SOLUTIONS

4.1: Fluid mosaic membranes

1. **C**
   Phospholipids form a bilayer in the cell membrane, creating a semi-permeable barrier essential for bacterial cell function.

2. **D**
   Statements 2 and 4 are correct as hydrophobic tails face inward, while hydrophilic heads face outward. Phospholipids contribute to membrane flexibility. Ions require channels to pass, and polar heads face both cytoplasm and extracellular fluid, making statements 1 and 3 incorrect.

3. **C**
   Glycoproteins (1) are membrane proteins with attached carbohydrate chains involved in cell recognition and signaling. Phosphate heads (2) are part of phospholipids, forming the hydrophilic outer layer of the bilayer. Thus, option C is correct.

4. **D**
   The carbohydrate chains of both glycoproteins and glycolipids are found on the outer surface of the cell membrane, where they play roles in cell recognition and communication.

5. **B**
   The width of a typical cell membrane is within the range of 5–10 nm, which allows for its selective permeability and essential biological functions.

6. **C**
   Cholesterol stabilizes the membrane by reducing phospholipid movement, preventing excessive fluidity, especially at high temperatures.

7. **B**
   The β-adrenergic receptor is a protein. When adrenaline binds to it, the receptor changes shape, activating the G protein and triggering processes inside the cell.

8. **C**
   Cell recognition and signaling rely on glycolipids and glycoproteins, which have carbohydrate chains that extend from the cell surface. These molecules play a key role in cell adhesion, immune responses, and development. In contrast, cholesterol and phospholipids primarily maintain the structure and fluidity of cell membranes.

9. **D**
   Cholesterol regulates membrane fluidity by:
   – Inserting itself between phospholipid molecules, maintaining membrane structure.
   – Preventing phospholipid chains from packing too closely together at low temperatures.
   – Restraining phospholipid movement at high temperatures.
   – Reducing membrane permeability to ions and small molecules.

10. **B**
    Ligand binding to receptors and the consequent change in receptor shape is a core principle in cell signaling. This concept illustrates the dynamic nature of receptor-ligand interactions in cellular communication processes.

11. **D**
    Option D is correct, cholesterol is a lipid, thus it is non-polar and span between the phospholipids which would be hydrophobic, too. Carbohydrate chains of glycoprotiens and glycolipids usually are on the outer surface because they are hydrophilic.

12. **D**
    This question assesses knowledge of membrane transport mechanisms. Calcium ions (Ca^2) typically cannot pass directly through cell surface membranes without a carrier or channel protein due to their charge and hydration shell. Carbon dioxide (CO^2) is a small, nonpolar molecule that can diffuse directly through the phospholipid bilayer of cell membranes without the need for a carrier or channel. Glucose ($C_6H_{12}O_6$) is a large, polar molecule and therefore also requires a transport protein to cross the membrane efficiently.

13. C
Option C is the correct answer as in region 1 the hydrophobic region can be transported that is away from the water and in region 2 the hydrophilic region can be transported that is in contact with the water.

14. C
Glycoproteins on the cell surface membrane act as enzymes and have specific sites for chemical binding. They are also involved in cell signaling, including the secretion of specific chemicals or acting as receptors for signaling molecules

15. A
Option A is the correct answer as decreasing the ratio of saturated to unsaturated fatty acids helps to alter the permeability of the membrane by helping the tails remain adjacent to one another.

16. B
Option B is the correct answer as the signal molecule has a shape that is complementary to the shape of the cell surface receptor on the target cells allowing it to be detected by the target cell.

17. D
Option D is the correct answer as the enzymes are transported out of the cells via exocytosis.

18. A
Option A is the correct answer as the flexibility of the phospholipids allow them to separate in cytokinesis and during phagocytosis when ingesting a pathogen. Their polarity allows small non-polar molecules such as carbon dioxide and oxygen to diffuse directly through them.

19. A
Option A is the correct answer as changing the surface area of the membrane, concentration gradient or the number of specific protein channels all affect the rate of diffusion.

20. D
Option D is the correct answer as the signaling molecules do not always need to have the same shape. They can work with similar shapes as well. Increase in temperature may denature the protein receptors causing malfunctions in cell to cell signaling and a mutation in the DNA may decrease the number of protein receptors produced for the cell.

21. B
Option B is the correct answer as saturated fatty acid tails decrease the permeability of the cell surface membrane meaning that the movement of phospholipids is reduced. The glycoproteins in the membrane can move due to the fluid mosaic model. Channel proteins are not fixed and can move freely in the membrane.

22. D
Statement 1 is incorrect as the sucrose concentration may be difference but the water potential for the cell and the solution is the same. Statement 2 is correct as the water potential of the cell and the solution must be the same for no change in size to occur. Statement 3 is incorrect as there is no net movement of water meaning that the amount of water that moves out is the same as the amount that moves in. Hence, option D is the correct answer.

23. D
Option A is incorrect as proteins move as well. Option B is incorrect as cholesterol molecules exist within the cell membrane not on it. Option C is incorrect as the pattern is not regular. Hence, option D is the correct answer as the mosaic pattern is produced due to the scattering of different proteins in the bi-layer.

24. B
Phospholipids and proteins are found in the cell surface membrane. Peptidoglycan is found in the cell wall not the cell membrane. Hence, option B is the correct answer.

25. D
1 is a protein, 2 is a glycoprotein, 3 is a glycolipid and 4 is a cholesterol molecule. Only cholesterol molecules are always identical in the cell membrane. Hence, option D is the correct answer.

