure) just like membrane proteins being synthesized by ribosome are dragged to ER by Signal Recognition Particle (SRP) bound to protein's signal chain.

Precursor protein does not fold in the cytoplasm because of interactions with other proteins, some of which are general chaperones like hsp 70 family.

There is no possibility for membrane fusion between vesicles and mitochondrial bi-membranes so no SNARE needed for protein translocation.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 136 All the following cellular events involve actin filaments, except

- a. amoeboid movement
- b. cytokinesis in animal cells
- c. flagellar movement in bacteria
- d. Both B and C

**Correct Answer: C**

Microtubules are responsible for a variety of cell movements, including the intracellular transport and positioning of membrane vesicles and organelles, the separation of chromosomes at mitosis and the beating of cilia and flagella. As for actin filaments, movement

along microtubules is based on the action of motor proteins that utilize energy derived from ATP hydrolysis to produce force and movement. Members of two large families of motor proteins the kinesins and the dyneins are responsible for powering the variety of movements in which microtubules participate.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 137. Which of the following organelle could be used as an analogy to the post office that is involved in processing, packaging and distribution?

- a. Plasma membrane
- b. Nucleolus
- c. Golgi apparatus
- d. Mitochondria

**Correct Answer: C**

Secretion of proteins from eukaryotic cells requires the coordinated function of multiple organelles and cellular machineries. After synthesis and translocation into the endoplasmic reticulum, proteins are exported to the Golgi apparatus, a multi-compartment organelle that is the protein modifying, packaging and distribution center of the secretory pathway.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 138.  $\text{Ca}^{2+}$  is important in skeletal muscle contraction because it

- a. activates the myosin ATPase by binding to it.
- b. binds to troponin to remove a constant inhibition of cross-bridge attachment.
- c. prevents the formation of bonds between the myosin cross bridges and the action filament.
- d. is required to detach the myosin head the actin filament.

**Correct Answer: B**

Muscle contraction is initiated by the release of calcium ions ( $\text{Ca}^{2+}$ ) from the sarcoplasmic reticulum (SR) into the myoplasm. The amount of  $\text{Ca}^{2+}$  released is of fundamental importance to understanding muscle contraction because it is a determinant of both force generation and energy consumption. Muscle is turned on by the release of calcium ( $\text{Ca}^{2+}$ ) into the myoplasm.

$\text{Ca}^{2+}$  in turn binds to troponin removing the inhibition from the thin filament and thereby allowing the myosin cross bridges to attach and generate force.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 139. Select the set of correct statement for cytoskeletal protein filaments

- A. Actin filament is about 8 nm wide.
  - B. Actin filament is 30 nm wide.
  - C. Intermediate filaments have size intermediate between actin filament and microtubules.
  - D. Protofilaments of microtubules are composed of  $\alpha/\beta$  tubulin heterodimer.
  - E. Colchicine binds to the tubulin subunit and cause disassembly to free units.
- a. A, D
  - b. B, D and E
  - c. A, C and D
  - d. A, B and D

**Correct Answer: C**

Monomers of the protein actin polymerize to form long, thin fibers. These are about 8 nm in diameter and being the thinnest of the cytoskeletal filaments, are also called microfilaments. Intermediate filaments have a diameter of about 10 nm, which is intermediate between the diameters of the two other principal elements of the cytoskeleton, actin filaments (about 7 nm) and microtubules (about 25 nm). Microtubules are non-covalent cytoskeletal polymers found in all eukaryotic cells that are involved in mitosis, cell motility, intracellular transport, secretion, the maintenance of cell shape and cell polarization. They are polarized structures composed of  $\alpha$  – and  $\beta$  – tubulin heterodimer subunits assembled into linear protofilaments.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 140. Which among the following has correctly described about Kinesin?

- a. Kinesin is an enzyme that phosphorylates actin filament proteins.
- b. Kinesin is an enzyme that phosphorylates intermediate filament proteins.
- c. Kinesin is a motor protein that conducts vesicles along microtubules.
- d. Kinesin protein is involved in the control of movement.

**Correct Answer: C**

Two families of motor proteins, the kinesins and dyneins, move vesicles along microtubules and members of the myosin family move them along microfilaments. The direction of movement of vesicles along the cytoskeleton is absolutely dependent on the polarity of the microfilaments and microtubules. Some motor proteins move from the minus end to the plus end and others in the opposite direction. The direction of movement of vesicles along the cytoskeleton is absolutely dependent on the polarity of the microfilaments and microtubules. Some motor proteins move from the minus end to the plus end and others in the opposite direction.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 141. Which of the following is not a characteristic of gap junctions?

- a. Gap junction allow ions and molecules to migrate from a cell to an adjoining cell.
- b. Gap junctions are constituted of a class of membrane associated proteins named connexion.
- c. Gap junctions are found only in plant cells.
- d. Both A and C

**Correct Answer: C**

Gap junctions in animal cells are like plasmodesmata in plant cells in that they are channels between adjacent cells that allow the transport of ions, nutrients and other substances that enable cells to communicate. Gap junctions are particularly important in cardiac muscle. The electrical signal for the muscle to contract is passed efficiently through gap junctions, allowing the heart muscle cells to contract in tandem. Plasmodesmata join plant cells and act as an analogous to gap junction.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 142. Which among the following is the location of the photosynthetic pigment?

- a. Inner mitochondrial membrane
- b. Outer mitochondrial membrane
- c. Inter mitochondrial matrix
- d. Thylakoid membrane

**Correct Answer: D**

In each chloroplast, the thylakoid membrane is believed to constitute a single, interconnected sheet that forms numerous small flattened vesicles, the thylakoids, which commonly are arranged in stacks termed grana. The spaces within all the thylakoids constitute a single continuous compartment, the thylakoid lumen. The thylakoid membrane contains a number of integral membrane proteins to which are bound several important prosthetic groups and light-absorbing pigments, most notably chlorophyll.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 143. Which of the following are not having plastids?

- a. Animals

- b. Bacterium and Fungi
- c. Plants
- d. Both A and B

**Correct Answer: D**

Plastids occur in most plant cells and are absent in animals cells. Cells of lower non-flowering plants like bacteria, blue-green algae and fungi contain chromatophores instead of plastids.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 144 Which among the following statement is true regarding histones?

- a. The amino acid sequences of histone proteins are very similar in different organisms.
- b. Histones are acidic proteins.
- c. Histones are found in animal chromatin but not in plant cells.
- d. All histones form part of the nucleosome core particles in chromatin.

**Correct Answer: A**

Histones are small basic proteins, rich in lysine or arginine, which are found in chromatin of all eukaryotic cells. Their sequence is very highly conserved from one species to another and the sequences of particular histones differ very little even between plants and animals.

Nucleosome core particles are made of an octamer of the 4 core histones -

H2A, H2B, H3 and H4 . Histone H1 is not part of the nucleosome but has a role in condensing nucleosomes together.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 145 *E. coli* cells containing F plasmid are capable of carrying out which of the following important process?

- a. Transduction process
- b. Induce mutations in the chromosome
- c. Conjugation, promoting horizontal gene transfer
- d. All of the above

**Correct Answer: C**

Some plasmids are designated as F factor (F plasmid, fertility factor or sex factor) because they carry genes that mediate their own transfer. The F factor can replicate autonomously in the cell. These genes code for the production of the sex pilus and enzymes necessary for conjugation. Cells possessing F plasmids are  $F^+$  (male) and act as donors. Those cells lacking

this plasmid are  $F^-$  (female) and act as recipient. All those plasmids, which confer on their host cells to act as donors in conjugation are called transfer factor. About half of the plasmids are incapable of horizontal transmission by conjugation. These asymmetries are thought to prevent the maintenance of plasmids as bacterial parasites in the absence of positive selection for plasmid-encoded genes.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 146 How many times longer is the DNA in a human chromosome than the length of the chromosome?

- a. 1000×
- b. 10,000×
- c. 20,000×
- d. 1,00,000×

**Correct Answer: B**

Each human chromosome contains a DNA molecule that is approximately 10,000× as long as the length of the chromosome at mitosis.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 147 Which of the following is negative regulator of trp operon?

- a. Lactose
- b. Allolactose
- c. C-AMP
- d. Tryptophan

**Correct Answer: D**

Enzyme repression is a form of negative control (down-regulation) of bacterial transcription. This process, along with that of enzyme induction, is called negative control because a regulatory protein brings about inhibition of mRNA synthesis which, leads to decreased synthesis of enzymes. Although feedback inhibition shuts off synthesis of the end product of a pathway, it still allows some waste of energy and carbon if the cell continued to manufacture enzymes for which it has no use. It is the process of enzyme repression that prevents the synthesis of the enzymes concerned with the synthesis of that particular end product. In the case of the pathway of tryptophan biosynthesis the end product of the pathway, tryptophan, serves as an effector molecule that can shutdown the synthesis of the Enzymes a, b, c, d , and c that are concerned with tryptophan biosynthesis. This results in saving of many molecules of ATP which must be expended during protein synthesis, and it conserves amino acid



precursors for synthesis of other proteins. The process is slower to act than is feedback inhibition (which acts immediately) because pre-existing enzymes have to be diluted out as a result of cell division before its effects are seen.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 148 Choose the correct statement.

