2.1: Testing for biological molecules

1. **C**
   Solution 2, which turns red after acid hydrolysis, contains sucrose as it breaks down into reducing sugars. Solution 3, turning purple in the biuret test, indicates the presence of amylase (a protein).
2. **C**
   The correct procedure involves first boiling the sample with dilute hydrochloric acid to hydrolyze non-reducing sugars, neutralizing with sodium hydrogen carbonate, and then performing the Benedict's test to detect reducing sugars.
3. **B**
   Tay-Sachs disease is caused by a malfunction in the lysosome, which is responsible for breaking down lipids. In this disease, lipids accumulate due to lysosomal dysfunction.
4. **B**
   Goblet cells secrete mucus and have extensive Golgi bodies to modify, package, and transport the proteins and lipids used in secretion.
5. **C**
   Circle 1 represents prokaryotes, which contain circular DNA (2). Circle 3 is mitochondria, which also contain circular DNA (4). Circle 5 is chloroplasts, which share these structures with mitochondria and prokaryotes. Hence, row C is correct.
6. **C**
   Animal cells contain linear DNA. Prokaryotic DNA is not surrounded by a double membrane but is double-stranded.
7. **D**
   Guanine is present in both DNA and RNA, which are found in all viruses, whereas uracil, ribose, and thymine are specific to either RNA or DNA.
8. **C**
   After a negative Benedict's test (blue), the sample is boiled with dilute hydrochloric acid to hydrolyze non-reducing sugars. It is then neutralized with sodium hydrogencarbonate before repeating the Benedict's test.
9. **D**
   The emulsi9on test for lipids involves adding ethanol and water to a sample, and if lipids are present, a milky emulsion will form. Boiling is not part of this rest.
10. **B**
    Sample one initially tested negative for reducing sugars with Benedict's solution, but after breaking down non-reducing polysaccharides with acid and base, it tested positive, indicating the presence of reducing sugars. This is because glycosidic bonds in polysaccharides were broken down to release reducing sugars.
11. **B**
    To test for non-reducing sugars, you need to:
    - Add dilute hydrochloric acid and heat in a water bath (boiling)
    - Neutralize with sodium hydrogen carbonate (step 3).
    - Add Benedict's reagent and heat in a water bath (boiling)

    Since steps 2 and 4 require boiling/heating, and none of the options include these steps without steps, the correct answer is B.

12. **C**
    The Benedict's test is a chemical test commonly used to detect the presence of reducing sugars. The steps involved in the test include:
    1 Standardizing the volume of Benedict's solution and the volume of the test solution to ensure consistency.
    2 Boiling the mixture to provide the energy necessary for the reaction between the reducing sugar and the Benedict's solution.
    3 Standardizing the boiling time with Benedict's solution and comparing the final color with numbered color standards to determine the approximate concentration of the reducing sugar.

13. A

In the given procedure to estimate glucose concentration, the independent variable is what the researcher changes or controls. In this case, it is the concentration of glucose solutions, as they are being varied to determine their impact on the resulting color change in the Benedict's test.

14. A

The test results for sample A indicate the presence of starch only, as shown by the blue-black iodine solution. There were no reducing sugars or protein indicated by the Benedict's and biuret reagents, respectively

15. A

The Benedict's test detects reducing sugars (brick-red indicates presence), and the ethanol emulsion test detects lipids (cloudy indicates presence).

16. A

Analyzing biochemical test results for different substances reveals that a blue result in Benedict's test indicates the absence of reducing sugars, a yellow result in the non-reducing sugar test suggests the presence of non-reducing sugars such as sucrose, a blue-black result in the iodine test indicates the presence of starch, and a blue result in the Biuret test indicates the absence of proteins.

17. D

Option D is the correct answer as blue represents no reducing sugar while red represents a high concentration of reducing sugar present. After blue green comes and after that yellow which is followed by red.

18. C

Option B is the correct answer as glucose will give yellow color in both reducing and non-reducing sugar tests. Sucrose will give blue color in reducing sugar test but yellow in the non-reducing one since it is not a reducing sugar. The mixture of glucose and sucrose will give blue color in the reducing sugar test and yellow in the non-reducing one due to presence of sucrose.

19. D

Since the solution remains blue and the solution contains a carbohydrate that means it must a non-reducing sugar. Hence, option D is the correct answer as sucrose is a non-reducing sugar while glucose, fructose and maltose are reducing sugars.

20. C

Option C is the correct answer as the cloudy result suggests that fat is present. The yellow color of the Benedict's test indicates that a small concentration of reducing sugar is present but we do not know if it is glucose or not. The purple color of the Biuret test confirms the presence of proteins and the yellow color of the iodine solution confirms that starch is not present.

21. B

Option B is the correct answer as a semi-quantitative analysis is used to tell the concentrations of a particular substance. In this case the Benedict's test can only tell about the relative concentrations of the reducing sugar through the color changes and not what type of sugar is present.

22. C

Option C is the correct answer as since the first Benedict's test gave blue result it means reducing sugar is not present. After treatment with acid the red color shows which means that non-reducing sugar is present. The purple color means that protein is present while the yellow color of the iodine solution indicates that starch is not present.

23. C

Option C is the correct answer as there is no way of knowing that the reducing sugar that caused the color change was glucose as the color change also depends on the relative concentration of the sugar. There are also non-reducing sugars present as the non-reducing sugar test gave the red color.

24. B

Option B is the correct answer as of all the biological molecules only fasts contain ester bonds and the fat emulsion test giving a cloudy result confirms the presence of fats and hence ester bonds.

25. C

Option C is the correct answer as the Biuret test has a purple color meaning that protein is present. Fat is present due to the cloudy emulsion. Glucose is not present as the color change is not intense enough. It should be somewhat red if glucose is present. Starch is not present as the iodine test does not give blue-black color.

26. A

Since the diastase is boiled that means it has probably denatured since enzymes are temperature sensitive. Hence, starch will not be converted into maltose meaning that the iodine solution will be blue-black, and Benedict's reagent will remain blue. Hence, option A is the correct answer.

27. C

Since the Benedict's test carried out gives a red color that means reducing sugars are present in the milk. In addition to that the purple color in the Biuret test confirms the presence of proteins. The yellow color of the iodine solution confirms that starch is not present. Hence, reducing sugars and proteins are present in the milk making option C the correct answer.