26. B
The G protein acts as a switch to release the secondary messenger that results in an enzyme signaling cascade. Hence, option B is the correct answer.

27. C
The liposomes formed will have the hydrophilic heads facing outwards and the hydrophobic tails facing inwards. Hence, option C is the correct image.

28. C
A decrease in the proportion of phospholipids with saturated fatty acid chains and proportion of long fatty acid chains will increase the fluidity of the cell membrane. Hence, option C is the correct answer.

29. D

Options A and C are incorrect since these are not involved in the fluid mosaic model. Option B is incorrect as fluids do not move via osmosis. Hence, option D is the correct answer as the model dictates that proteins and phospholipids can change locations by moving.

30. D

Option A is incorrect as cholesterol molecules increase the cell membrane fluidity not its permeability. Option B is incorrect as cell membrane has low permeability to large hydrophilic substances. Option C is incorrect as saturated fatty acids are not involved in permeability rather are involved in fluidity. Hence, option D is the correct answer as in the absence of carrier and channel proteins large polar molecules cannot enter the cell.

31. D

1 is incorrect as ions are polar molecules and cannot pass directly though the lipid bi-layer. 2 is correct as it is a channel protein that is involved in facilitated diffusion. 3 is incorrect as glycoproteins act as antigens. 4 is correct as cholesterol is involved in membrane fluidity. Hence, option D is the correct answer.

32. B

Options C and D are incorrect as unsaturated and shorter fatty acids increase the membrane fluidity. Option A is incorrect as channel proteins are not linked to number of phospholipids. Hence, option B is the correct answer as an increase in the hydrophobic interaction by the tails of phospholipids improves the membrane stability.

33. A

The extracellular part of the protein acts as a place for the binding of the signaling protein which results in a signally cascade set of by the G protein intracellularly. Hence, option A is the correct answer.

34. A

All the statements are correct as proteins and glycoproteins in the cell membrane help in the formation of tissues form cells. Glycoproteins acts as antigens for cell recognition and can also recognize hormones. Hence, option A is the correct answer.

35. A

1, 2 and 3 are all hydrophilic since they are facing outside towards the water which is evident from the arranged of the hydrophobic tails. Hence, option A is the correct answer.

36. C

Option A is incorrect as W is a phospholipid that forms the membrane. Option B is incorrect as X is a channel protein that not involved in active transport. Option D is incorrect as Z is a cholesterol molecule that is involved in cell membrane fluidity. Hence, option C is the correct answer as glycoproteins are involved in cell signaling.

37. C

Elaidic acid fits closely with other fatty acids due to the linear chain and this means that the membrane is less fluid at high temperatures. Oleic acid does not fit closely with other fatty acids due to the kink in the chain and this result in the membrane being more fluid at lower temperatures. Hence, option C is the correct answer.

38. D

The fatty acid chains and the cholesterol molecules are involved in the cell membrane fluidity and they are represented by 6 and 4 respectively making option D the correct answer.

39. A

The plateau is a result of the carrier proteins being saturated with glucose molecules. Hence, option A is the correct answer.

40. A

Option A is the correct answer as 1 is a glycoprotein which acts as an antigen and 4 is a phospholipid molecule which makes up the cell membrane and stabilizes it.

41. D

Water molecules are polar in nature and they pass through the channel proteins only. Hence, option D is the correct answer.

42. C

This highlights the fluid mosaic model of the cell membrane where the proteins diffuse freely in the membrane. Hence, option C is the correct answer.

43. B

In order for the rate to be the highest the surface area and difference in concentration should be the high while the thickness of the membrane should be low. Hence, option B is the correct answer.

44.   A

All the statements are correct as channel proteins allow polar molecules to pass through the membrane. Glucose can pass into the cell via carrier proteins and oxygen can pass through the membrane directly since it is soluble in lipids and some glycoproteins act as cell surface antigens. Hence, option A is the correct answer.

45.   A

Unsaturated and short fatty acids paired with cholesterol molecules increase the fluidity of the cell membrane. Hence, option A is the correct answer.

46.   A

Glycoproteins and glycolipids act as antigens as represented by 1 and 2 respectively. Hence, option A is the correct answer.

47.   C

Cholesterol helps to regulate the fluidity of the cell membrane making option C the correct answer.

48.   B

Carbon double bonds are responsible for increasing the fluidity of the cell membranes. Hence, option B is the correct answer.

49.   B

Statements 1 and 2 are correct as the proteins in different position indicate the validity of the fluid mosaic model by showing that proteins can move freely in the cell membranes. It does not however show that proteins are not fluid. Hence, option B is the correct answer.

50.   D

Option D is the correct answer as phospholipids regulate the fluidity of the cell membrane, cholesterol stabilize the membrane over a range of temperatures, protein form channels for polar molecules and glycoproteins are involved in cell to cell signaling. Hence, option D is the correct answer.

51.   D

Option D is the correct answer as the proteins molecules in the cell membrane and those that span the bilayer move freely between the phospholipid molecules confirming the fluid mosaic model.

52.   B

Carrier proteins are glycoproteins that are involved in moving substances through the membrane via both active and passive transport. Hence, option B is the correct answer.

53.   A

Cholesterol is involved in stabilizing the hydrophobic layer and regulating the fluidity. Phospholipids and proteins allow osmosis to occur and phospholipids act as a barrier to dissolved ions preventing them from passing directly through the membrane. Hence, option A is the correct answer.