- a. Reverse transcriptase is an enzyme that is used by retroviruses and retrotransposons to synthesize DNA.
- b. In human cells most of the repetitive DNA is present because of transposons.
- c. Transposons have no known direct function but they may have benefits in evolution.
- d. All of the above

**Correct Answer: D**

Transposons or 'jumping genes', are DNA sequences that can move around the genome. They occur in bacteria and eukaryotes. In DNA-only transposons the DNA sequence is cut out of the chromosome and can insert itself elsewhere in the genome. Retrotransposons are not cut out of the DNA. A copy of the transposon is transcribed into RNA, which is then reverse transcribed into DNA by an enzyme known as reverse transcriptase. It is this DNA copy that can move and insert itself into another place in the genome. Retrotransposons are closely related to retroviruses (like HIV) which also use reverse transcriptase to make a DNA copy of their RNA genome. Transposons have no known function, but they can result in gene duplications which are an essential part of the evolutionary process. Reverse transcriptase is an enzyme used to generate complementary DNA (cDNA) from RNA template, a process termed reverse transcription.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 149 Split genes are

- a. the coding sequence in human genes that are interrupted by spacer sequences called exons.
- b. human genes that can be split by up to 500 spacer sequences.
- c. the genes in bacteria that do not get split.
- d. Both B and C

**Correct Answer: D**

The coding sequence in human genes is interrupted by spacer sequences called introns. These are found almost exclusively in eukaryotic genes, especially in higher eukaryotes like mammals, though a few bacterial genes do have introns. A single human gene can contain up to 500

introns. This means that human genes can be very large indeed. The largest gene in humans is the gene for dystrophin and it is 2.4 megabases (2.4 million bases), which is half the size of the entire *E. coli* genome.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 150 In the past, a large part of the human genome has been regarded as 'junk' DNA. As per correct understandings which of the following statements about 'junk' DNA is correct?

- a. About 1.6% of the human genome has no known function and has been described as 'junk' DNA.
- b. Bacteria do not contain junk DNA
- c. MicroRNA genes do not code for proteins.
- d. There are no genes in junk DNA.

**Correct Answer: C**

Coding sequences make up about 1.6% of the human genome. Introns that separate the coding sequences within genes make up about 25% of the genome. Over 50% has no known function and has been described as 'junk'. Even bacteria have a small amount of repeat-sequence 'junk' DNA, comprising about 1–2% of their genome. A new class of genes called microRNA genes were discovered relatively recently and these genes are found in junk DNA.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 151 Choose the correct statement regarding the linked genes.

- a. They can co-segregate
- b. They can assort randomly
- c. They can crossover
- d. They can recombine easily

**Correct Answer: A**

Co-segregation is the transmission of two or more linked genes on a chromosome to the same daughter cell leading to the inheritance by the offspring of these genes together.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 152. What is the most appropriate definition of an operator, in the context of prokaryotic gene expression?

- a. A cluster of genes that are regulated by a single promotor.
- b. A non-coding, regulatory DNA sequence that is bound by a repressor protein.
- c. A non-coding, regulatory DNA sequence that is bound by RNA polymerase.
- d. A DNA-binding protein that regulates gene expression.

**Correct Answer: B**

Operator is a non-coding DNA sequence that code protein sequences. It is a segment of DNA to which a repressor binds. A repressor is a DNA-binding protein that regulates the expression of one or more genes by binding to the operator and blocking the attachment of RNA polymerase to the promotor, thus preventing transcription of the genes. This blocking of expression is called repression.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q.153. What is the type of inheritance in which both the chromosomes are from the same parent?

- a. Displaced duplication
- b. Uniparental disomy
- c. Tandem duplication
- d. Unbalanced polymorphism

**Correct Answer: B**

Uniparental disomy (UPD) occurs when a person receives two copies of a chromosome or part of a chromosome, from one parent and no copies from the other parent. UPD can occur as a random event during the formation of egg or sperm cells or may happen in early fetal development.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 154. Gene \_\_\_\_\_ consists of the copies of a gene that arose by gene duplication.

- a. complex
- b. family
- c. tandem complex
- d. disorder

**Correct Answer: B**

A gene family is composed of several genes which share similar features. One or more copies of duplicated genes constitute the gene family. A gene cluster is part of a gene family, which is a

group of two or more genes found within an organism's DNA that encode for similar polypeptides or proteins, which collectively share a generalized function and are located within a few thousand base pairs of each other.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 155 Which bacterial toxin does not have ADP- ribosyl transferase activity?

- a. Enterotoxin
- b. Diphtheria toxin
- c. *Pseudomonas* toxin
- d. *S. aureus*  $\alpha$  – toxin

**Correct Answer: D**

*S. aureus*  $\alpha$  – toxin can be considered the prototype of oligo-merizing poreforming cytotoxins. The  $\alpha$  – toxin gene resides as a single copy on the chromosome of most pathogenic *S. aureus* strains and its expression is environmentally regulated at the transcriptional level by the staphylococcal accessory gene regulator (*agr*) locus. The  $\alpha$  – toxin is synthesized as a 319 amino acid precursor molecule that contains an N-terminal signal sequence of 26 amino acids. The secreted mature toxin or promoter, is a hydrophilic molecule that lacks cysteine residues and has a molecular mass of approximately 33 kDa.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 156. Nucleosome remodeling complexes influence the stability of histone octamer-DNA interaction. If these complexes are damaged beyond repair it will

- a. inhibit sliding of the histone octamer along the DNA.
- b. lead to enhanced weight in the complete transfer of the histone octamer.
- c. lead to remodeling of the nucleosome.
- d. make DNA highly accessible.

**Correct Answer: A**

Nucleosome core particles contain 147 bp of DNA wrapped around the histone octamer with two copies each of histones H2A, H2B, H3, and H4. The neighboring core particles are connected by “linker DNA”, which is typically 30–50 bp in length and linker histones. Cellular DNA is being modified constantly by endogenous and exogenous DNA-damaging agents. Among these, UV light is one of the most prevalent environmental stresses that produce lesions in DNA. Access to buried UV DNA lesions in chromatin can be achieved by ATP -dependent chromatin remodeling factors, which use ATP hydrolysis to slide or unwrap DNA. These multisubunit complexes also can catalyze eviction of histone octamers or promote histone

variant replacement. In addition, post-translational modifications of histones can alter histone-DNA or histone-histone interactions.

**Core Concept:**

**Topic:**

**Difficulty Level:**

**Complexity: Difficult**

- Q. 157 In the regulation of *trp* operon expression by attenuation,
- the leader peptide sequence encodes enzymes required for tryptophan synthesis.
  - rapid translation of the leader peptide prevents completion of the mRNA transcript.
  - rapid translation of the leader peptide allows completion of the mRNA transcript.
  - the leader peptide sequence contains no tryptophan residues.

**Correct Answer: B**

Translation of the *trp* operon encoded mRNA begins with the synthesis, not of one of the enzymes, but of a short 'leader' peptide encoded by the 5' end of the message. The leader peptide contains codons encoding tryptophan. If there is tryptophan in the cell, then tRNA charged with tryptophan will be available and ribosomes will move rapidly along the sequence encoding the leader peptide. The effect of this is to leave part of the mRNA sequence free to base pair with itself, forming a stem-loop transcription termination signal so the mRNA is never completed and the enzymes needed for tryptophan synthesis are not made. The leader peptide has no other function but to play this regulatory role by its translation, and is rapidly degraded.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

- Q. 158 An *E. coli* mutant constitutive for the *lac* operon was mated with a wild type strain. The merodiploid thus obtained was inducible by lactose. This observation indicates that the original mutation is
- dominant
  - trans-dominant
  - recessive
  - cis-dominant

**Correct Answer: C**

In the presence of the substrate lactose, the operon is turned on and in its absence, the operon is turned off. In a merodiploid strain, in which one copy of the *lac* operon is on the chromosome and another copy is on an F' factor, one can test for dominance of one allele over another. The wild-type  $lacI^+$  is dominant over  $lacI^-$  in *trans*. In a situation where the only functional *lacZ* gene is on the same chromosome as  $lacI^-$ , the functional *lacI* still causes repression in the absence of inducer.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q.159. Telomerase activity was monitored in the following cell types. The highest amount of telomerase activity was found in the combination of

- a. embryonic and hematopoietic stem cells.
- b. hepatocytes and muscle cells.
- c. hematopoietic stem cells and macrophages.
- d. hepatocytes and eosinophils.

**Correct Answer: A**

Telomerase activity and long telomeres are characteristic of proliferating cells in embryonic tissues and of germ cells. Human somatic cells, however, do not show telomerase activity and their telomeres are considerably shorter. Unlike ES cells, differentiated somatic cells also stop dividing in culture a phenomenon called replicative senescence.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q.160.. The C- value paradox suggests

- a. colinearity between genome size and complexity of organism.
- b. non-colinearity between genome size and complexity of organism.
- e. linkage analysis.
- d. number of chromosome.

**Correct Answer: B**

The DNA content of eukaryotic nuclei (C– value) varies ~ 200,000- fold, but there is only a ~ 20- fold variation in the number of protein-coding genes. Hence, most C– value variation is ascribed to the repetitive fraction, although little is known about the evolutionary dynamics of the specific components that lead to genome size variation. There appears to be no correlation between the amount of DNA per cell and organismal advancement or genetic complexity. This well documented lack of correspondence between genome size and morphological or physiological complexity of an organism has been historically termed the “C– value paradox”.

**Core concept:**

Topic:

Difficulty Level: Difficult

Complexity:

Q.161. The inactivation of X – chromosome

P. yield a completely inactive X – chromosome.

Q. yield a mostly inactive X – chromosome.

R. is controlled via non-coding RNAs

S. is controlled via two special proteins

a. P, Q

b. R only

c. Q and R

d. P, R and S

**Correct Answer: C**

The inactive X chromosome ( $X_i$ ), the most extensive instance of facultative heterochromatin in mammals, replicates later than the active X chromosome ( $X_a$ ), but the replication dynamics of inactive chromatin are not known. The X – inactive specific transcript ( $Xist$ ) gene encodes a large non-coding RNA that is responsible for mediating the specific silencing of the X chromosome from which it is transcribed.