28. D

Since the iodine test and biuret test gave positive results starch and proteins must be present. In addition, the yellow color of the non-reducing sugar test suggests a small amount of non-reducing sugars present. Looking at the option, options A and C are incorrect since there is no starch. Option B is incorrect since glucose is a reducing sugar and Benedict's test was negative. Hence, option D is the correct answer as sucrose is a non-reducing sugar and catalase is an enzyme which is a protein.

29. B

Subtracting the mass from the initial test tells the amount of non-reducing sugar present in the sample. From the options we can see that option B is the correct answer since subtracting gives 15 g which is the greatest amount.

30. C

Options A and B are incorrect since milk does not contain reducing sugar. Option C is the correct answer since reducing sugars cause a color change in the Benedict's solution. The higher concentration is in milk X since it changes color in a shorter period of time.

31. C

If the Benedict's test gave a negative result treat the sample with hydrochloric acid and then neutralize it with an alkali. Then the Benedict's test is performed again and if there is a color change then non-reducing sugars are present otherwise they are absent. Hence, option C is the correct answer.

32. B

Proteins and reducing sugars can be present since the Benedict's and Biuret test gave positive results. From the options we can see that option B is the correct answer since globin and collagen are proteins and glucose is a reducing sugar.

33. B

The student has to ensure that the same volume of the solutions is used for the reducing sugar test. Additionally, he/she has to ensure that the temperature remains constant. Hence, 1 and 2 need to be standardized making option B the correct answer.

34. B

A green color indicates the lowest amount of reducing sugar present after the Benedict's test. Hence, option B is the correct answer.

35. B

Fructose is a reducing sugar meaning Benedict's test will give red color. Starch will give blue=black color with the iodine solution. Triglycerides are fats which give a white/cloudy solution in the ethanol emulsion test. Hence, option B is the correct answer.

36. B

Option C is incorrect since yellow color indicates a small concentration of reducing sugars. Option D is incorrect since sucrose is a non-reducing sugar. Option A is incorrect since reducing sugars are present. Hence, option B is the correct answer.

37. A

As the concentration of alpha glucose increases the time taken for the first color change decreases. Hence, option A is the correct answer since the graph shows an inverse relationship will the correct variable on the correct axes.

38. A

30 seconds means that very little of the starch is converted into maltose. Hence, iodine test will still give blue-black color. Benedict's will give a green color give very little reducing sugar is present. The Biuret test will be purple since amylase is a protein. Hence, option A is the correct answer.

39. C

The addition of hydrochloric acid and boiling the solution causes the glycosidic bonds to break. Hence, option C is the correct answer.

40. D

In the 45 minutes amylase converts most of the starch into maltose meaning that the iodine test gives a brown color. The Benedict's test gives an orange color due to greater amount of reducing sugar and Biuret test gives purple color due to presence of amylase. Hence, option D is the correct answer.

41. A

Green color suggests the least amount of reducing sugar. Yellow suggests an intermediate amount and red suggests a large amount. Blue color tells that no reducing sugar is present. Using this information, option A is the correct answer.

42. B

Options C and D are incorrect since sucrase isn't used in the non-reducing sugar test. Option A is incorrect since fructose and glucose are monosaccharides so they cannot be reactants. Hence, option B is the correct answer as hydrochloric acid is used and sucrose and water are the reactants.

43. D

Option A is incorrect since solution 1 has greater protein content that solution 2. Option B is incorrect since solution 2 has the greatest amount of starch. Option C is incorrect since solutions 1 and 3 have the greatest amount of protein and solutions 1, 3 and 4 have the least amount of starch. Hence, option D is the correct answer since red indicates high reducing sugar content.

44. A

Using $M_1V_1 = M_2V_2$ and putting values in we have $1 \times 8 = C \times 12$. Solving this we get 0.6 as the answer which is the required concentration. Hence, option A is the correct answer.

45. D

Glucose is a reducing sugar meaning that the Benedict's test initially should be positive. Looking at the table we can see that solutions 2 and 3 contain glucose since they give positive results. Hence, option D is the correct answer.

46. A

In serial dilutions concentrations differ by a fixed factor. Looking at the options we can see that only in option A is the concentrations are decreasing by half of the previous value. Hence, option A is the correct answer.

47. B

Of all the options given cellulose and glycogen are polymers and sucrose is a non-reducing sugar. Hence, option B is the correct answer since fructose is a reducing sugar.

48. C

Since the Benedict's test carried out gives a red color that means reducing sugars are present in the milk. In addition to that the purple color in the Biuret test confirms the presence of proteins. The yellow color of the iodine solution confirms that starch is not present. The non-reducing sugar gives brick red color indicating the presence of a non-reducing sugar. Hence, reducing sugars, non-reducing sugars and proteins are present in the milk making option C the correct answer.

49. D

The presence of starch is confirmed by the blue-black color of the iodine test and the presence of protein is confirmed by the purple color of the Biuret test. Hence, option D is the correct answer.

50. B

The solution is boiled once the acid is added and finally after the Benedict's solution is added. Hence, option B is the correct answer.

51. D

Since there is a yellow color reducing sugars are present in the solution. This makes options B and C incorrect since sucrose is a non-reducing sugar. Option A is incorrect since yellow indicates a small amount of reducing sugars. Hence, option D is the most suitable conclusion.

52. D

Statement 1 is incorrect since taking an average will have no effect since the error of 2 seconds is still there. Statement 2 is incorrect since the concentration depends on the color not the time. Statement 3 is correct since the student has the error in every measurement making it systematic. Hence, option D is the correct answer.

53. C

The first solution will give positive results with the iodine test and the non-reducing sugar test which is boiling the Benedict's solution after acid hydrolysis. Solution 2 will give positive results for the reducing sugar test and the Biuret test and negative results for the iodine test and the non-reducing sugar test. Hence, option C is the correct answer.

54. C

Sucrose is a non-reducing sugar meaning that solution 2 shows its presence since it is the non-reducing sugar test. Amylase is an enzyme which is a protein meaning that solution 3 shows its presence since it is the Biuret test. Hence, option C is the correct answer.

55. **C**
Solutions 1 and 3 show color changes after boiling the Benedict's solution following acid hydrolysis. Solution 3 does not contain any non-reducing sugars since the color remains the same after the non-reducing sugar test. Hence, option C is the correct answer.

56. **C**
Since Benedict's test is negative no reducing sugars are present. Proteins and starch are present since the iodine test and the Biuret test gave positive results. Hence, option C is the correct answer.

57. **C**
Only the Benedict's test gives a positive results meaning only reducing sugars are present. From the structures, structures 2 and 3 are different forms of glucose which is a reducing sugar. Hence, option C is the correct answer.