54.   B

A cell membrane is around to 5-10 nm in width. Hence, option B is the correct answer.

55.   B

Phospholipids and proteins are found in the cell surface membrane. Peptidoglycan is found in the cell wall not the cell membrane. Hence, option B is the correct answer.

56.   B

Statements 1 and 2 are correct as freeze fracture shows the bilayer nature of the membrane as the phospholipid layers separate and it also shows how proteins are arranged in each layer. Hence, option B is the correct answer.

57.   D

Cholesterol is found inside the membrane whereas glycolipids and phospholipids are found on the surface of the membrane. Hence, option D is the correct answer.

58.   D

Cholesterol is responsible for the stabilization of the hydrophobic layer and it regulated the fluidity of the membrane. Hence, option D is the correct answer as this all contributes to the flexibility of the membrane.

59.   A

All the statements above are correct as the phospholipid layers are pinched during cytokinesis, allow carbon dioxide and oxygen to pass directly through the membrane and modify their shape to engulf pathogens. Hence, option A is the correct answer.

60.   D

1 is phospholipid as it not only denies entry to polar molecules but also stabilizes the membrane. 2 is cholesterol as its only function is to stabilize the membrane. 3 is glycolipid that stabilizes the membrane and

acts as a receptor and 4 is a glycoprotein that acts just as a receptor. Hence, option D is the correct answer.

61. **B**
Glycolipids and glycoproteins are involved in cell signaling making option B the correct answer.

62. **D**
Options A, B and C are incorrect as increase in saturated fatty acids and long fatty acid chains decrease the fluidity of the membrane. Option D is correct as an increase in temperature paired with the fatty acids with unsaturated fatty acid chains increases the fluidity.

63. **D**
Cholesterol is responsible for maintaining the fluidity and stability of the membrane. Hence, option D is the correct answer.

64. **C**
The carbon double bond helps to increase the cell membrane fluidity making option C the correct answer.

65. **D**
Cholesterol and phospholipid are responsible for maintaining the fluidity of the cell membrane. Hence, option D is the correct answer.

66. **B**
Since channel proteins are permanently attached to the membrane and span across it, they are integral intrinsic. Hence, option B is the correct answer.

4.2: Movement of substances into and out of cells

1. **A**
Facilitated diffusion is a passive process but temperature affects kinetic energy; increasing it from 15 °C to 20 °C raises particle movement, thus increasing diffusion rate at saturation point Q.

2. **D**
The cell in solution Q appears unchanged, indicating no net water movement. This happens when the water potential of the cell sap equals the water potential of the surrounding solution.

3. **C**
The sucrose solution prevents mitochondria from changing in dimension by maintaining an isotonic environment, preventing osmotic swelling or shrinking.

4. **A**
Water moves from higher (less negative) to lower (more negative) water potential. In option A, water correctly flows from −22 kPa to −33 kPa, −33 kPa to −36 kPa, and −36 kPa to −40 kPa, following the osmotic gradient.

5. **C**
Oxygen diffuses directly through the phospholipid bilayer, and water moves in and out by osmosis. Sodium ions, being charged, require protein channels for diffusion, making statement 2 incorrect.

6. **D**
Facilitated diffusion is a passive process that does not require energy from ATP, unlike active transport, endocytosis, and exocytosis, which do require ATP.

7. **D**
Molecule X is polar, as shown entering through a protein channel. The rate of its entry does not depend on ATP concentration, indicating that it enters via facilitated diffusion, which is a passive process.

8. **C**
Water moves out of cell X by osmosis because the water potential inside the cell is higher than the surrounding solution, leading to a net movement of water out of the cell.

9. **B**
Both nicotine and sucrose are transported through cotransporter proteins by facilitated diffusion, without requiring ATP, where protons drive the movement of the transported molecules.

10. B

The water potential of the cell was more negative than the external solution in slide 1, causing water to enter the cells and make them burst. In slide 2, the external solution had a more negative water potential, leading to water leaving the cells, which made them crinkle.

11. B

Facilitated diffusion occurs through channel or carrier proteins, which may or may not change shape, without using energy from the cell.

12. A

The diagram shows the transport of H^+ ions out of the companion cell through a pump (X) and the co-transport of H^+ ions with sucrose into the cell through a cotransporter (Y), indicating X is H^+ ions and Y is sucrose.

13. B

Sodium ions cross the membrane via facilitated diffusion through ion channels when moving down the concentration gradient, and via active transport using pumps like the sodium-potassium pump when moving against the gradient.

14. C

Cell Q remains turgid in the 1% solution because water moves into the cell, which has a more negative water potential than the surrounding solution.

15. C

The surface area to volume ratio is largest for smaller and thinner cylinders. Calculating the SA ratios for each, Z has the highest ratio, followed by X, then Y. Hence, $Z \rightarrow X \rightarrow Y$ is the correct order

16. C

As the side length of a cube increases, its volume (line 1) increases more rapidly than its surface area (line 2). This results in a decreasing surface area-to-volume ratio, making diffusion less efficient in larger cells.

17. B

Water moves by osmosis from areas of higher water potential to lower water potential. In solutions lower than the cell's water potential, the cell volume decreases, and in solutions with equal water potential, there is no change, while higher water potential leads to increased cell volume.

18. D

The correct surface area to volume ratio for an agar cube with side length of 5.5 mm is 1.1 : 1, calculated using the formula for surface area and volume of a cube.