Core concept:

Topic:

Difficulty Level: Difficult

Complexity:

162.. All of the following statements are correct about telomerase except

a. The RNA component acts as a template for the synthesis of as segment of DNA.

b. It adds telomeres to the 5' ends of the DNA strands.



- c. It provides a mechanism for replicating the ends of linear chromosomes.
- d. All of the above are correct statements about telomerase.

**Correct Answer: B**

Telomeric regions contain DNA with distinctive features of its own. Telomeric DNA has specific short sequences of tandem repeats, ranging from few repeats to several hundred or more (a total length of 5000 to 10000 or more base pairs). The DNA ends are not free but folded into closed loops, with the insertion of 3' single stranded region, which can form a single loop recognizable under TEM or they may develop quartet or quadruplex structural form; many such loops may be found at each ends.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q.163. Which among the following is common to both *E. coli* and eukaryotic chromosomes?

- a. DNA is circular.
- b. DNA is negatively supercoiled.
- c. DNA is positively supercoiled.
- d. DNA is packaged into nucleosomes.

**Correct Answer: B**

DNA supercoiling is a major regulator of transcription in bacteria. Negative supercoiling acts both by promoting the formation of nucleoprotein structures containing wrapped DNA and by altering the twist of DNA. Although both bacterial and eukaryotic DNA are-with few exceptions negatively supercoiled, a supercoiled DNA duplex can, in principle, assume either a toroidal form or a lower energy plectonemic (interwound) form.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 164. The mobile genetic elements present in human genome are

P. Long interspersed elements (LINEs)

Q. Short interspersed elements (SINEs)

R. P elements

S. IS elements

a. P, R

b. P, Q

c. P, S

d. Q, S

**Correct Answer: B**

The most abundant mobile elements in mammals are non-viral retrotransposons, which lack LTRs. Many of these belong to the two classes of moderately repeated DNA sequences found in mammalian genomes; long interspersed elements (LINEs) and short interspersed elements (SINEs). In humans, full-length LINEs are  $\approx 6-7$  kb long and SINEs are  $\approx 300$  bp long. Repeated sequences with characteristics of LINEs have been observed in protozoa, insects and plants, but for unknown reasons they are particularly abundant in the genomes of mammals. SINEs also are found primarily in mammalian DNA. The large numbers of LINEs and SINEs in higher eukaryotes have accumulated over evolutionary time by repeated copying of a sequence at a few positions in the genome and insertion of the copies into new positions. Although these mobile elements do not contain LTRs, the available evidence indicates that they transpose through an RNA intermediate.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q.165. How does an eukaryotic genome differ from a prokaryotic genome?

- a. In prokaryotes, DNA is single-stranded.
- b. Intervening sequences are present in eukaryotic DNA.
- c. In prokaryotes, DNA is circular.
- d. Both A and B

**Correct Answer: B**

The genomes of most eukaryotes are larger and more complex than those of prokaryotes. Some of the noncoding DNA in eukaryotes is accounted for by long DNA sequences that lie between genes (spacer sequences). However, large amounts of noncoding DNA are also found within most eukaryotic genes. Such genes have a split structure in which segments of coding sequence (called exons) are separated by noncoding sequences (intervening sequences or introns). The entire gene is transcribed to yield a long RNA molecule and the introns are then removed by splicing, so only exons are included in the mRNA. Although most introns have no known function, they account for a substantial fraction of DNA in the genomes of higher eukaryotes.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q.166.. Satellite DNA is made up of \_\_\_\_\_

- a. repeated DNA sequences
- b. interspersed repeated sequences
- c. tandemly repeated sequences
- d. minichromosomes

**Correct Answer: C**

Satellite DNA consists of very large arrays of tandemly repeating, non-coding DNA. Satellite bands of eucaryotic DNA fragments are composed of a long series (often hundreds of kb in

length) of tandem repeats. There can be several different types of satellite DNA in a particular genome, with repeat units of 5 to 200 bp.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q.167 . In addition to the transposase gene, mobile IS elements must also carry

- a. an antibiotic resistance gene,
- b. inverted terminal repeat sequence,
- c. interspersed repeating sequences,
- d. terminal genes.

**Correct Answer: B**

Transposons are segments of DNA that can move around to different positions in the genome of a single cell. Transposase binds to both ends of the transposon, which consist of inverted repeats; that is, identical sequences reading in opposite directions. A sequence of DNA that makes up the target site. Some transposases require a specific sequence as their target site; others can insert the transposon anywhere in the genome.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q.168. Which among the following is a false statement about short interspersed elements (SINEs)?

- a. The major family of SINEs contain the Alu sequences.

- b. They arose by reverse transcription of small RNAs.
- c. Both A and B.
- d. They encode reverse transcriptase.

**Correct Answer: D**

SINEs do not encode a functional reverse transcriptase protein and rely on other mobile elements for transposition. The most common SINEs in primates are called Alu sequences. Alu elements are approximately 350 base pairs long, do not contain any coding sequences and can be recognized by the restriction enzyme AluI (hence the name).

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q.169.. Why microsatellites are used more commonly than minisatellites as DNA markers?

- a. Minisatellites are present diversely within the genomes.
- b. Restriction enzymes can be used to type micro satellites but not minisatellite.
- c. There are very few microsatellites so they are easily analysed.
- d. Microsatellites are present throughout eukaryotic genomes and are easily amplified using PCR.

**Correct Answer: D**

Microsatellite loci are useful as genetic markers because they are numerous, occur in every chromosome and have a high content of polymorphism information. Furthermore, they can be amplified by PCR and the resulting fragments resolved on agarose gels. Microsatellites abound and are useful as molecular markers in maize because they can be found in all chromosomes and contain a high-polymorphism information content Moreover, they are inexpensive and very easy to handle since they require small amounts of template DNA.

**Core concept:**

**Topic:**

Difficulty Level: Difficult

Complexity:

Q. 170 Which of the following statements is (are) true? about retrotransposons?

- P. Retrotransposons replicate through an RNA intermediate.
  - Q. Retrotransposons utilize reverse transcriptase for transposition.
  - R. Retrotransposons may contain introns.
- a. P only
  - b. R only
  - c. Q only
  - d. P, Q and R

**Correct Answer: D**

Retrotransposons comprise the bulk of large plant genomes, replicating via an RNA intermediate whereby the original, integrated element remains in place. The RNA copies of retrotransposons are then transcribed back into DNA-using a reverse transcriptase and these are inserted into new locations in the genome. Mobile group II introns have been used to develop a novel class of gene targeting vectors, targetrons, which employ base pairing for DNA target recognition and can thus be programmed to insert into any desired target DNA.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q.171. Complete the statement, histones

- a. are highly basic because they contain many positively charged amino acid side chains.
- b. account for approximately one-fifth of the mass of chromosome.
- c. in combination with DNA, they are the primary constituents of chromatin
- d. Both B and C.

**Correct Answer: B**

The histones are extremely abundant proteins in eukaryotic cells; together, their mass is approximately equal to that of the cell's DNA. In addition, chromatin contains an approximately equal mass of a wide variety of non-histone chromosomal proteins.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 172. Why Haemophilia is more common in males?

- a. Because it is a recessive character carried by Y – chromosome.
- b. Because it is a dominant character carried by Y – chromosome.
- c. Because it is a dominant trait carried by X – chromosome.
- d. Because it is a recessive trait carried by X – chromosome.

**Correct Answer: D**

Haemophilia is more common in males because it is a recessive trait Carried by X chromosome. Haemophilia A is the most common X – linked genetic disease that prevents normal blood clotting when blood vessels are ruptured. It appears in about in 7000 males. In most of the severe cases, an affected person can bleed to death from a bruise or cut. Haemophilia A is caused by the absence of a protein called antihemophilic factor of factor VIII that is essential for blood clotting.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**



Q. 173. A sequence that can be several thousand base pairs upstream or downstream of a eukaryotic promoter and which increases gene expression as much as 200 -fold is called

- a. CAAT box
- b. Insulator
- c. TATA box
- d. Enhancer

**Correct Answer: D**

Eukaryotic genes often have control elements called enhancers, which increase gene expression and which can be thousands of base pairs away from the promoter. These can be tissue-specific, enhancing transcription in only certain tissues. The enhancer is brought into proximity with the promoter by looping of the DNA that lies between them.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 174. All of the following statements are true about transposition, except

- a. Transposons move from one location to a different one within a chromosome.
- b. Both the donor and target sites must be homologous.
- c. Both A and B
- d. The transposon may either be excised or moved.

**Correct Answer: B**

When a transposon moves by a non-replicative mechanism, it is completely excised from one place (the donor site) and moved to a second place (the target site). Homologous recombination would use the intact copy of the donor site to repair the damaged donor site. When a transposon moves by a replicative mechanism, no gap is left in the donor DNA. Instead an intact copy of the transposon remains in the donor site.

**Core concept:**

**Topic:**

Difficulty Level: Difficult

Complexity:

Q.175. What is the effect 2,4– dinitrophenol on mitochondria?

- a. Blocks ATP synthesis without inhibiting electron transport by dissipating the proton gradient.
- b. Blocks electron transport and ATP synthesis by inhibiting ATP-ADP exchange across the inner mitochondrial membrane.
- c. Blocks electron transport and proton pumping at complex I,II,III .
- d. Interacts directly ATP synthase and inhibits its activity.

**Correct Answer: D**

Some chemicals (*e.g.* 2,4-dinitrophenol; DNP) are uncoupling agents; they allow electron transport to proceed without ATP synthesis. They uncouple mitochondria by carrying H<sup>+</sup> ions across the inner mitochondrial membrane and hence dissipate the proton gradient. The energy derived from uncoupled electron transport is released as heat.

Core concept:

Topic:

Difficulty Level: Difficult

Complexity:

Q.176. Choose the correct statement concerning the regulation of *trp* operon expression by attenuation.