58. **B**
The ethanol emulsion test and the Biuret test give positive results indicating the presence of lipids and proteins. Benedict's test also gives a positive results indicating the presence of a reducing sugar. Using this we can see that option B is the correct answer since it contains proteins, lipids and glucose which is a reducing sugar.

2.2: Carbohydrates and lipids

1. **D**
Cellulose has alternate monomers rotated by 180°, is unbranched, and forms hydrogen bonds between molecules, providing structural support in plant cell walls.

2. **A**
L-glucose is the mirror image of D-glucose and does not fit into the active site of glucose oxidase, which is specific to D-glucose due to enzyme-substrate specificity.

3. **D**
Fatty acid 2 of the 56:4 triglyceride has 18 carbon atoms and 4 carbon-carbon double bonds, meaning it is unsaturated. Therefore, it is an unsaturated fatty acid with 18 carbon atoms.

4. **D**
Hemoglobin consists of 2 α-globin chains, 2 β-globin chains, and 4 haem groups. The total mass is:
$(2 \times 15{,}126) + (2 \times 15{,}868) + (4 \times 617) = 64{,}500$ Da = 64.5 kDa.

5. **B**
In α-glucose, the hydroxyl group (-OH) on carbon 1 is positioned below the plane of the ring, as shown in structure B. This differentiates it from β-glucose, where the -OH group is above the plane.

6. **C**
The phosphate heads of phospholipids are hydrophilic because they become ionized in water, gaining a charge that makes them polar and able to interact with water molecules.

7. **D**
Cellulose is adapted for its function by forming many hydrogen bonds between adjacent molecules, which provide strength. There are no covalent bonds or triple helix structures in cellulose.

8. **D**
Glycerol is joined to fatty acids by covalent ester bonds during the formation of a triglyceride molecule, through a condensation reaction.

9. **D**
The error is systematic because the student consistently timed each solution for two seconds after the end-point (3 correct). This will not affect identifying the highest concentration or be reduced by repetitions (1 and 2 are incorrect).

10. **A**
Bond 1 (ester bond) is found in glycolipids only, as it connects fatty acids to glycerol. Bond 2 (glycosidic bond) connects carbohydrates in both glycolipids and glycoproteins. Bond 3 (peptide bond) is exclusive to glycoproteins.

11. **A**
A glycosidic bond forms between two monosaccharides during a condensation reaction, releasing a water molecule. All three diagrams (1, 2, and 3) show this process.

12. B

Both amylopectin and glycogen contain 1-4 glycosidic bonds (1 correct). Glycogen has more 1-6 branches than amylopectin (3 correct). However, amylopectin contains α-glucose, not β-glucose, so statement 2 is incorrect.

13. B

The monomer shown is glucose, which is a component of both glycogen and amylopectin, as represented by the overlapping section (B) in the Venn diagram.

14. C

Fatty acids can be either saturated or unsaturated (correct). They do not always have at least two double bonds (incorrect). They serve as energy stores and are insoluble in water, so do not affect the water potential of the cell (both correct).

15. A

The three fatty acids (L, O, P) can be arranged in 3! (factorial) ways. 3! = 6, but due to the identical positions in a triglyceride molecule, the distinct number of arrangements is reduced to 3. Hence, the total number of different arrangements is 3.

16. C

Phospholipids have hydrophilic heads and hydrophobic tails, which help them form cell membranes.

17. D

Molecules 2 and 4 contain unsaturated fatty acids (with double bonds), which are more commonly found in oils (liquids) compared to fats (solids) that generally contain saturated fatty acids.

18. D

Cellulose is composed of unbranched chains of β-glucose molecules, which are held together by hydrogen bonds, providing the strength and rigidity necessary for plant cell walls.

19. D

The correct description of cellulose is:

D an unreactive linear chain of 1-4 β-glucose.

Cellulose is a polysaccharide made up of linear chains of β-glucose molecules connected by β-1,4-glycosidic bonds. These chains are unbranched and form a strong and stable structural component in plant cell walls.

20. C

Cellulose consists of linear chains of glucose molecules, not helical coils. The correct answer should be 2 and 3, as follows:

Many hydrogen bonds forming between adjacent chains are crucial for the overall stability of the cellulose structure.

Insolubility in water is also a key characteristic of cellulose, which is important for its function in plant cell walls.

21. B

B is the intersection of collagen and haemoglobin, both of which contain molecues with at least two double bonds. Collagen contains double bonds in amino acids, and haemoglobin contains them in its heme group. Hence, B is the correct answer.

22. A

Triglycerides are:

- Non-polar molecules
- Hydrophobic (water-repelling)
- Insoluble in water (polar molecule)
- Soluble in non-polar solvents like ethanol (similar non-polar characteristics)

This is due to the “like dissolves like” principle, where substances with similar polarities tend to mix and dissolve in each other.

23. A

Saturated triglycerides do not have double bonds between the carbon atoms in their fatty acid chains, meaning they have the maximum number of hydrogen atoms bonded to the carbon chain. Unsaturated triglycerides have one or more double bonds in their fatty acid chains, which reduces the number of hydrogen atoms since each double bond replaces two hydrogen atoms. Therefore, unsaturated triglycerides have more double bonds and fewer hydrogen atoms than saturated triglycerides.

24. C

Stearic Acid contains two more carbons then palmitic acid, thus the triglyceride SOS will contain four more carbons than triglyceride POP. Statement A is incorrect because POP will contain only one unsaturated fatty acid (Oleic Acid.) Triglyceride SOS will contain 3 not 2 fatty acids, thus D is wrong. Statement B is wrong because trigleceride POS will contain two more carbon atoms rather than two less carbon atoms than POP.

25. D

The diagrams represent different biological molecules. To identify the polymer with a structural role in plants, To examine each structure. Molecule D is a glucose monomer, which is the building block of cellulose. Cellulose is a polysaccharide that forms a rigid structure in plant cell walls.

26. B

Both amylose and amylopectin are polysaccharides found in plants, which are indeed carbohydrate molecules (statement 1), and they are formed by condensation reactions (statement 2), where monosaccharides are joined together with the elimination of water. Amylopectin is branched, containing alpha-1,6 glycosidic bonds at the branch points, along with alpha-1,4 glycosidic bonds like amylose (statement 4), which is mostly linear. Therefore, statement 3 is incorrect for amylopectin. The correct statements for both amylose and amylopectin are 1, 2, and 4.