19. D

All four statements are correct: Endocytosis and exocytosis involve vesicles, allow bulk transport, and involve membrane exchange with endocytosis losing and exocytosis gaining membrane.

20. C

To double the rate of diffusion, you need to double the value on the right side of the equation.
Examining each change:
-   Doubling the surface area (option 1) directly doubles the rate of diffusion.
-   Halving the concentration difference (option 2) decreases the rate of diffusion, not double it.
-   doubling the thickness of the membrane (option 3) decreases the rate of diffusion, not doubles it.
-   Halving the thickness of the membrane (option 4) directly doubles the rate of diffusion.

21. B

The response of plant epidermal cells to a hypertonic solution demonstrates the principles of osmosis and water potential. The movement of water out of the cell, leading to changes in cell turgidity, provides insight into cellular responses to environmental osmotic changes.

22. A

To predict the time for complete diffusion in the 5 mm × 10 mm × 15 mm agar block:
—   The time proportional to the size of the agar block.
—   Comparing the volume of the 5 mm × 10 mm × 15 mm block to the 10 mm × 10 mm block (which took 16.1 seconds to diffuse), the smaller block as half the volume.
—   Therefore, predict half the time (8.05 seconds) for complete diffusion, which matches option A.

23. A

The given diagram represents the organization of living things from the least complex to the most complex. The correct order is as follows:
1. Cells: The basic unit of life.
2. Tissues: Groups of similar cells with specialized functions.
3. Organs: Structures made up of different types of tissues working together.
4. Organ Systems: Groups of organs that work together to perform specific functions.
5. Organism: The complete living individual.

24. B

Endocytosis and exocytosis refer to mass movement of substances inside or outside the cell, respectively. They do not depend on concentration, thus B would be the only correct answer.

25. A

Water potential of the cytoplasm of the cells at the start of the experiment compared with the water potential of 0.45 mol dm^{-3} sucrose solution is less negative. This is indicated by the fact that percentage change in mass of plant tissue cylinder is negative at this concentration which means that water moved out of the plant tissue cells.
Since water moved out of the plant tissue cell, change in volume of the vacuoles of the cells at the end of the experiment, that were initially placed in sucrose solution is decreased.

26. B

The correct statement about simple diffusion is:
B. It is a passive mode of transporting substances.
Simple diffusion is a passive process in which molecules or ions move from an area of higher concentration to an area of lower concentration without the need for specific molecules in the cell membrane. It can occur in both prokaryotic and eukaryotic cells.

27. C

The relationship between the size and dimensions of blocks and the efficiency of diffusion is an application of the surface area to volume ratio concept. Understanding how changes in block shape affect diffusion efficiency is essential in interpreting transport processes in cells.

28. A

The cell Y has a lower water potential than the sugar solution that it was put into. This is due to the fact that water has moved into the cell and it appears to be turgid. Water moves from an area of high water potential to an area of lower water potential.
The cell Z has a less negative (more positive) water potential than the sugar solution that it was put into. This means that it was put into a hypertonic solution and water moved out of it, resulting in plasmolysis as seen in the diagram provided. Since the plant cells were put in 3 different sugar concentrations, i.e. 10%, 5% and 2.5%, It makes sense that cell Z was put in the highest of these concentrations.

29. D

The diagram illustrates a phospholipid, which is a major component of cell membranes. Phospholipids are composed of two fatty acid tails that are hydrophobic (water-fearing) and a phosphate-containing group that is hydrophilic (water-loving).

30. B

For a cube, the surface area is proportional to the square of the edge length (length × length), while the volume is proportional to the cube of the edge length (length × length × length). If the edge length is doubled, the surface area increases by a factor of 2^2 (or 4), and the volume increases by a factor of 2^3 (or 8). The surface area to volume ratio thus decreases by a factor of 2 (8/4), which means the ratio halves.

31. C

The diagram illustrates facilitated diffusion, where molecules move across the cell membrane through protein channels or carriers without energy use, from higher to lower concentration.

32. C

The photomicrograph shows onion epidermal cells after being soaked in a solution. The space labeled Y is where solution X has entered the cells, causing the cytoplasm to shrink away from the cell wall, a process known as plasmolysis. This occurs when cells are placed in a hypertonic solution, and water moves out of the cell, causing the cytoplasm to contract. Since the cells have been soaked in solution X and exhibit signs of plasmolysis, the space labeled Y is filled with solution X.

33. C
Adding sodium chloride to a culture solution decreases its water potential. When freshwater plant cells are placed in this solution, they may lose water and undergo plasmolysis due to the osmotic gradient.

34. D
The surface area to volume ratio for a cube is calculated by dividing the surface area ($6 \times side^2$, since there are six faces on a cube) by the volume ($side^3$).
For a cube with a side length of 2 μm:
– Surface area = $6 \times (2 \ \mu m)^2 = 6 \times 4 \ \mu m^2 = 24 \ \mu m^2$
– Volume = $(2 \ \mu m)^3 = 8 \ \mu m^3$
So, the surface area to volume ratio is 24 μm² : 8 μm³, which simplifies to 3 : 1.

35. D
If the potato piece did not change in size, this suggests that there was no net movement of water into or out of the potato cells, which happens when the water potential is equal in both the potato cells and the sucrose solution. "The water potential is the same in the potato and in the sucrose solution and there is no net movement of water into or out of the potato." It is not necessarily true that the concentrations of sucrose are the same, as osmosis is driven by the water potential, not just the concentration of the solute.