- a. Rapid translation of the leader peptide prevents completion of the mRNA transcript.
- b. Rapid translation of the leader peptide helps in the completion of the mRNA transcript.
- c. The leader peptide sequence contains no arginine residues.
- d. The leader peptide sequence contains tryptophan residues.

**Correct Answer: A**

Translation of the *trp* operon encoded mRNA begins with the synthesis, not of one of the enzymes, but of a short 'leader' peptide encoded by the 5' end of the message. The leader

peptide contains codons encoding tryptophan. If there is tryptophan in the cell, then tRNA charged with tryptophan will be available and ribosomes will move rapidly along the sequence encoding the leader peptide. The effect of this is to leave part of the mRNA sequence free to base pair with itself, forming a stem-loop transcription termination signal so the mRNA is never completed and the enzymes needed for tryptophan synthesis are not made. The leader peptide has no other function but to play this regulatory role by its translation and is rapidly degraded.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 177 A gene expressing a 50kDa protein from an eukaryotic was cloned in an *E.coli* plasmid under the lac promoter and operator. Upon addition of IPTG, the 50kDa protein was not detected. Which one of the following explains the above observation?

- a. The cloned sequence lacked the Kozak sequence.
- b. *E. coli* does not make proteins larger than 40kDa.
- c. Differences in codon preference.
- d. 50kDa protein contains a nuclear localization signal.

**Correct Answer: B**

Plasmids, phages and cosmids are the classic cloning vectors, which are limited to the size insert they can accommodate, taking up to 10,20 and 45 kb, respectively.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q.178. Choose a correct statement for the telomeres that are present in eukaryotic genome at the chromosomal ends.

- a. Telomeres are present at the chromosomal ends as a selfish DNA.
- b. Telomeres are present at the chromosomal ends to protect them from breakdown.
- c. Telomeres are present at the chromosomal ends to encode the genes that are involved in ageing.
- d. Both A and C

**Correct Answer: B**

Telomeres consist of up to 3,300 repeats of the DNA sequence TTAGGG. They protect chromosome ends from being mistaken for broken pieces of DNA that would otherwise be fixed by cellular repair machinery. But every time our cells divide, the telomeres shrink. When they get short enough, our cells no longer divide and our body stops making those cells. Over time, this leads to aging and death.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 179. Which of the following is not a second messenger in the case of eukaryotes?

- a. 1,2 – diacyl glycerol
- b. Cyclins
- c. Inositol 1,4,5 – triphosphate
- d. All of the above are second messenger in eukaryotes

**Correct Answer: B**

The changes are passed along through the nucleus of the cell by a network of molecules called second messengers. In response to second messenger, the concentrations in the nucleus of proteins called cyclins change. When the concentration of cyclin D is high, the cell enters the S phase, committing it to division.

**Core concept:**

Topic:

Difficulty Level: Difficult

Complexity:

Q. 180. Which of the following is the correct order in which the extra-cellular signals are transmitted?

- a. Adenylate cyclase - cAMP - Protein kinase A
- b. Protein kinase A- Adenylate cyclase -c ATP- cAMP
- c. Protein kinase A- cAMP - Adenylate cyclase
- d. cAMP - Adenylate cyclase - cATP- Protein kinase A

**Correct Answer: A**

The signal is passed from a 7 – helix receptor to an intracellular G- protein. Adenylate Cyclase (AC) is a transmembrane protein, with cytosolic domains forming the catalytic site. Adenylate Cyclase, activated by the stimulatory  $G_{\alpha}$ -GTP, catalyzes synthesis of cAMP. Protein Kinase A (cAMP Dependent Protein Kinase) catalyzes transfer of phosphate from ATP to serine or threonine residues of various cellular proteins, altering their activity.

Core concept:

Topic:

Difficulty Level:

Complexity: Medium

Q. 181. Given below are the events in the cell cycle.

(a) Phosphorylation of laminin A, B, C

(b) Phosphorylation of Rb (Retinoblastoma protein)

(c) Polyubiquitination of securin

(d) Association of inner nuclear membrane proteins and nuclear pore complex protein with chromosomes. Which one of the following reflects the correct sequence of events in the mammalian cell cycles?

a.  $a \rightarrow b \rightarrow c \rightarrow d$

b.  $b \rightarrow c \rightarrow d \rightarrow a$

c.  $c \rightarrow a \rightarrow b \rightarrow d$

d.  $b \rightarrow a \rightarrow c \rightarrow d$

**Correct Answer: D**

Phosphorylation of Rb protein is the 1st step during G<sub>1</sub>–S phase transition. G<sub>1</sub> to S phase transition is tightly regulated by the expression and phosphorylation of a number of well characterized cyclins, cyclin-dependent kinases and members of the retinoblastoma gene family. Then mitotic CDKs promote nuclear envelope breakdown by phosphorylation of laminins. Mitotic CDKs are best known for their role in triggering entry into mitosis. They are composed of a catalytic CDK subunit and a regulatory B-type cyclin subunit. Mitotic CDKs promote nuclear envelope breakdown, spindle assembly and organization, chromosome condensation, and Golgi fragmentation and contribute to APC/C regulation. Polyubiquitination of securin cause the separation of sister chromatids and finally the nuclear membrane and pore complex reappear.

**Core concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q.182. In \_\_\_\_\_, G<sub>0</sub> phase of the cell cycle is usually absent.

a. fibroblast cells

- b. early cleavage stage cells
- c. epidermal cells
- d. epithelial cells

**Correct Answer: B**

Inhibition of PKB (protein kinase B) activity using a highly selective PKB inhibitor resulted in inhibition of cell cycle progression only if cells were in early G1 phase at the time of addition of the inhibitor, as demonstrated by time-lapse cinematography. Addition of the inhibitor during mitosis up to 2h after mitosis resulted in arrest of the cells in early G1 phase, as deduced from the expression of cyclins D and A and incorporation of thymidine. After 24h of cell cycle arrest, cells expressed the cleaved caspase-3, a central mediator of apoptosis. These results demonstrate that PKB activity in early G1 phase is required to prevent the induction of apoptosis.

**Core concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 183. The frequency of cells in a population that are undergoing mitosis (the mitotic index) is a convenient way to estimate the length of the cell cycle. In order to measure the cell cycle in the liver of the adult mouse by measuring the mitotic index, liver slices are prepared and stained to easily identify cells undergoing mitosis. It was observed that only 3 out of 25,000 cells are found to be undergoing mitosis. Assuming that M phase lasts 30 minutes, calculate the approximate length of the cell cycle in the liver of an adult mouse?

- a. 76 hours
- b. 50 hours
- c. 42 hours
- d. 21 hours

**Correct Answer: C**

The sum of all cells in phase as prophase, metaphase, anaphase and telophase, respectively; N is the total number of cells. Mitotic Index  $(MI) = \frac{3}{25000} \times 100 = 1.2\%$ . From the cell cycle, 1.2% is mitotic and the rest will obviously be interphase.

So, 1.2% is 30 minutes, so 100% (length of total cell cycle) is 2500 minutes (42 hours).

**Core concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 184. Many cancers carry mutant p53 genes, while some cancers have normal p53 genes. p53 activates p21 (Waf1) which inhibits G1/Cdks, and phosphorylation of the retinoblastoma protein (Rb). Cancers with normal p53 genes could

- a. express non-phosphorylated form of Rb.
- b. express high levels of p53-deubiquitinases.
- c. express inactive forms of G1/S -cdks.
- d. express inactive forms of G1/S cyclins.

**Correct Answer: D**

When damage is sensed, the activity of the p53 protein aids in the decision between repair and the induction of cell death (apoptosis).

As a transcription factor, p53 stimulates the transcription of a group of target genes. Among them, p21 is one of the most important. The product of the p21 gene is a negative regulator of cyclin-dependent kinases, enzymes that are critical in the progression of the cell cycle and ultimately cell division.

**Core concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 185 Complete the statement, 'Proto-oncogenes are\_\_\_\_\_ '.

- a. oncogenes of transformed retroviruses



- b. oncogenes present in living organisms
- c. genes encoding oncoproteins
- d. cellular genes encoding proteins related to viral oncogenes

**Correct Answer: D**

An oncogene formed by the first mechanism encodes an oncoprotein that differs slightly from the normal protein encoded by the corresponding proto-oncogene. In contrast, the latter two mechanisms generate oncogenes whose protein products are identical with the normal proteins; their oncogenic effect is due to their being expressed at higher than normal levels or in cells where they normally are not expressed.

However they arise, the gain of function mutations that convert proto-oncogenes to oncogenes act dominantly; that is, mutation in only one of the two alleles is sufficient for induction of cancer.

**Core concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 186 The normal cellular counterparts of oncogenes are important for the given functions except which of the following?

- a. Cell cycle progression promotion.
- b. Apoptosis inhibition.
- c. Promotion of DNA repair.
- d. All of the above are important function of oncogenes.

**Correct Answer: C**

Hypermethylation of many tumor suppressor and DNA repair genes has been demonstrated in human tumors, including the p53 pathway, the APC/E-cadherin signaling network and a number of mismatched DNA repair genes.

**Core concept:**

Topic:

Difficulty Level: Medium

Complexity:

Q.187.. In *in-vitro* conditions, some oncogenic retro-viruses can transform normal mammalian cells to cancer cells. This transformation of a cell is basically associated with

- a. the host cell DNA conversion into viral RNA.
- b. the presence of viral particles in the cell membrane.
- c. the viral genome integration into the host's nuclear DNA.
- d. All of the above

**Correct Answer: C**

Oncogenic viruses have served as important experimental models to identify and molecularly investigate such cellular networks. The advent of modern tumor virology came about with the development of an *in vitro* transformation assay for Rous Sarcoma Virus (RSV). Shortly after infection, the viral RNA genome is reverse-transcribed by the virally encoded reverse transcriptase into a double-stranded DNA copy, which then integrates into the host chromosome and is expressed under the control of viral transcriptional regulatory sequences.