27. C

A reducing sugar is a sugar that can donate electrons to another chemical. Disaccharides are carbohydrates composed of two monosaccharides. Maltose is a disaccharide consisting of two glucose units and can act as a reducing sugar because it has a free aldehyde group capable of being oxidized. Fructose is a monosaccharide, glucose is a monosaccharide, and sucrose, although a disaccharide, is not a reducing sugar because it has no free aldehyde or ketone group.

28. C

Triglycerides and phospholipids both have hydrophobic regions. In triglycerides, it's the fatty acid tails, and in phospholipids, it's the fatty acid tails and the glycerol backbone.

29. B

In polysaccharides, glycosidic bonds can be formed between the hydroxyl groups of two monosaccharides. At position X in the provided structure, the bond is between the first carbon of one sugar molecule and the sixth carbon of the adjacent sugar molecule.

30. A

Understanding the structural chemistry of glucose, specifically the difference between alpha-glucose and beta-glucose, involves identifying the position of the hydroxyl (OH) group on the first carbon in the ring form. In beta-glucose, the OH group on carbon-1 is above the plane of the ring.

31. D

Basic knowledge of biological molecules and their classifications is tested. Sucrose is a disaccharide, cellulose is a polymer and a macromolecule made of many glucose units, fructose is a monomer and a monosaccharide, and collagen is a protein polymer.

32. C

The specificity of the enzyme alpha-amylase towards glycosidic bonds in polysaccharides is key. The enzyme can hydrolyze alpha-1,4-glycosidic bonds in a straight chain like those found in amylose (part of amylopectin) but cannot break alpha-1,6-glycosidic bonds or the terminal alpha-1,4 bonds at the end of a chain.

33. C

Molecule X shows a single fatty acid chain attached to glycerol, indicating it's not a triglyceride, which typically has three fatty acids. There are no double bonds in the chain, suggesting the fatty acid is saturated.

34. A

Sucrose formation involves a condensation reaction between alpha-glucose and fructose, resulting in the release of water, as depicted in the provided reaction.

35. A

The structure of alpha-glucose (α-glucose) is specifically suited to form polysaccharides like starch and glycogen, crucial in plant and animal energy storage.

36. B

Alginic acid's structure involves two monomers joined by glycosidic bonds, similar to the arrangement seen in glycogen molecules.

37. A

Triglycerides and phospholipids share structural similarities, including ester bonds with glycerol and fatty acids, and hydrophobic fatty acid chains that can be saturated or unsaturated.

38. A

Option B is incorrect as ribose is a monosaccharide. Option C is incorrect as starch and amylose are polymers not a monomer. Option D is incorrect as sucrose is a disaccharide. Hence, option A is the correct answer as cellulose, glycogen and amylopectin are all polymers.

39. D

Option D is the correct answer as short chain unsaturated fatty acids are more likely to form triglycerides in mammals in cold climates in order to help the mammals to conserve heat.

40. A

Option A is the correct answer as the removal of double bonds will allow the fatty acid chains to fit together more closely. Saturated fatty acids are less soluble and have a higher melting point so are solids are room temperature.

41. A

Option A is the correct answer as X, Y and Z all contain at least one chain of saturated fatty acids. Only X and Y contain unsaturated fatty acid chains that it chains having at least one double bond in them. X and Y contain 3 different fatty acid chains.

42. C

Option A is incorrect as ribose is a monosaccharide. Option B is incorrect as glucose is a monosaccharide. Option D is incorrect as sucrose is a disaccharide. Hence, option C is the correct answer as deoxyribose, fructose and ribose are all monosaccharides.

43. C

Option C is the correct answer as amylose, cellulose and glycogen all contain 1-4 linkages.

44. D

Option D is the correct answer as ribose and deoxyribose are ringed sugars that cannot be represented using a linear structure. However, glucose has both linear and ring shaped forms so it can be represented using this.

45. D

Statement 1 is incorrect as cellulose that makesthe cell walls is made of beta glucose monomers only. Statement 3 is incorrect as glucose is a hexose sugar. Hence, option D is the correct answer as only statement 2 is correct as the beta glucose monomers are joiner together using beta 1, 4 linkages.

46. A

Option A is the correct answer as animal cells contain glycogen which is a polymer that contains alpha 1,4 and 1,6 linkages that make it a branched molecule.

47. C

Those molecules whose number of hydrogen atoms is less than 2 times the number of carbon atoms are the ones that are unsaturated since they can still hold more hydrogen atoms. According to this option C is the correct answer.

48. D

Option D is the correct answer as the main function of triglycerides is energy storage which is accomplished through the use of a high ratio of carbon-hydrogen bonds to carbon atoms that release a lot of energy when broken down.

49. B

Option B is the correct answer as monosaccharides such as fructose contain the same number of carbon and oxygen atoms but twice the number of hydrogen atoms.

50. A

Option A is the correct answer as cellulose is a linear molecule that is made of beta glucose molecules with beta 1, 4 glycosidic bonds. Glucose is a hexose monomer.

51. A

Option A is the correct answer as glycogen is a highly branched structure that contain both alpha 1, 4 and 1, 6 linkages meaning that it will be hydrolyzed but not completely. Amylose on the other hand is a linear molecule containing only alpha 1, 4 linkages meaning that it will undergo the most hydrolysis.

52. C

Options A, B and D are incorrect as saturated fatty acids contain only one carbonyl double bond. Hence, option C is the correct answer as hemoglobin and collagen are proteins that contain more than 2 double bonds.

53. A

Option A is the correct answer as the formation of a disaccharide such as maltose that contain 2 molecules of glucose releases one molecule of water as a result of condensation reaction. Phospholipid formation releases 2 molecules while the formation of polysaccharide releases molecules depending on the length of the chain.

54. A

Option A is the correct answer as glycogen contains both alpha 1, 4 and 1, 6 linkages. The molecules is branched and acts as a storage molecule.

55. D

Option D is the correct answer as the number of double bonds in the chain increases the fluidity of the membrane increases.

56. B

The Biuret test identifies proteins, which consist of amino acids containing carboxyl groups, and the Ethanol test detects lipids, specifically fatty acids, which also contain carboxyl groups. Benedict's test, however, identifies reducing sugars, which do not always contain carboxyl groups Hence the correct overlap is B, as both Biuret and Ethanol tests can detect molecules with carboxyl groups.

57. A

Option A is the correct answer as the hydrophobic fatty acid tails pack together with heads pointed out. The non-polar tails form bonds using hydrophobic interactions. Since phosphate groups are polar hydrogen bonds between them and water form.

58. C

Option C is the correct answer as the condensation reactions in the glycogen monomers result in the release of water so subtracting the water molecule from the general formula of glucose we find the general formula for it.