36. C
Facilitated diffusion and active transport both involve the selective movement of substances across a cell membrane. Facilitated diffusion uses specific carrier proteins for movement down the concentration gradient without energy, whereas active transport requires energy to move substances against their concentration gradient.

37. B
The diagram illustrates diffusion, where molecules move from a higher concentration in solution P to a lower concentration in solution Q through a partially permeable membrane.

38. C
Active transport and facilitated diffusion both involve specific membrane proteins. However, only active transport requires ATP for molecule and ion movement.

39. C
The salt solution maintains isotonic conditions, preventing the net movement of water into or out of the cells by osmosis, ensuring that cells neither swell nor shrink. Hence, C is the correct answer.

40. A
Option A is the correct answer as phagocytosis and active transport both require ATP to be carried out while facilitated diffusion can occur without the presence of ATP.

41. A
The potato cylinder's mass loss in a salt solution is due to osmosis, where water moves from the potato (higher water potential) to the salt solution (lower water potential).

42. A
Option A is the correct answer as a large surface area, short diffusion pathway and the maintenance of a constant diffusion gradient are all required for efficient diffusion.

43. B
Option B is the correct answer as endocytosis of water and exocytosis of enzymes from cells require ATP. Phagocytosis requires ATP as well while facilitated diffusion does not require ATP.

44. A
Option A is the correct answer as the block with the greatest surface area to volume ratio changes color the quickest and this is represented by the block in option A.

45. B
Option B is the correct answer as a decrease in concentration with time indicate processes such as diffusion, osmosis and exocytosis that move things out of cells.

46. A
Option A is the correct answer as exocytosis is the bulk transport of material out of a cell and it does not require the presence of a concentration gradient.

47. B
When the cell is placed in a solution with an equal water potential the water molecules will move into and out of the cell in equal amounts at a rate less than R form the first experiment since the concentration gradient is less steep.

48. D

Option D is the correct answer as since the vesicles have proteins that are specific for the transport of glucose that means that the membrane must contain channel proteins that assist in the uptake of glucose via facilitated diffusion when the vesicles fuse with the membrane.

49. D

Option D is the correct answer as water moves from a region of less negative water potential to a region of more negative water potential. This means that water will move into the cells via osmosis causing them to become turgid.

50. B

Option B is the correct answer as this has a surface of 1 : 2 and 2 agar blocks with a lower temperature which means that diffusion will be slower resulting in a lighter blue color that is divided between the 2 agar blocks.

51. C

Option C is the correct answer as since the cell membrane has pulled away from the cell wall the solution Y fills the space between the cell wall and the cell membrane as the cell wall is fully permeable.

52. D

Option D is the correct answer as a decrease in water potential of the solution causes the water potential gradient to decrease and this results in less water moving into the cell and the contractile vacuole emptying less.

53. D

Option D is the correct answer as since the membrane is permeable to water and monosaccharides water will move into the model cell and glucose will move out since it is a monosaccharide. Sucrose will not move since it is a disaccharide and cannot pass through the membrane.

54. A

Option A is the correct answer as it has the largest surface area amongst all the blocks which means that it will turn colorless the quickest.

55. A

Option A is the correct answer as the water potential of leaf cells in solution Y is less negative that in solution X since water has flowed into the leaf causing it to become turgid. This means that the water potential of solution Y when compared to solution X is less negative.

56. D

Option D is the correct answer as for osmosis to occur there must always be a selectively permeable membrane and a water potential gradient present. Carrier proteins and cell surface membrane are not necessary for osmosis to occur.

57. D

Options A, B and C are all incorrect as these are correct statements. Hence, option D is the correct answer as water moves from a less negative to a more negative water potential. According to that cell Z has a less negative water potential that the sugar solution it was put in.

58. B

Option B is the correct answer as being exported in vesicles means that the dye was removed from the cell via exocytosis. It moved into the cell via diffusion then as osmosis is applicable for the movement of water molecules only.

59. A

All the 3 processes can help in the transport of materials into or out of the cells. Hence, option A is the correct answer.

60. A

Statement 1 is correct as water moved into cell Y indicated it had a lower water potential than the sugar solution. Statement 2 is also correct as cell Z is plasmolyzed indicating that it was put into the highest sugar concentration that resulted in water moving out. Statement 3 is also correct as cell Z had a negative water potential which resulted in water moving out of it. Hence, option A is the correct answer.

61. A

Options B, C and D are incorrect since osmosis is used for the movement of water molecules only. Hence, option A is the correct answer as active transport, diffusion or facilitated diffusion could be used for the transport of the molecule.

62.   D
Facilitated diffusion uses protein channels and moves molecules from high to low concentration (statement 2). It does not require ATP (so statement 1 is incorrect), and the rate depends on the number of protein channels (statement 3). Hence, D is correct.

63.   B
Statements 1 and 2 are correct as there is no net movement as the water potential of the cell and the solution is the same. Statement 3 is incorrect as the concentration of sucrose might be different inside the cell. Hence, option B is the correct answer.

64.   B
Option B is the correct answer as this options has the dimensions that result in the greatest surface area to volume ratio.

65.   A
Water moves from the more negative water potential to the less negative water potential. Thus, water will move from P to Q, P to R and R to Q. Hence, option A is the correct answer.

66.   A
Calculating the surface area to volume ratio for the last block it is 5 : 1 which is exactly the same as that for the $5 \times 5 \times 5$ block. Hence the time taken will be 6.2 seconds making option A the correct answer.