**Core concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 188. Why the daughter cells that are formed as a result of meiosis are not similar to that of parent cell?

- a. Because meiosis is completed in two stages.
- b. Because prophase is the longest phase.
- c. Because nucleus size increases in daughter cells.
- d. Because crossing over takes place and chromosome number is halved.

**Correct Answer: D**

In meiosis I, homologous chromosomes pair with each other and can exchange genetic material in a process called chromosomal crossover. The homologous chromosomes are then pulled apart into two new separate daughter cells, each containing half the number of chromosomes as the parent cell and the daughter cells produced are not genetically identical because of occurrence of crossing over. At the end of meiosis I, sister chromatids remain attached and may differ from one another if crossing-over occurred, and the daughter cells

produced are not genetically similar because during prophase I of meiosis crossing over takes place and the maternal and parental homologous chromosomes of an organism pair up and exchange some portions of their genetic portions. Chromosome number of parent cell is halved, hence daughter cells differ from parent cell.

**Core concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 189. Which among the following takes place in somatic cell cycle?

- a. G1 phase DNA content is double the amount of DNA present in the origin cell.
- b. G2 phase follows mitotic phase.
- c. A short interphase is followed along mitotic phase.
- d. DNA replication takes place in S phase.

**Correct Answer: D**

DNA replication takes place only in the S (synthesis) phase of the cell cycle, which is part of interphase. In the other parts of interphase, the gap phases G1 and G2, which precede and follow S phase respectively, parts of the DNA are transcribed, protein synthesis takes place and the cell grows, but DNA is not synthesized.

**Core concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 189 \_\_\_\_\_ precedes re-formation of the nuclear envelope during M phase of cell cycle.

- a. De-condensation from chromosomes and reassembly of the nuclear lamina
- b. Transcription from chromosomes and reassembly of the nuclear lamina
- c. Formation of the contractile ring and formation of the phragmoplast
- d. Formation of the contractile ring and transcription from chromosomes

**Correct Answer: C**

The mitotic spindle assembles first and segregates the chromosomes. The contractile ring assembles later and divides the cell in two. Plant cells use a very different mechanism to divide the cytoplasm. In animal cells and many unicellular eukaryotes, it is the contractile ring; in most plant cells, it is the phragmoplast. The contractile ring contains both actin and myosin filaments and forms around the equator of the cell, just under the plasma membrane; as the ring contracts, it pulls the membrane inward, thereby dividing the cell in two.

**Core concept:**

**Topic:**

Difficulty Level: Medium

Complexity:

Q. 190 How tumor cells are destroyed?

- a. By the action of Natural Killer cells.
- b. By the action of T cell.
- c. By the action of B cell.
- d. All of the above

**Correct Answer: A**

The human body's first line of defense against cancer is the natural killer (NK) cell. NK cells are white blood cells that actively scan the body for abnormal cells, destroying them before they can develop into actual cancers. NK cells recognize infected or tumorigenic cells and kill them. When NK cells detect an infected or tumor cell, they secrete granules that contain perforin, creating a pore in the target cell; granzymes then pass through these pores, degrading cellular proteins, causing cells to undergo apoptosis.

Core concept:

Topic:

Difficulty Level: Medium

Complexity:

Q.191. Choose from the following and Interleukin that causes a proliferation of T-cells and activation of NK cells.

- a. IL – 1
- b. IL – 2
- c. IL – 3
- d. IL – 4

**Correct Answer: B**

Interleukin (IL)–12 plays a critical role in modulating the activities of natural killer (NK) cells and T-lymphocytes. IL –2 is produced by CD-4 lymphocytes that are stimulated. IL –2 causes proliferation of activated T and B cells and increase production of NK cells. Activated T cells produce IL –2, which induces proliferation of antigen-activated T cells and enhances NK -cell activity.

**Core concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 192 Which among the following would not result via the treatment of root tip meristem cells with microtubule inhibitor?

- a. induction of polyploidy
- b. Cessation of DNA replication
- c. Inhibition of mitotic spindle assembly
- d. Both B and C

**Correct Answer: B**

Different concentrations of colchicine ( $2\mu\text{M}$ ,  $50\mu\text{M}$ ,  $100\mu\text{M}$ ,  $150\mu\text{M}$ ,  $200\mu\text{M}$  and  $250\mu\text{M}$ ) were used to induce endoreduplication in root tips cells of *Allium cepa*. There was remarkable inhibition in growth of roots and c- tumor formation was observed at the tip of roots. Cytological analysis showed that the cells of root tip were endoreduplicated and were arrested at metaphase. There was an increase in cell and nucleus size after colchicine treatment.

**Core concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 193 A tumor suppressor protein called as retinoblastoma is directly involved in

- a. cell cycle progression

- b. cell cycle regulation
- c. transmission of signals
- d. Both A and B

**Correct Answer: A**

The Rb protein is a tumor suppressor, which plays a pivotal role in the negative control of the cell cycle and in tumor progression. It has been shown that Rb protein (pRb) is responsible for a major G1 checkpoint, blocking S – phase entry and cell growth. The retinoblastoma family includes three members, Rb/p105, p107 and Rb2/p130, collectively referred to as 'pocket proteins'.

**Core concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 194. Complete the statement, Apoptosis is

- P. an energy dependent biochemical mechanism of programmed cell death.
  - Q. a genetically programmed process of deliberate suicide.
  - R. characterized by morphological changes including cell shrinkage, blebbing, chromatin condensation and nuclear fragmentation.
  - S. comprises only effectors phase and degradation execution phase.
- a. P and R
  - b. Q and S
  - c. P, R and S
  - d. P, Q and R

**Correct Answer: D**

The process of programmed cell death or apoptosis, is generally characterized by distinct morphological characteristics and energy-dependent biochemical mechanisms. Apoptosis is



considered a vital component of various processes including normal cell turnover, proper development and functioning of the immune system, hormone-dependent atrophy, embryonic development and chemical-induced cell death. Apoptosis is a genetically determined process, consequently referred to as the “programmed cell death”, leading to the suicide of the cell. In cells with deregulated *c-Myc* expression but not in control cells, *cis* diammine dichloroplatinum induced p38 activity and typical features of apoptosis, including internucleosomal DNA degradation, induction of caspase activities and both nuclear (nuclear condensation and fragmentation) and extranuclear (cell blebbing) morphological alterations.

**Core concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q.195. FOS, JUN and MYC are

- a. proteins that are expressed on the surface of cancerous cells.
- b. proteins that phosphorylate transcription factors in cancerous cells.
- c. proteins involved in regulation of expression of genes involved in growth promotion.
- d. All of the above

**Correct Answer: C**

Up-regulation of *IL-2* gene expression is also the major endpoint of signaling by the T cell antigen receptor (TCR). In normal T cells, engagement of TCR-CD3 complexes and costimulation by CD28 lead to the stimulation of multiple pathways followed by activation of transcription factors, including NF- $\kappa$ B, nuclear factor of activated T-cells cytoplasmic calcineurin-dependent 2 (NF-AT1), Early growth response 1 (EGR1), E74-like factor 1 (ELF1), E1K-1, c-Fos, c-Jun/c-Fos and AP-1. Together, NF- $\kappa$ B, NF-AT1, EGR1, ELF1, AP-1 and constitutively expressed POU class 2 homeobox 1 (Oct-1) regulate the *IL-2* proximal promoter to drive *IL-2* gene transcription.

**Core concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 196. The proteins encoded by proto-oncogenes participate in various metabolic processes including

- a. regulation of transcription
- b. cell-to-cell signaling
- c. intracellular signaling transduction
- d. All of the above

**Correct Answer: D**

Pim – 1 is a proto-oncogene which encodes for the serine/threonine kinase of the same name. Pim – 1 is mainly involved in cell cycle progression, apoptosis and transcriptional activation, as well as more general signal transduction pathways. C – ABL is a proto-oncogene encoding a non-receptor protein kinase that is localized to both the cytoplasm and nucleus. Interestingly, c – ABL can have both agonistic and antagonistic effects on cellular function depending on its cellular localization. Proto-oncogenes or cellular oncogenes are important in the normal regulation of growth. Signal transduction from membrane kinases may be modulated by the ras oncogenes, which are highly conserved GTP binding proteins located in the cell membrane. Oncogenes coding for nuclear proteins that bind DNA and may be phosphorylated by kinases such as raf or ab1 represent the final step in signal transduction.

**Core concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q.197. Ras oncogene transforms viral encoded normal mammalian cells into cancer cells. How do viral Ras protein differs from its normal counterpart?

- a. It diminished GTPase activity.
- b. It increased GTPase activity.
- c. It diminished ATPase activity.
- d. It increased ATPase activity.

**Correct Answer: A**

By using the FRAP (fluorescence recovery after photobleaching) technique, it was found that RAS at the neurites turned over rapidly; therefore, the sustained RAS activity at neurites was due to high GTP/GDP exchange rate and/or low GTPase activity, but not to the retention of the active RAS.

Core concept:

Topic:

Difficulty Level: Medium

Complexity

Q.198. Which of the following is a characteristic feature of a malignant tumor?

- a. Malignant tumor is a process of slow expansion of cells.
- b. Atypical tissue structure with uncontrolled growth.
- c. It is a procedure of proto-oncogenes expression.
- d. Transforms normal cells at a rapid pace.

**Correct Answer: B**

A malignant tumor, however, is capable of both invading surrounding normal tissue and spreading throughout the body via the circulatory or lymphatic systems (metastasis). Only malignant tumors are properly referred to as cancers, and it is their ability to invade and metastasize that makes cancer so dangerous. Malignant tumors are made up of cells that grow out of control. Cells in these tumors can invade nearby tissues and spread to other parts of the body. Whereas benign tumors can usually be removed surgically, the spread of malignant tumors to distant body sites frequently makes them resistant to such localized treatment.