59. B

Option B is the correct answer as amylopectin and glycogen are alpha glucose polymers and cellulose is a beta glucose polymer.

60. A

An saturated hydrocarbon chain has hydrogen atoms of the order 2n+2 with n referring to the number of carbon atoms. However since this fatty acid contains oxygen as well the maximum number will be 2n which equates to 36 making option A the correct answer.

61. D

Option D is the correct answer as starch is a macromolecule, alpha glucose is a monomer and glycogen is a polymer made of amylose and amylopectin.

62. C

Option C is the correct answer as chitin is most like cellulose since every other monomer is flipped 180 degrees for the glycosidic bonds to form.

63. A

Option A is the correct answer as caprylic acid and lauric acid do not have double bonds in the carbon chains making them saturated fatty acids.

64. B

Collagen is a structural protein found in animal connective tissues, and glycogen is the storage form of glucose in animal cells. Both are marcromolecules specific to animals. Other options include molecules like starch and sucrose, which are typically found in plants. Hence, B is correct.

65. A

Option A is the correct answer as cellulose is made of beta glucose monomers and carbon 1 has the hydroxyl group on the top side and on carbon 4 the hydrogen atom should be on the top side.

66. D

Option D is the correct answer as from lactose we can see that the left molecule is beta galactose as the opposite carbon atoms have the same arrangement and the right molecule is beta glucose as the opposite carbon atoms have inverted arrangements.

67. B

Option A is incorrect as triglycerides do not contain a phosphate group. Option C is incorrect as triglycerides are not polar. Option D is incorrect as phospholipids have 2 ester bonds. Hence, option B is the correct answer as both triglycerides and phospholipids contain hydrocarbon chains that can be unsaturated or saturated.

68. D

Option D is the correct answer as carbohydrates are already polymers. However both carbohydrates and triglycerides contain carbon, hydrogen and oxygen and they are both used as energy stores.

69. C

Option C is the correct answer as this this the alpha 1-6 glycosidic branching that promotes branching and is present only in amylopectin, glycogen and starch since they are branched molecules.

70. A

Option A is the correct answer as carbon 1 has hydrogen on top and OH on bottom. Then carbon 2 has the same arrangement followed by alternating position of H and OH molecules.

71. C

Statement 1 is incorrect formation of sucrose forms water and does not use it. Statements 2 and 3 are correct as glycogen contains alpha 1, 4 and 1, 6 glycosidic bonds formed via condensation and the hydrolysis of amylopectin uses water molecules to release alpha glucose molecules. Statement 4 is incorrect as amylose contains alpha glycosidic bonds.

72. C

Option C is the correct answer as a triglyceride has ester bonds formed by joining fatty acids to glycerol.

73. D

Option D is the correct answer as Z is an unsaturated hydrocarbon that contains double bonds meaning that it increases the permeability of the hydrophobic region. Y and Z are both hydrocarbon chains that are non-polar meaning that they repel polar molecules. X contains the phosphate group meaning that it attracts polar molecules such as water.

74. A

The monomer is usually a monosaccharide. The polymer is a combination of several monomers. The macromolecule is an expansive structure made using the polymers. Fructose is a monomer, amylose and amylopectin are polymers, and starch, glycogen and cellulose are macromolecules. Hence, option A is the correct answer.

75. A

All branched structures contain 1,6 glycosidic bonds. Hence, option A is the correct answer since amylopectin, glycogen and starch are all branched structures.

76. C

Sucrose is a combination of alpha glucose and fructose. The correct monosaccharides are shown in option C.

77. A

The C:H ratio for glucose and saturated fatty acids is the same which is 1:2 but is 1:1.8 for sucrose due to the condensation polymerization that results in the loss of a few molecules. Hence, option A is the correct answer.

78. C

Option A is incorrect as phosphate group is hydrophilic. Option B is incorrect since phospholipids do not contain glycerol. Option D is incorrect since triglyceride molecules have more ester linkages. Hence, option C is the correct answer since triglyceride molecules have more ester linkages than phospholipid molecules.

79. C

The first linkage is beta 1, 3 linkage due to bond between carbon 1 and 3 and the second one is beta 1, 4 due to bond between carbon 1 and 4. Hence, option C is the correct answer.

80. A

Both maltose and sucrose are isomers of each other. Since maltose has the formula $C_{12}H_{22}O_{11}$ sucrose has the same formula. Hence, option A is the correct answer.

81. C

1 is alpha glucose, 2 is fructose and 3 is beta glucose. Sucrose contains 1 and 2. Cellulose contains 3 and glycogen contains 1. Hence, option C is the correct answer.

82. B

F is 2 with 1, 4 beta linkages. G is 3 since there are 1, 4 alpha linkages and H is 1 since the second monomer is flipped 180 degrees resulting in beta 1,4 linkages. Hence, option B is the correct answer.

83. A

The three ester linkages release 3 molecules of water. Hence, option A is the correct answer.

84. B

Amylose and cellulose are linear molecules whereas glycogen and amylopectin are branched. Branched molecules contain both 1, 4 and 1, 6 linkages. Hence, option B is the correct answer.

85. C

1 can be used since the enzyme breaks down the polymer into monomers. 2 cannot be used since the polymer is not broken down. 3 can be used since the hydrochloric acid breaks down the polymer. Hence, option C is the correct answer.

86. A

Option B is incorrect since glucose is not a macromolecule. Option C is incorrect since cellulose and starch are polymers not monomers. Option D is incorrect since starch and sucrose is a disaccharide. Hence, option A is the correct answer as amylopectin, amylose and cellulose are all polymers.

87. C

The molecular formula for this linear structure is $C_6H_{12}O_6$ meaning that this can only be glucose. Hence, option C is the correct answer.

88. A

This is triglyceride formation which results in the removal of 3 molecules of water as a result of ester linkages. Hence, option A is the correct answer.

89. D

The monomers are involved in a condensation reaction where the OH groups react to from a glycosidic bond with the loss of a water molecule. Hence, option D is the correct answer.

90. A

Ribose, deoxyribose and glucose are monomers. Sucrose is a disaccharide. Hence, option A is the correct answer.

91. D

The ability of triglycerides to be liquid or solid or their ability to float on water does not make them efficient energy stores. The large amount of carbon hydrogen bonds and their insolubility in water make them excellent stores of energy. Hence, option D is the correct answer.

92. A

Option B is incorrect since their solubility decreases due to increase in the single bonds. Option C is incorrect as saturated compounds have no double bonds. Option D is incorrect since their temperature for melting increases so they might be solid. Hence, option A is the correct answer since single bonds allows for more flexibility allowing the chains to fit together closely.