67.   B
Simple diffusion does not require the presence of a membrane. Hence, option B is the correct answer.

68.   A
Water moves form less negative water potential to more negative potential. Hence, water will move into the cell which will result in the water potential increasing and as a result the cell will become turgid. Hence, option A is the correct answer.

69.   D
No change in the size of potato indicates that the water potential of the cell and the sucrose solution is the same and there is no net movement of water out of the cell. Hence, option D is the correct answer.

70.   B
Option B is the correct answer as a membrane protein being involved in active transport indicates that oxygen needs to be supplied to mitochondria in order to product ATP that will assist in active transport.

71.   D
Only CO_2 can pass through the cell membrane without the assistance of any carrier or channel proteins as it is small and non-polar. Hence, option D is the correct answer.

72.   B
The process shown is exocytosis where vesicles fuse with the membrane in order to leave the cell. Hence, option B is the correct answer.

73.   A
Water moved from the cells to the solution due to a higher water potential in the cells (–100 kPa) compared to the solution (–500 kPa). This caused plasmolysis, leading to cytoplasm shrinkage and membrane separation. Hence, A is correct.

74.   B
Option B is the correct answer as the size of the diffusing molecule and the distance over which it diffuses are inversely proportional to the rate of diffusion.

75.   C
The water potential of the raisin is more negative that the surrounding water resulting in water moving into the raisin. Hence, option C is the correct answer.

76.   B
Facilitated diffusion and active transport will be affected since they are carried out with the aid of carrier and channel proteins. Diffusion can occur without any membrane. Hence, option B is the correct answer.

77.   D
Statement 1 is incorrect as water move from less negative to more negative water potential. Statements 2 and 3 are correct as water crosses the membrane with the help of channel proteins and can cross the cell wall freely since it is fully permeable. Hence, option D is the correct answer.

78.   C
The signal molecule binds to a protein in the cell membrane which activates an enzyme in the cytoplasm that leads to a response. Hence, option C is the correct answer.

79. A
The 1 cm^3 cube would change the color completely whereas the 3 cm^3 one will change color up to a depth of 0.5 cm. Hence, option A is the correct answer.

80. A
As the water in the cells in replaced by the cells adjacent to each other this means that option A is the correct answer as it must have the least negative water potential for water to replace the lost water in cell B.

81. A
1 represents the diffusion of sodium ions from higher to lower concentration. 2 and 3 represent the movement of potassium and sodium ions respectively via active transport from a region of lower to higher concentration. 4 represents the diffusion of potassium ions. Hence, option A is the correct answer.

82. C
Statement 1 is incorrect as if the red blood cell had a higher water potential then it would shrink and not burst. Statements 2 and 3 are correct as the cells burst since they are not supported by a cell wall and because more water flows into them than what leaves them. Statement 4 is incorrect as water does leave the cell. Hence, option C is the correct answer.

83. D
In order form plants to keep carrying out exocytosis in cold weather the plants need to maintain the fluidity of the cell membrane which can be done by increase the ratio of unsaturated to saturated phospholipids. Hence, option D is the correct answer.

84. C
Options A and B is incorrect as endocytosis does not depend on any concentrations. Option D is incorrect as endocytosis in movement into the cell. Hence, option C is the correct answer as endocytosis is the movement of a vesicle across the membrane into the cells and it requires energy.

85. C
Options A and B are incorrect as facilitated diffusion is faster than the simple diffusion. Option D is incorrect as the alkali moves not the indicator. Hence, option C is the correct answer as the alkali solution moves via simple diffusion.

86. B
In low water potential the cells will be plasmolyzed. In equal potential the cells will remain turgid as the plant is well watered and in high water potential the cells will remain turgid as well due to inflow of water. Hence, option B is the correct answer.

87. B
Option B is the correct answer as exocytosis and endocytosis require ATP but not facilitated diffusion. Hence, option B is the correct answer.

88. C
Option C is the correct answer as for the enzyme to act outside the cell they would be required to be secreted in vesicles via exocytosis.

89. B
Option B is the correct answer as facilitated diffusion and active transport are used to bring hydrogen ions back in and move them out of the cell respectively.

90. A
Option A is the correct answer as the channel proteins which assist in active transport are fixed in place so even if the fluidity decreases they are not affected.

91. A
The substance could pass directly through the phospholipid bilayer or pass through the channel proteins. Hence, option A is the correct answer.

92. C
Water which is a solvent is moved down a concentration gradient without the requirement of any energy. Hence, option C is the correct answer.

93. A
All of the processes allow movement in both direction across the membrane. Hence, option A is the correct answer.

94. C
Since the water is less negative in potential as the cell, water will move inside the cells causing it to be turgid. Hence, option C is the correct answer. Option D is incorrect as it shows the nucleus expanded as well which is not possible.

95. C

Hydrogen carbonate ions leave red blood cells via facilitated diffusion. Hence, option C is the correct answer.

96. B

48Option B is the correct answer as from Q to P the dots will move due to the concentration difference. Similarly, from P to Q the oval shapes will move and there will be no net movement of the rectangle shapes since there are equal number of molecules on each side.

97. B

First mRNA binds to the ribosomes, then the glycoprotein is synthesized. After than it accumulates in the secretory vesicle after which exocytosis occurs. Hence, option B is the correct order.

98. D

Water will move into the bacterium from less negative to more negative water potential. The bacterium will not burst though due to the presence of the cell wall which provides it support. Hence, option D is the correct answer.