Core concept:

Topic:

Difficulty Level: Medium

Complexity:

Q.199 . Which of the following is an incorrect match?

- a. erbB-EGF receptor
- b. fos – PDGF receptor
- c. erbA – Thyroid receptor
- d. ras – GTPase activity

**Correct Answer: B**

The mechanism by which the Src family of protein-tyrosine kinases (SFKs) regulates mitogenesis and morphological changes induced by platelet-derived growth factor (PDGF) is not well known. The cholesterol-enriched membrane microdomains, caveolae, regulate PDGF receptor signalling in fibroblasts and we examined their role in SFK functions. Using biochemical fractionation, it is shown that caveolac-enriched subcellular membranes regulate the formation of PDGF - receptor- SFK complexes.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 200 Choose the correct statement from the following regarding functioning of pax6 .

- A. Pax6 generates competence in optic vesicle.
  - B. Pax6 generates competence in head ectoderm.
  - C. Optic vesicle can induce lens formation of any part of head ectoderm which expresses Pax6.
  - D. Lens formation can also be induced by BMP and FGF besides Pax6.
- a. B, C
  - b. A, B, C
  - c. C, D
  - d. All of the above

**Correct Answer: A**

Competence is not a passive state, but an actively acquired condition. For example, in the developing chick and mammalian eye, the Pax6 protein appears to be important in making the ectoderm competent to respond to the inductive signal from the optic vesicle. Pax6 expression is seen in the head ectoderm, which can respond to the optic vesicle by forming lenses and it is not seen in other regions of the surface ectoderm.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 201 \_\_\_\_\_ is necessary for transport of mRNA from nucleus.

- a. RNA editing and 3' -polyadenylation
- b. 5'-capping and secondary structure
- c. Only polyadenylation
- d. Only secondary structure

**Correct Answer: D**

The stemloop structure precludes ribosome binding and, thus, translation of the mRNA and its formation is dependent upon the position of transcriptional initiation by RNA polymerase. This mechanism for regulating *pyrD* expression involving pyrimidine-regulated transcriptional start-site selection by RNA polymerase, RNA secondary structure and translational repression provides an autoregulatory mechanism to ensure sufficient levels of pyrimidine nucleotide in the cell independent of any additional regulatory proteins.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 202 Which among the following are the two major properties of stem cells?

- a. Unlimited self-renewal and multipoint differentiation.

- b. Transformation and commitment.
- c. Unidirectional differentiation and limited passage.
- d. Limited lifespan and multipoint differentiation.

**Correct Answer: A**

Stem cells are undifferentiated biological cells that can differentiate into specialized cells and can divide (through mitosis) to produce more stem cells. Neural stem cells and to culture conditions and methods of culturing neural stem cells (NS cells or NSCs) in order to promote symmetrical division and self renewal of the stem cells by self remaining cell divisions. Compositions, cell populations, cell lines and single neural stem cells are also provided.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 203 Choose bacterial toxins that have dependency on the incubation time, toxin dose and ADP-ribosyl transferase activity.

- a. Cholera toxin
- b. Diphtheria toxin
- c. Staphylococcus exotoxin
- d. *S aureus*  $\alpha$ -toxin

**Correct Answer: D**

Staphylococcal  $\alpha$ -toxin resulted in ADP-ribosylation of the 37 and 41 kDa proteins of a membrane preparation from rabbit erythrocytes. In the presence of 100  $\mu$ M GTP, the toxin ADP-ribosylated proteins of 54 and 59 kDa and potentiated ADP-ribosylation of the 37 and 41 kDa forms. The ADP-ribosylation of these proteins was observed to be dependent on the incubation time and toxin dose and was abolished by prior boiling.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

Complexity:

Q. 204. Maximum Ethidium Bromide binds to

- a. negatively supercoiled
- b. covalently closed relaxed circle
- c. linear DNA molecule
- d. positively supercoiled DNA molecule

**Correct Answer: C**

Ethidium is a large planer molecule that binds tightly to DNA. It is often used in biochemistry laboratories to visualize fragments of DNA that have been separated on gels. The ethidium molecule is fluorescent when illuminated with ultraviolet light it shines in the visible range. When ethidium intercalates into DNA, it changes the structure of the DNA. Ethidium increases the distance between the two base pairs that it binds to, causing the overall length of the DNA to increase. In addition, ethidium intercalation decreases the pitch of the bases (the angle of one base relative to the base above or below it) which has the effect of untwisting the double helix.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 205. What will happen if the p53 gene in a cell is mutated?

- a. Cells cannot pass the M checkpoint.
- b. Cells are marked for apoptosis.
- c. Cells with damaged DNA may proliferate in an uncontrolled manner.
- d. The  $G_0$  checkpoint won't work properly.

**Correct Answer: C**

In the absence of functional p53 protein, there is no stopping cell with damaged DNA from moving through the  $G_1/S$  checkpoint and proliferating.

**Core concept:**



Topic:

Difficulty Level: Difficult

Complexity:

Q.206. The passage of a cell through the stages of the cell cycle is controlled by what type of protein kinases, that phosphorylate many different proteins at appropriate times?

- a. Cdk activating kinases
- b. Cyclin-dependent kinases
- c. Cyclins
- d. Tyrosine protein kinases

**Correct Answer: B**

Cyclin-dependent kinases (Cdks) are the key enzymes that carry out the phosphorylations that regulate progression through the cell cycle. The activity of Cdks is closely regulated and varies continuously throughout the cycle, but the actual amounts of Cdks present do not vary very much. Instead, their activity is controlled by cyclins and by phosphorylation.

Core concept:

Topic:

Difficulty Level: Difficult

Complexity:

Q. 207. What is the role of Bcl-2 protein family members Bax and Bcl-2 in regulating the intrinsic pathway of apoptosis?

- a. Bax inhibits apoptosis while Bcl-2 stimulates apoptosis.
- b. Bax stimulates apoptosis while Bcl-2 inhibits apoptosis.
- c. Both Bax and Bcl-2 inhibit apoptosis.
- d. None of the above

**Correct Answer: B**

The intrinsic apoptotic pathway is tightly regulated in mammalian cells by two groups of proteins, one favouring apoptosis and the other inhibiting it. They all belong to a single protein family, the Bcl-2 family. Bax and Bad are proapoptotic members of the family and are believed to be involved in the initial formation of pores in the mitochondrial membrane. Bcl-2 (the first discovered member) and Bcl-xL are important anti-apoptotic proteins that prevent pore formation and cytochrome c release.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 208. In bacterial cell division

P. MreB, (similar to actin) helps in chromosome movement.

Q. FtsZ, (a tubulin homologue), helps in cytokinesis.

R. ATP provides the energy.

S. Microtubules make cell plate.

a. P and R

b. P and Q

c. P, Q and R

d. P, Q, R and S

**Correct Answer: C**

The actin-like MreB cytoskeletal protein and RNA polymerase (RNAP) have both been suggested to provide the force for chromosome segregation. MreB-like proteins are essential for cell viability and have been implicated in major cellular processes, including cell morphogenesis, chromosome segregation and cell polarity. FtsZ localizes to a yet-to-be defined nucleation site at the mid-point of the cell soon after daughter cell formation and assembles as a ring (FtsZ- or simply Z-ring) that remains associated with the cytoplasmic membrane. This subcellular organelle, a functional analog of the contractile ring used in cytokinesis of many eukaryotic cells, is thought to form the scaffold for recruitment of other key cell division proteins (e.g. FtsL localization). ATP is the abbreviation of Adenoside-triphosphate. The three phosphates are attached to the sugar component (a ribose bound to Adenosine) through high energy bonds. Especially the third phosphate stores a lot of energy when bound to ADP. It is this energy that

can be passed on to other molecules, for instance to enable chemical reactions that are endothermic (require energy to take place).

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 209. In animal cells, cell division is made possible by a belt like bundle of actin filaments and myosin-II filaments known as

- a.  $\alpha$ -actinin
- b. tropomyosin
- c. contractile ring
- d. troponin

**Correct Answer: C**

Contractile assemblies of actin and myosin, resembling small-scale versions of muscle fibers, are present also in non-muscle cells. As in muscle, the actin filaments in these contractile assemblies are interdigitated with bipolar filaments of myosin II, consisting of 15 to 20 myosin II molecules, which produce contraction by sliding the actin filaments relative to one another. Toward the end of mitosis in animal cells, a contractile ring consisting of actin filaments and myosin II assembles just underneath the plasma membrane. Its contraction pulls the plasma membrane progressively inward, constricting the center of the cell and pinching it in two. Interestingly, the thickness of the contractile ring remains constant as it contracts, implying that actin filaments disassemble as contraction proceeds. The ring then disperses completely following cell division.

**Core concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 210. Maturation-promoting factor (MPF) controls the initiation of mitosis in eukaryotic cells. MPF kinase activity requires cyclin B. Cyclin B is required for chromosome condensation and breakdown of the nuclear envelope into vesicles. Cyclin B degradation is followed by chromosome decondensation, nuclear envelope reformation and exit from mitosis. This requires ubiquitination of a cyclin destruction box motif in cyclin B. RNase-treated *Xenopus* egg

extracts and sperm chromatin were, mixed. MPF activity increased with chromosome condensation and nuclear envelope breakdown. However, this was not followed by chromosome decondensation and nuclear envelope reformation because

- a. RNase contamination persisted in the system.
- b. cyclin B was missing from the system.
- c. ubiquitin ligase had been overexpressed.
- d. cyclin B lacking the cyclin destruction box had been overexpressed.