93. C

Whenever 2 alpha glucose molecules react a molecule of water is produced as a result. Hence, option C is the correct answer. Option A is incorrect as 1, 6 linkages are also possible. Option B is incorrect since a glycosidic bond in formed. Option D is incorrect since water is formed not hydroxyl.

94. C

The three ester linkages release 3 molecules of water. Hence, option C is the correct answer.

95. B

Amylose and cellulose both contain 1,4 linkages. Both are polymers of glucose. Both are linear structures so none of them contain 1, 6 linkages. Hence, option B is the correct answer.

96. D

1 is alpha glucose, 2 is beta glucose and 3 is fructose. Sucrose contains 1 and 3. Cellulose contains 2 and starch contains 1 only. Hence, option D is the correct answer.

97. A

Option B is incorrect as glycosidic bonds are formed. Option C is incorrect since molecules of water are produced. Option D is incorrect since monosaccharides are taking part in this reaction. Hence, option A is the correct answer as 2 monosaccharides combining produce a disaccharide.

98. C

Statements 1 and 4 are the same and are correct. Statement 2 is incorrect since glycosidic bonds are formed in condensation reactions not broken. Statement 3 is correct as condensation reactions produce a molecule which may be water. Hence, option C is the correct answer.

99. B

Triglycerides are hydrophobic but are soluble in alcohol due to their polarity. Hence, option B is the correct answer.

100. D

Triglycerides are hydrophobic and are soluble in alcohol. Hence, option D is the correct answer.

101. A

Options B, C and D are incorrect since both molecules are polysaccharides, contain alpha glucose and 1, 4 linkages. Hence, option A is the correct answer since glycogen molecules are highly branched as compared to starch.

102. C

Statement 1 is incorrect since monosaccharides cannot be broken down. Statement 2 is correct since glycosidic bonds are broken during hydrolysis. Statement 3 is incorrect since molecules of water are used. Statement 4 is correct since monosaccharides can be formed. Hence, option C is the correct answer.

103. B

1 is amylose since it is made of alpha glucose and has 1, 4 bonds. 2 is glycogen since it is branched and is an alpha glucose polymer. 3 is amylopectin since it is an alpha glucose polymer that contain 1, 4 bonds and is branched as well. 4 is cellulose that contain beta glucose and 1, 4 bonds. Hence, option B is the correct answer.

104. B

Molecule X is a monosaccharide like glucose due to 1:2:1 of carbon to hydrogen to oxygen. Molecule Y is a polysaccharide since the ratios are random due to loss of molecules as a result of condensation reactions. Molecule Z is a triglyceride since the oxygen is significantly less as compared to the carbon or hydrogen. Hence, option B is the correct answer.

105. D

Statement 1 is incorrect since triglycerides also have hydrophobic regions. Statement 2 is incorrect since the fatty acid chains in phospholipids can be saturated or unsaturated. Statement 3 is correct since phospholipids have the polar phosphate group and triglycerides are non-polar. Hence, option D is the correct answer.

106. A

Alpha glucose straight chain is amylose and alpha glucose branching chain polysaccharides is amylopectin. Beta glucose straight chain is in cellulose. Hence, option A is the correct answer.

107. C

The loss of a water molecule from the glucose molecules result in the subunit have the formula $C_6H_{10}O_5$ making option C the correct answer.

108. B

Option A is incorrect as triglycerides as insoluble in water. Option C is incorrect since not all phospholipids have saturated chains. Option D is incorrect since there is not always 3 ester bonds in phospholipids. Hence, option B is the correct answer as glycolipids are present in all cell membranes and plants store excess carbohydrates as starch.

109. A

Looking at the possibilities
LOP - same as POL (because number 1 can be counted from any end)
OLP - same as PLO
LPO - same as OPL
Hence there are 3 possible arrangements making option A the correct answer.

110. D

The completed statement is: The polysaccharide amylose is a polymer made up of monomers of the monosaccharide glucose. Hence, option D is the correct answer.

111. B

Statement 1 is correct as glycosidic bonds are a result of condensation reactions that release water molecules. Statement 2 is incorrect since glycosidic bonds can also form between glucose and fructose to form sucrose. Statement 3 is incorrect since there are more positions where these bonds can be formed. Statement 4 is correct since hydrolysis of these bonds' releases energy. Hence, option B is the correct answer.

112. C

The loss of a water molecule from the glucose molecules results in the subunit have the formula $C_6H_{10}O_5$ making option C the correct answer.

113. C

Statements 1 and 3 are correct but statement 2 is incorrect since the hydroxyl group of the glycerol reacts with the carboxy group of the fatty acids. Hence, option C is the correct answer.

114. C

The molecule cannot be amylose or cellulose since those are linear molecules. It isn't starch due to the extensive branching. Hence, it is glycogen meaning option C is the correct answer.

115. C

Option C is the correct answer since fructose and beta glucose are both reducing sugars. Additionally, beta glucose is a monomer and so is an amino acid.

116. D

Cellulose is made from beta glucose monomers meaning option A and C are incorrect. Every other molecule in cellulose is flipped 180 degrees in order for a beta 1, 4 glycosidic bond to form. Hence, option D is the correct answer.

117. C

The loss of a water molecule from the glucose molecules results in the subunit have the formula $C_6H_{10}O_5$ making option C the correct answer.

118. C

The double bonds are located within the fatty acids only. Hence, option C is the correct answer.

119. C

Triglycerides are non-polar, and phospholipids have hydrophobic tails. Hence, option C is the correct answer.

120. A

Since amylose and amylopectin are polymers made of alpha glucose only alpha glucose will be present after hydrolysis. Hence, option A is the correct answer.

121. C

The bi-layer forms due to the molecules having hydrophobic regions that face inwards and hydrophilic regions that face outwards. Hence, option C is the correct answer.

122. D

Statement 1 is incorrect since amylose is made of alpha glucose. Statement 2 is incorrect since branches in amylopectin form from 1,6 linkages. Statement 3 is correct since in cellulose adjacent molecule are rotated 180 degrees. Hence, option D is the correct answer.

123. B

The molecular formula for this molecule is $C_6H_{12}O_6$ meaning that this can only be glucose. Hence, option B is the correct answer.

124. B

When hydrolyzed the fatty acid chains have carboxyl groups and the amino acids in proteins also have them. Hence, option B is the correct answer.

125. C

Statement 1 is incorrect since the molecule is linear. Statements 2 and 3 are correct since the chains form hydrogen bonds between each other and the molecule in insoluble in water. Hence, option C is the correct answer.