99. D

Facilitated diffusion does not require ATP and molecules move down a concentration gradient with the assistance of a membrane protein. Hence, option D is the correct answer.

100. A

Lipids are lipid soluble molecules so they can pass through X pathway only. Water can pass through the X pathway due to its small size but also with the assistance of channel or carrier proteins. Glucose can only pass via the Y pathway. Hence, option A is the correct answer.

101. C

These stem cells divide in the bone marrow only. Hence, option C is the correct answer.

102. C

Facilitated diffusion and osmosis are passive processes meaning that they do not require energy. Hence, option C is the correct answer.

103. D

Statement 1 is incorrect as if the concentration was 0 outside the cell then the graph would should the decrease in concentration inside the cell as the molecule moves backwards. Statement 2 is incorrect as the rate would be constant if the carrier proteins were limiting not the concentration. Statement 3 is correct as the amount of X that moves outside if the same as the amount that moves inside. Hence, option D is the correct answer.

104. D

Statements 1 and 3 are incorrect as active transport requires a membrane and it move other molecules as well. Hence, only statement 2 is correct since molecules are moved against a concentration gradient making option D the correct answer.

105. A

All 3 statements are correct as endocytosis requires ATP as an energy source. Phagocytosis is similar to endocytosis and the products that are brought in via this process are enclosed in small vacuoles. Hence, option A is the correct answer.

106. C

The methods requiring energy will be inhibited which are active transport and endocytosis. Hence, option C is the correct answer.

107. C

Option C is the correct answer as sodium ions move outside the cell via active transport through channel proteins. Carbon dioxide moves directly through the bilayer via diffusion and water can enter directly through the bilayer into the cell via osmosis. Glucose is brought in by carrier proteins via facilitated diffusion.

108. B

Option B is the correct answer as endo and exocytosis require energy meaning they are active processes whereas facilitated diffusion and osmosis do not require energy meaning they are passive.

109. B

When a red blood cell is placed in pure water there is a net movement of water inside the cell that causes the cell to swell and burst. Hence, option B is the correct answer.

110. D

All the 4 statements are correct making option D the right answer.

111.   A

Option A is the correct answer as endo and exocytosis require energy meaning they are active processes whereas diffusion and osmosis do not require energy meaning they are passive.

112.   B

Option B is the correct answer as water will flow down the concentration gradient into the visking tube resulting in an increased volume while glucose will move into the water surrounding the tube resulting in successive colors in the Benedicts test.

113.   C

Option C is the correct answer as endo and exocytosis require energy meaning they are active processes whereas diffusion and osmosis do not require energy meaning they are passive.

114.   C

Glucose will move into V down the concentration gradient and water will move to Y down the concentration gradient. Hence, option C is the correct answer.

115.   C

1 represents simple diffusion, 2 represent facilitated diffusion with the help of carrier proteins and 3 represents active transport. Hence, option C is the correct answer.

116.   B

Active transport requires ATP as an energy source so if the protein does not function in the absence of ATP in means that active transport will not occur. This shows that the protein is involved in active transport. Hence, option B is the correct answer.

117.   B

The plateau is a result of the carrier proteins being saturated with glucose molecules. Hence, option B is the correct answer as statements 2, 3 and 4 are not the reasons for the plateau.

118.   C

Fat soluble substances can pass directly through the bilayer meaning that vitamin D passes through X. Water soluble substances require the assistance of channel proteins meaning that vitamin C will pass through Z. Hence, option C is the correct answer.

119.   A

Water can flow from 1 to 4 and 1 to 2. In can also flow from 3 to 4 and 3 to 2. It can flow from 3 to 1 as well since 3 is more turgid than 1. Using these paths we can see that option A is the correct answer.

120.   A

Statement 1 is correct as water moves in and out of all the cells. Statement 2 is correct as water moves from less negative to more negative water potential. Statement 3 is incorrect as there is no net movement of water but water does move in the cell. Statement 4 is incorrect as water moves into cell 1. Hence, option A is the correct answer.

121.   D

Statements 1 and 4 are incorrect as the glucose concentration come closer to each other the net diffusion of water and glucose decreases. Statements 2 and 3 are correct as glucose molecules can reach equilibrium quicker and there is less change in the volume of the surrounding solution as the water potential becomes similar as well. Hence, option D is the correct answer.

4.3: Multiple topics

1.   B

For the first block: surface area = $2(30 \times 20 + 30 \times 4 + 20 \times 4) = 1600$ mm^2;
volume = $30 \times 20 \times 4 = 2400$ mm^3; SA : V = $1600 \div 2400 = 0.67 : 1$.
For the second block: surface area = $2(10 \times 15 + 10 \times 8 + 15 \times 8) = 700$ mm^2;
volume = $10 \times 15 \times 8 = 1200$ mm^3; SA : V = $760 \div 1200 = 0.58 : 1$.
So, the large block with a SA : V of 0.67 : 1 decolourised faster than the smaller block (0.58 : 1),
because diffusion was more efficient relative to its volume.

2. **B**

Each phospholipid consists of 1 phosphate (95), 1 glycerol (92), 2 fatty acids (2×282) and loses 1 water molecule (18) during formation. The molecular weight of one phospholipid is calculated as: $(95 + 92 + 2 \times 282) - (18 \times 2) \approx 697$ g mol^{-1}. For six molecules: $697 \times 6 = 4182$ g mol^{-1}.