**Correct Answer: D**

Maturation-promoting factor (MPF) is also known as as mitosis-promoting factor. It is a heterodimeric protein, composed of cyclin B and cyclin-dependent kinase (Cdk1). MPF promotes the entrance into mitosis from the G<sub>2</sub> phase by phosphorylating multiple proteins needed during mitosis. MPF is activated at the end of G<sub>2</sub> by a phosphate known as Cdc 25, which removes an inhibitory phosphate group added earlier. The G<sub>2</sub> checkpoint triggers the start of the M phase (mitosis). In order for this checkpoint to be passed, the cell has to check a number of factors to ensure the cell is ready for mitosis.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 211. Chemolithotrophs are the bacteria that can utilize

- a. inorganic material as the energy source.
- b. light as the energy source.
- c. organic and inorganic compound as the electron source.
- d. All of the above

**Correct Answer: A**

All animals are chemoheterotrophs (meaning they oxidize chemical compounds as a source of energy and carbon), as are fungi, protozoa and some bacteria. The important differentiation amongst this group is that chemoorganotrophs oxidize only organic compounds while chemolithotrophs instead use inorganic compounds as a source of energy.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 212. ADP-ribosyltransferase activity is not shown by

- a. Cholera toxin
- b. *S. aureus* toxin
- c. Exotoxin A

d. None of the above

**Correct Answer: B**

ADP-ribosylation is the process involving an addition of one or more ADP-ribose moieties to a protein. It is a reversible post-translational modification that is involved in many cellular processes, including cell signaling, DNA repair, gene regulation and apoptosis. Improper ADP-ribosylation has been implicated in some forms of cancer. It is also the basis for the toxicity of bacterial compounds such as cholera toxin, diphtheria toxin and many others. The majority of *P. aeruginosa* strains secrete ExoS, a bifunctional toxin with GTPase-activating protein and ADP-ribosyl transferase activities. Numerous *in vitro* studies have investigated the targets and cellular effects of ExoS, linking both its enzymatic activities with inhibition of bacterial internalization.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 213. It was observed that doubling time of normal stem cells isolated from brain is 24 hours, whereas tumor-derived cells have a doubling time of 12 hours. For 24 hours, both these cell types were grown in the presence of radioactive thymidine, following which they were grown in normal media. What would be radioactivity per cell at the end of a week?

- a. High level of radioactivity in stem cells as compared to cancer cells.
- b. Half level of radioactivity in stem cells as compared to cancer cells.
- c. Same in both stem and cancer cells.
- d. None in stem cells and high levels found in cancer cells.

**Correct Answer: C**

Isolated transplantable melanoma cells were incubated for 4 and 24 hours and after that time the expression of Fas and FasL was estimated by flow cytometry. The results show that there was no Fas expression, although FasL was detected on both melanoma cell lines. Therefore the data reported by other authors indicate that a lack or a low level of Fas expression and an ectopic expression of FasZ on melanoma cells can be an escape mechanism of the tumour, to avoid host immune responses.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 214. The *Vibrio cholerae* pathogenesis depends on the small intestine colonization by the organism and secretion of an enterotoxin. Which one of the following is an incorrect statement related to pathogenicity of cholera?

- a. *Vibrio cholera* secretes the enterotoxin cholera toxin.
- b. Cholera toxin consists of A (active) and B (binding) subunit.

c. Cholera toxin alone cannot reproduce the symptoms of cholera in the absence of *Vibrio cholera*.

d. Both B and C

**Correct Answer: C**

*Vibrio cholerae* is a bacterial pathogen that colonizes the chitinous exoskeleton of zooplankton as well as the human gastrointestinal tract. Colonization of these different niches involves an *N*-acetylglucosamine binding protein (GbpA) that has been reported to mediate bacterial attachment to both marine chitin and mammalian intestinal mucin through an unknown molecular mechanism. *Vibrio cholerae* is the bacterium that causes cholera, a disease endemic in developing countries with poor sanitation. The pathogenesis of cholera is dependent on colonization of the small intestine by the organism and secretion of enterotoxin. After adhering, the organism multiplies and secretes an enterotoxin called cholera toxin. This exotoxin can reproduce the symptoms of cholera even in the absence of the *Vibrio* organisms.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 215 Name the group of organisms which uses light as the energy source and CO<sub>2</sub> as the principal carbon source.

a. Photoheterotrophs

b. Chemoautotrophs

c. Chemoheterotrophs

d. Photoautotrophs

**Correct Answer: D**

Photoautotrophs use energy from sun to convert water from the soil and carbon dioxide from the air into glucose. Glucose provides energy to plants and is used to make cellulose which is used to build cell walls *e.g.* Plants, algae, phytoplankton and some bacteria. Carnivorous plants like pitcher plant use photosynthesis for energy production but depend on other organisms for other nutrients like nitrogen, potassium and phosphorous. Hence, these plants are basically autotrophs. The carbon source commonly used by photoautotrophs is CO<sub>2</sub>.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 216 Choose an incorrect statement about *Corynebacterium diphtheria*.

a. All strains of *C. diphtheria* are producers of diphtheria toxin.

b. The production of diphtheria toxin can be minimized by high concentration of iron.

c. Diphtheria toxin inhibits protein synthesis.

d. Both A and B

**Correct Answer: A**

*Corynebacterium diphtheriae* belong to the family Mycobacteriaceae, which also includes Mycobacteria and Nocardia, and are Gram-positive and aerobic. Not all strains of *C. diphtheriae* are toxic because the gene for diphtheria toxin (the actual disease causing agent, abbreviated DT) is not found in the bacterial genome. The DT gene is actually located on the genome of a corynephage, a certain type of prophage. Not all phages carry the DT gene *tox*, so it is possible for a *C. diphtheria* bacteriatio undergo lysogenic conversion or be infected by a prophage, without producing the diphtheria toxin. Therefore, the toxinogenicity of *C. diphtheriae* is dependent on phage conversion with a phage that has a functional gene for the toxin protein.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 217 What type of organisms can grow best above 45°C?

- a. Psychrophilic
- b. Mesophilic
- c. Thermophilic
- d. Any of these

**Correct Answer: C**

The upper temperature limit for growth of any thermophilic eukaryotic organism is about 62–65°C. And the upper limit for any photosynthetic eukaryote is about 57°C - for the red alga *Cyanidium caldarium*, which grows around hot springs and has a temperature optimum of 45°C. In contrast to this, some unicellular cyanobacteria can grow at up to 75°C and some non-photosynthetic prokaryotes can grow at 100°C or more.

**Core Concept: Medium**

**Topic:**

**Difficulty Level:**

**Complexity:**

Q. 218 .Select the antibiotics from the following that are used to treat fungal infections.

- P. Ampicillin
  - Q. Cephalosporins
  - R. Griseofulvin
  - S. Polyenes
  - T. Penicillin
- a. P, Q and R
  - b. R and S

c. R, S and T

d. S and T

**Correct Answer: B**

Griseofulvin is an antifungal product especially active in certain dermatophyte infections such as athlete's foot. The drug is deposited in the epidermis, nails and hair, where it inhibits fungal growth. Polyenes bind to fungal membranes and cause loss of selective permeability. They are specific for fungal membranes because fungal membranes contain a particular sterol component called ergosterol, while human membranes do not. The toxicity of polyenes is not completely selective, however, because mammalian cell membranes contain compounds similar to ergosterol that bind polyenes to a small extent.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 219 .A very low concentration of free oxygen is present in the root nodules because

a. the nitrogen fixing bacteria present in the root nodules are anaerobic.

b. of binding of oxygen to leghemoglobin.

c. reductase enzyme present in leguminous plant helps in removal of  $O_2$  .

d. the nitrogen fixing bacteria present in the root nodules are aerobic.

**Correct Answer: B**

Leghemoglobin is a nitrogen or oxygen carrier, because naturally occurring oxygen and nitrogen interact similarly with this protein and a hemoprotein found in the nitrogen-fixing root nodules of leguminous plants. It is produced by legumes in response to the roots being colonized by nitrogen-fixing bacteria, termed rhizobia, as part of the symbiotic interaction between plant and bacterium.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 220. Which of the following statement better describe aerotolerant anaerobes?

a. These are the organisms that cannot tolerate oxygen.

b. These are the organisms that require less oxygen for survival.

c. These are the organism that doesn't use oxygen but can grow in the presence of oxygen.

d. These are the organisms that can grow in the presence of oxygen.

**Correct Answer: C**

The anaerobes are further subdivided into three main classes. There are obligate anaerobes, which are organisms that use an anaerobic metabolism to grow and are killed in the presence of oxygen, aerotolerant anaerobes, which are organisms with an anaerobic metabolism that can live in oxygen or oxygen-free environments and facultative anaerobes, which are organisms



that prefer to grow using aerobic metabolic processes but can switch to an anaerobic metabolism in the absence of oxygen.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 221. What can be inferred if a culture broth tube is very turbid at the surface but clear throughout the rest of the tube?

- a. Organism are aerobes.
- b. Organism should be grown in an anaerobic chamber.
- c. Organism cannot produce superoxide dismutase and/or catalase.
- d. Organisms are anaerobes.

**Correct Answer: A**

In broth media, nutrients are dissolved in water and bacterial growth is indicated by a change in the broth's appearance from clear to turbid. The turbidity or cloudiness of the broth is due to light deflected by bacteria present in the culture. Strict anaerobes will grow at the bottom of the broth tube, whereas aerobes will grow near the surface.

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

Q. 222. Exponential phase of growth curve of bacteria is of limited duration. Why?

- a. Because of rise in cell density.
- b. Because of accumulation of toxic metabolites.
- c. Both A and B
- d. None of the above

**Correct Answer: C**

Exponential phase is of limited duration because of;

- (i) exhaustion of nutrients
- (ii) accumulation of toxic metabolic end products
- (iii) rise in cell density
- (iv) change in pH ; and
- (v) decrease in oxygen tension (in case of aerobic organisms).