126. B

Amylopectin and glycogen are both branches due to the 1,6 linkages. Hence, option B is the correct answer.

127. B

Statement 1 is correct as the monomers are joined by 1, 4 linkages. Statement 2 is correct as every other monomer is rotated by 180 degrees. Statement 3 is incorrect as the complete structure is not shown so there might be more elements. Hence, option B is the correct answer.

128. C

Triglycerides are non-polar, less dense than water and have more hydrogen than carbohydrates. Hence, option C is the correct answer.

129. A

1 and 2 are glucose molecules due to the alternating and flipped H and OH positions on the carbon atoms. Hence, option A is the correct answer.

130. A

Alpha glucose (1) and fructose (2) combine to form sucrose. Hence, option A is the correct answer.

131. B

Since glycogen is a polymer of alpha glucose only alpha 1, 4 and 1, 6 linkages will be broken. Hence, option B is the correct answer.

132. D

The fatty acid with the most number of double bonds would contribute greatest to the fluidity of the cell membrane. Hence, option D is the correct answer.

133. B

Option B shows alpha glucose due to H being upwards on the 1 carbon and alternating H–OH bonds.

134. D

Option A is incorrect as amylose has a linear structure and amylopectin has a branched one. Option B is incorrect as breakdown is done via hydrolysis not condensation. Option C is incorrect as condensation reactions form amylose and amylopectin. Hence, option D is the correct answer as starch is insoluble and does not interfere will the cell's water potential.

135. B

Since cellulose is a beta glucose polymer amylase cannot digest it. Amylopectin will be digested a little bit since it contain 1, 6 bonds as well. Amylose will be digested the most since it contains only 1, 4 linkages. Hence, option B is the correct answer.

136. D

The loss of a water molecule from the glucose molecules results in the subunit have the formula $C_6H_{10}O_5$ making option D the correct answer.

137. D

The ratio of the short to long fatty acids is lower for whale milk indicating that they have longer chains. This means that young whales need more energy than young cows. Hence, option D is the correct answer.

138. D

Glycerol attached to fatty acids forms triglycerides which do not form the cell membrane. Hydrophobic fatty acid chains help to form the bilayer. Saturated chains are not of use in the cell membrane as they decrease fluidity. Hence, option D is the correct answer.

139. A

Option A shows the monomer for cellulose which is beta glucose since carbon 1 has OH upwards followed by alternating H–OH bonds.

140. C

Amylose and amylopectin are both polymers. They are formed by condensation reactions not hydrolysis reactions. Amylose is linear but amylopectin is branched. Both polymers contain alpha 1,4 glycosidic bonds. Hence, option C is the correct answer.

141. B

Amylose contain alpha 1,4 glycosidic linkages but not 1,6 linkages. It forms a helical molecule. Hence, option B is the correct answer.

142. A

The first carbon is the one on which the OH position is different and cellulose contains beta glucose but not alpha glucose. Hence, option A is the correct answer.

143. D

3 and 4 do not show glucose molecules since carbon atoms 3 and 4 contain the same bonds when they should be flipped when next to each other. Hence, option D is the correct answer.

144. D

Amylose will be digested the greatest since it contains only alpha 1, 4 bonds.
Amylopectin will be digested more since it contains 1, 4 linkages but 1, 6 as well.
Glycogen will be digested the least since it does contain 1, 4 bonds but is a highly branched structure containing more 1, 6 bonds. Hence, option D is the correct answer.

145. C

The molecule has the formula $C_6H_{12}O_6$ which means it can be glucose only since ribose and sucrose have different formulas. Hence, option C is the correct answer.

146. A

Unsaturated fatty acids contain all the 3 types of bonds shown whereas saturated fatty acids contain only 1 and 3 and not 2 since they do not have any double bonds. Hence, option A is the correct answer.

147. D

Triglycerides can contain saturated tails as well. Triglycerides do form by ester linkages and cannot form hydrogen bonds. The glycerol head is not hydrophilic. Hence, option D is the correct answer.

148. D

Option D is the correct answer since glycogen and amylopectin contain alpha 1, 6 bonds and amylopectin and amylose contain alpha 1, 4 bonds.

149. D

The advantage of the OH group being on the opposite sides of the molecules is that it can form hydrogen bonds with adjacent OH and CH_2OH groups of other cellulose molecules. Hence, option D is the correct answer.

150. C

Cellulose is most similar to chitin since in cellulose hydrogen bonds forms between OH groups on the chains lying adjacent to each other. Hence, option C is the correct answer.

151. D

Option A is incorrect since the fatty acids are joined with glycerol not glycogen. Option B is incorrect as it depends on the fatty acid chains. Option C is incorrect as phospholipids form the bilayer not triglycerides. Hence, option D is the correct answer as carbohydrates have a greater carbon to oxygen ratio.

152. B

Cellulose contain X which is beta glucose. Glycogen, amylose and amylopectin contain alpha glucose which is Y. Hence, option B is the correct answer.

153. B

Option B shows beta glucose as carbon 1 has OH facing upwards and alternating H–OH bonds.

154. B
Starch is made up of amylose and amylopectin. 1 is amylose since it contains only 1,4 bonds and is helical. 4 is amylopectin since it contains both 1,4 and 1,6 linkages and is branched. Hence, option B is the correct answer.

155. A
Option A is the correct answer as amylopectin and glycogen both contain alpha 1,6 linkages and glycogen and amylopectin contain alpha 1,4 linkages. Hence, option A is the correct answer.

156. D
The bond linking the individual units of both cellulose and glycogen is the glycosidic bond, represented in diagram D. This bond forms between monosaccharide units in polysaccharides like cellulose and glycogen. Hence, D is correct.

157. C
Sucrose is not a reducing sugar and it contains a hexose sugar that is glucose. Hence, option C is the correct answer.

158. A
Statement 1 is correct as both molecules have hydrophobic fatty acid tails. Statement 2 is correct as well since triglycerides are non-polar and phospholipids are polar. Statement 3 is incorrect as phospholipids can also contain unsaturated fatty acids. Hence, option A is the correct answer.

159. C
Triglycerides are not hydrophilic, and they are soluble in alcohol. Hence, option C is the correct answer.

160. C
Option C is the correct answer as both amylose and glycogen contain glycosidic linkages.

161. B
Glycosidic bonds and hydrogen bonds hold together the structure of cellulose. Hence, option B is the correct answer.