3. **C**

Surface area to volume ratio decreases as cell size increases because volume grows faster than surface area. Doubling the width increases volume more than surface area, reducing the ratio from 23:12.

4. **B**

Row B is correct as ethanol disrupts phospholipids in cell membranes, increasing permeability and allowing red pigment to leak from beetroot vacuoles. This results in the test-tube turning red, confirming the correct observation and explanation.

5. **C**

Using the formulas SA $= 2\pi r^2 + 2\pi rh$ and V $= \pi r^2 h$, where r = 2.0 cm and h = 5.0 cm.
Surface area SA $= 2(3.14)(2.0)^2 + 2(3.14)(2.0)(5.0) = 87.92$ cm^2
Volume V $= (3.14)(2.0)^2(5.0) = 62.83$ cm^3. The ratio SA : V = 1.4 : 1.0, matching option C.

6. **C**

The surface area-to-volume (SA) ratio is calculated using the given formulas. Block 1 has an SA ratio of 1.33:1, Block 2 has 0.67:1, and Block 3 has 0.5:1, matching row C.

7. **C**

The surface area to volume ratio decreases with increasing block size, which increases the time taken for the indicator to turn yellow. Block 1 has the highest ratio and shortest time, while block 3 has the lowest ratio and longest time.

8. **B**

Exocytosis begins with the Golgi membrane folding around molecules (1), forming a secretory vesicle (4). The vesicle moves through the cytoplasm on microtubules (3) and fuses with the cell membrane (2).

9. **C**

Cylinder C, with the smallest percentage change in mass (–0.9%), indicates that its water potential was closest to that of the 10% salt solution, resulting in minimal net movement of water.

10. **A**

Water moves from the side with higher water potential (R, 5% solution) to the side with lower water potential (S, 10% solution), causing an increase in the volume of solution in S due to osmosis.

11. **C**

The smaller cube (1 cm^3) allows for faster diffusion throughout its volume, while the larger cube (3 cm^3) has a slower diffusion rate, resulting in less change in its inner regions compared to the outer layers. This makes option C correct.

12. **B**

Option B is the correct answer as it has the greatest surface area to volume ratio.

13. **B**

The vising tubing is used to represent a partially permeable membrane which can be wither the cell membrane or the tonoplast but not the cell wall since it is fully permeable. Hence, option B is the correct answer.

14. **A**

All the 3 statements are correct ans glycoproteins allows the cells to attach to each other. The glycoprotein must have a complementary structure to the proteins in the common cold virus and it must have hydrophobic region to stabilize it. Hence, option A is the correct answer.

15. **D**

The molecule will pass through the 2 layers of the cell membrane and then the 2 layers each of the inner and the outer mitochondrial membrane. Hence, option D is the correct answer.

16. **C**

Statements 1 and 3 are correct as oxygen passes directly through the membrane while water passes through channel proteins. Hence, option C is the correct answer.

17. **B**

Option B is the correct answer as the turgor pressure can no longer stop the influx on water meaning that the plant cell bursts.

18. **C**
Option C is the correct answer as the ratio of the epithelial cell is 0.2 as compared to 0.1 for the palisade cell.

19. **C**
Option C is the most probable explanation since the ice crystals damaging the cell membrane would cause the enzyme to leak out.

20. **C**
The random arrangement of the membrane proteins signifies that proteins move freely in the phospholipid bilayer. Hence, option C is the correct answer.

21. **A**
Placing the stalk in the solution with the highest water potential will result in the cells becoming turgid and this will cause the stalk to develop a curved shape since the outer cells do not expand as much as the inner cells. Hence, option A is the correct answer.

22. **D**
Statements 1 and 2 are incorrect as there a net movement of water out of the cell and plant tissues had a less negative water potential than the solution. Statement 3 is correct as between 0.8 and 1 concentration the volume remained constant which means that no more water flowed out indicating that the cells were fully plasmolyzed. Hence, option D is the correct answer.

23. **A**
Option A is the correct answer as active transport occurs only in living cells meaning that living cells must produce something that non-living cells cannot. The rate of active transport decreases in the presence of low oxygen which means that ATP is necessary for it to occur. Companion cells have large number of mitochondria to allow for the movement of hydrogen ions.

24. **B**
Carbon dioxide and water can pass through the cell membrane without using any carrier or channel proteins. Hence, option B is the correct answer.

25. **B**
Statement 3 is incorrect as the inner membrane is hydrophobic which cannot react with hydrophilic groups. Statements 1 and 2 are correct as the proteins can be involved in assisting active transport or facilitated diffusion and they can also be involved in antigenic recognition. Hence, option B is the correct answer.

26. **A**
Since sodium ions move out of the cells this causes the intracellular potential to be less negative than the extracellular solution that causes water to move out to cells and the cells shrink. Hence, option A is the correct answer.

27. **D**
Option D is the correct answer as only oxygen can pass through the cell membrane without the use of carrier and channel proteins.

28. **B**
Statement 1 is correct as no change in size indicates that the cell has the same water potential as that of the solution. Statement 2 is incorrect as if the cell sap had a lower water potential then water would move into the cell causing an increase in size. Statement 3 is correct as there is movement of water but no net movement as the amount moving in and out cancel each other. Statement 4 is incorrect as the cell wall will be in touch with the membrane. Hence, option B is the correct answer.

29. **C**
Glycoproteins are used in antigen recognition and cell to cell signaling. This means that cells associated with the immune system will have a large number of glycoproteins associated with them. Hence, option C is the correct answer as lymphocytes are involved in immune response.