**Core Concept:**

**Topic:**

**Difficulty Level: Medium**

**Complexity:**

- Q. 223 An actively growing culture of *E. coli* divides in about 20 minutes. Under laboratory conditions, time taken to replicate the entire genome of this bacterium would be about
- 15 minutes
  - 20 minutes
  - 10 minutes
  - 18 minutes

**Correct Answer: B**

The chromosome of *E. coli* has a contour length of approximately 1.35 mm, several hundred times longer than the bacterial cell, but the DNA is supercoiled and tightly packaged in the bacterial nucleoid. The time required for replication of the entire chromosome is about 20 minutes, which is approximately twice the shortest division time for this bacterium. Some bacteria can double every 10 or 20 minutes under optimum conditions (adequate oxygen, plentiful nutrients, an optimum temperature).

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

- Q. 224 Which of the statements about *Corynebacterium diphtheriae* biology is incorrect?
- All strains of *C. diphtheriae* are producers of diphtheria toxin.
  - Diphtheria toxin production can be minimized by high concentration of iron in the medium.
  - Diphtheria toxin inhibits protein synthesis.
  - Diphtheria toxin is an AB toxin secreted as a polypeptide of 62 kDa.

**Correct Answer: A**

Diphtheria is an acute, toxin-mediated disease caused by the bacterium *Corynebacterium diphtheriae*. Toxin production (toxigenicity) occurs only when the *bacillus* is itself infected (lysogenized) by a specific virus (bacteriophage) carrying the genetic information for the toxin (tox gene). Only toxigenic strains can cause severe disease.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

- Q. 225 Based on their properties, match the genera in group 1 with those in group 2.

Group 1

Group 2

P. *Bacillus*

1. *Sarcina*

Q. *Neisseria*

2. *Azotobacter*

R. *Rhizobium*

3. *Hyphomicrobium*

S. *Caulobacter*

4. *Clostridium*

- P-4, Q-1, R-2, S-3
- P-2, Q-1, R-3, S-4

- c. P-2, Q-4, R-1, S-3  
d. P-1, Q-2, R-4, S-3

**Correct Answer: A**

*Clostridia* are strictly anaerobic to aerotolerant sporeforming bacilli found in soil as well as in normal intestinal flora of man and animals. Symbion-*N* is a bio-fertilizer based on the selective strains of nitrogen-fixing beneficial bacteria such as *Rhizobium*, *Azospirillum* and *Azotobacter*. It was shown that the genera *Caulobacter* and *Hyphomonas* are closely related to each other, but they are both distant from *Hyphomicrobium* species. The new genus, "Hyphobacter", is placed between *Caulobacter* and *Hyphomonas*. Most of the studies show that skin bacteria are the most common bacteria. Members of the genera *Neisseria*, *Sarcina*, *Micrococcus* and *Staphylococcus* were found to the present.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 226. Match the names of investigators in group 1 with their contributions in group 2.

Group 1

- P. Joseph Lister  
Q. John Needham  
R. Elie Metchnikoff  
S. Lazzaro Spallanzani

Group 2

1. Role of phagocytosis in infection.
  2. Disprove spontaneous generation.
  3. Proved spontaneous generation.
  4. Use of agar as solidifying agent.
  5. Use of carbolic acid as disinfectant.
- a. P-5, Q-3, R-2, S-1  
b. P-5, Q-3, R-1, S-2  
c. P-2, Q-3, R-1, S-5  
d. P-3, Q-2, R-1, S-2

**Correct Answer: B**

Lister had heard that carbolic acid had been used to get rid of a cattle parasite in fields and to treat sewage. He decided to see if it could also stop wounds becoming infected. He started to clean the wounds of his patients with carbolic acid and soak the dressings in antiseptic liquid as well. John Needham was a Scottish clergyman who, from 1725 to 1728, attempted to show that there was a life force in the molecules of all inorganic matter that caused spontaneous generation to occur. Eli Metchnikoff was the first of two Jews, along with Paul Ehrlich, to receive the Nobel Prize for medicine in 1908 for their research on cellular immunity. He was awarded the honor for the theory of phagocytosis, which demonstrates the process of how

specific white blood cells can break down harmful bacteria in the body. Lazzaro Spallanzani was one of the first to disprove spontaneous generation. An Italian scientist who proved microorganisms could be killed by boiling.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 227 The number of bacteria,  $N(t)$ , in a culture is given by the formula, where  $t$  is the elapsed time (in minutes) and  $N(t) = 300(2)^{t/d}$ , where  $t$  is the elapsed time (in minutes) and  $d$  is the doubling time. How many bacteria were in the initial account?

- a. 100
- b. 200
- c. 300
- d. 400

**Correct Answer: C**

The formula for doubling time is  $N(t) = 300(2)^{t/d}$ ,  $N_0$  is the initial account. According to the equation given,

$$N_0 = 300$$

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 228 Choose the correct match of antibiotics in group 1 with their mechanism of action in group 2

Group 1

- P. Tetracycline
- Q. Chloramphenicol
- R. Cycloheximide
- S. Streptomycin

Group 2

- 1. Inhibits bacterial protein synthesis by blocking peptidyl transferase.
- 2. Inhibits bacterial protein synthesis by blocking the A-site on the ribosome.
- 3. Misreads the genetic code and inhibits initiation of protein synthesis.
- 4. Inhibits protein synthesis by blocking peptidyl transferase on 80S ribosome.

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

**Correct Answer: B**

Tetracyclines inhibit bacterial protein synthesis by blocking the attachment of the transfer RNA-amino acid to the ribosome. More precisely they are inhibitors of the codon-anticodon interaction. Chloramphenicol is bacteriostatic but may be bactericidal at higher concentrations. Chloramphenicol stops bacterial growth by binding to the bacterial ribosome (blocking peptidyl transferase) and inhibiting protein synthesis. Streptomycin binds to the 30S ribosome and changes its shape so that it inhibits protein synthesis by causing a misreading of messenger RNA information. Cycloheximide blocks the peptidyl transferase of 80S eukaryotic ribosomes but not that of 70S bacterial ribosomes.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 230. Match the disease in Group I with their corresponding organism in Group II.

Group I

- P. African sleeping sickness
- Q. Rocky mountain spotted fever
- R. Mumps
- S. Filariasis

Group II

- I. Rubula virus
- II. *Trypanosoma brucei*
- III. *Wuchereria bancrofti*
- IV. *Rickettsia rickettsii*
- V. *Leishmania donovani*

- a. P – II, Q – IV, R – III, S – I
- b. P – III, Q – I, R – II, S – V
- c. P – II, Q – IV, R – I, S – III
- d. P – III, Q – V, R – II, S – IV

**Correct Answer: C**

African Trypanosomiasis, also known as “sleeping sickness”, is caused by microscopic parasites of the species *Trypanosoma brucei*. It is transmitted by the tsetse fly (*Glossina* species). Rocky Mountain spotted fever (RMSF) is a tickborne disease caused by (the bacterium *Rickettsia rickettsii*. This organism is a cause of potentially fatal human illness. Mumps is an acute, self-limited, systemic viral illness characterized by the swelling of one or more of the salivary glands, typically the parotid glands. The illness is caused by the RNA virus, Rubulavirus. Lymphatic filariasis is a parasitic disease caused by thread-like worms called *Wuchereria bancrofti*. The parasite is carried from person to person by mosquitoes.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 231. Psychrotroph bacteria

- a. can grow at 0–70°C, has optimum growth between 20–300°C.
- b. can grow at 200°C and has an optimum growth temperature of 100°C.
- c. have optimum growth between 10–550°C.
- d. can grow at 650°C or higher.

**Correct Answer: A**

The presence of psychrotrophic bacteria which are capable of producing extracellular proteolytic and lipolytic enzymes in refrigerated, pasteurized milk frequently leads to shortened shelf-life, loss of saleable products and consumer dissatisfaction. The term psychrophile means cold and “philos”, which means loving. Therefore, this term implied that such microorganisms grow best at low temperatures and that they are cold-loving. However, several investigators objected the use of this term since it implies a preference for growth at low temperature. Actually, these microorganisms grow better at 20°C or higher. In a 1976 meeting of the International Dairy Federation, psychrotrophs were defined as microorganisms that grow at 70°C or less, irrespective of optimal temperature.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**

Q. 232. Choose the property that is/are not expected to be significantly different between hot-spring bacteria (that live at 1200°C) and regular intestinal *E. coli*.

- P. The number of cysteines in the proteins.
  - Q. The number of methionines in the protein.
  - R. The molecular weight of the protein.
  - S. GC richness of the genomic DNA
- a. P and Q
  - b. Q and R
  - c. P and S
  - d. P and R

**Correct Answer: B**

*D. radiodurans*, hot spring bacteria is dependent on exogenous nicotinic acid because it lacks key enzymes for NAD biosynthesis. When a morpholine propanesulfonic acid (MOPS) defined medium is used, biotin is required in addition to nicotinic acid. Its methionine auxotrophy can be alleviated with vitamin B<sub>12</sub>, which is required as a cofactor for methionine synthase. In the presence of vitamin B<sub>12</sub>, sulfate can be used as the sole sulfur source. As a proteolytic

bacterium, *D. radiodurans* encodes systems for protein degradation and amino acid catabolism, most of which were acquired by horizontal gene transfer (HGT). Intracellular proteolytic activity is induced following ionizing radiation. The increase in proteolytic activity may expedite the recovery process by providing amino acids and peptides from the degraded proteins or proteins from the cells that did not survive the stress conditions.

**Core Concept:**

**Topic:**

**Difficulty Level: Difficult**

**Complexity:**