162. B
Glycogen contains alpha 1, 4 and alpha 1, 6 bonds. Hence, option B is the correct answer.

163. D
Option D is the correct answer as it shows H upwards on the first carbon atom and alternating H–OH bonds.

164. B
Amylose has alpha glucose with no rotation and 1, 4 linkages. Cellulose has beta glucose with 180 degrees rotation and 1, 4 linkages. Hence, option B is the correct answer.

165. D
Since the structure shows alpha 1, 4 and 1, 6 linkages it can be amylopectin, starch or glycogen. Using these we can see that option D is the correct answer.

166. B
Options C and D are incorrect since water is released in condensation and used in hydrolysis. Option A is incorrect since the fatty acid molecule is unsaturated due to the presence of a double bond. Hence, option B is the correct answer.

167. B
Option B is the correct answer as it shows H upwards on the first carbon atom and alternating H–OH bonds.

168. D
Since sucrose contains glucose and fructose 2 spots will appear on the paper since there are different compounds. Hence, option D is the correct answer.

169. C
In lipids the double bonds are only located in the fatty acid chains. Hence, option C is the correct answer.

170. B
In the structure every other molecule is rotated 180 degrees. This only occurs in cellulose making option B the correct answer.

171. C
Option C is the correct answer as the alpha glucose shows H upwards on the first carbon and the OH upwards on the beta glucose structure.

172. C
Option C is the correct answer since it shows the C–O–C bond which is a glycosidic bond.

173. C
Amylose contains only alpha 1, 4 bonds meaning that those will be broken in the hydrolysis making option C the correct answer.

174. **C**
In lipids the double bonds are only located in the fatty acid chains. Hence, option C is the correct answer.

2.3: Proteins and water

1. **B**
Disulfide bonds are strong covalent bonds, while hydrogen and ionic bonds are weaker. Hydrophobic interactions are also weak forces stabilizing protein structure.
2. **A**
Haemoglobin consists of four polypeptide chains, each with a haem group that binds oxygen. The hydrophobic R-groups face inward, stabilizing the structure. At 50% saturation, two oxygen molecules are bound to the haem groups.
3. **C**
The quaternary structure of proteins is determined by the interaction of multiple polypeptides, and these interactions are influenced by the primary structure (amino acid sequence) of the individual polypeptides.
4. **B**
Hydrogen bonding between water molecules leads to cohesion, high latent heat of vaporisation, and high specific heat capacity, but it does not affect water's solvent properties.
5. **D**
A single water molecule can form up to four hydrogen bonds with other water molecules—two via its hydrogen atoms and two via its oxygen atom.
6. **C**
Aspartate has a negatively charged carboxyl group, and lysine has a positively charged amino group, giving both an overall charge. Alanine and glycine are neutral.
7. **B**
Collagen has a primary structure, the sequence of amino acids, and a quaternary structure, as it consists of three polypeptide chains interacting together. Secondary and tertiary structures are not emphasized in collagen's description.
8. **C**
Enzymes are globular proteins (statement 1) and contain hydrogen atoms (statement 3). However, their tertiary structure varies depending on their specific function.
9. **B**
Amino acids, fatty acids, and proteins all contain C=O bonds in their structures, as part of carboxyl or amide groups, while glycerol does not.
10. **A**
Viruses contain phosphodiester bonds (1) in nucleic acids, peptide bonds (2) in proteins, and covalent bonds (3) in both structures.
11. **D**
The side chain (R group) in option D has multiple hydroxyl groups, which is not a typical side chain for any of the 20 standard amino acids. The other options (A, B, C) represent possible side chains.
12. **B**
Primary structure is held by covalent bonds, secondary by hydrogen bonds, tertiary by hydrogen, ionic, covalent, and hydrophobic interactions, and quaternary by hydrogen, ionic, covalent, and hydrophobic interactions.
13. **C**
Covalent and phosphodiester bonds are found in the structure of viral nucleic acids, but ester bonds are not.
14. **B**
Hydrogen gas has a higher specific heat capacity (14.3 J g^{-1} $°C^{-1}$) than water (4.2 J g^{-1} $°C^{-1}$), meaning it requires more energy to raise its temperature. Therefore, option B is correct.
15. **B**
Hydrogen bonding helps prevent enzyme denaturation by stabilizing leaf temperature, reduces water loss by evaporation, and maintains water column cohesion in xylem vessels. Therefore, option B is correct.

16. B

The part of the structure of hemoglobin that carries oxygen is:
B) haem groups
Hemoglobin contains four heme groups, each of which contains an iron atom at its center. It's the iron within the heme group that binds to oxygen molecules in the blood, allowing hemoglobin to transport oxygen from the lungs to the body's tissues.

17. C

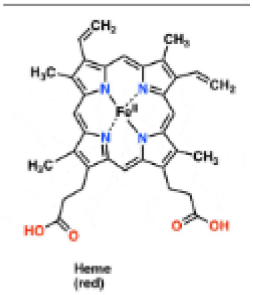
The secondary structure of proteins is stabilized mainly by hydrogen bonds, which occur between the carbonyl oxygen of one amino acid and the amide hydrogen of another. Bond 1 in the diagram shows a hydrogen bond, which is essential for maintaining the alpha-helix and beta-pleated sheet structures of proteins. Bond 2 represents a peptide bond, which is involved in the primary structure of proteins, linking amino acids together in a chain. Bond 3 shows a disulfide bond, which is important in the tertiary or quaternary structures of proteins where it stabilizes the folded shape of the protein by forming covalent links between different parts of the protein chain or between different chains.

18. C

Insulin is indeed a globular protein, and it does have a quaternary structure since it consists of two polypeptide chains that are connected by disulfide bonds. There are indeed six cysteine residues within insulin that form three disulfide bonds (not six, which would suggest six separate disulfide bonds), making statement 2 partially correct but misleading if interpreted as six separate disulfide bonds. As for statement 3, in globular proteins like insulin, hydrophobic amino acids are typically found on the interior of the protein, away from the aqueous environment, which helps to stabilize the protein structure.

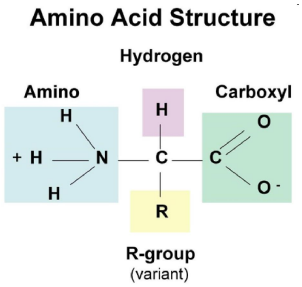
19. D

Triglycerides always contain at least three double bonds. When triglycerides are formed from fatty acids and glycerol, the C=O double bond in the carboxyl group of fatty acids is unaffected by the condensation reaction between –OH of glycerol and –OH of the fatty acid. As a result, triglycerides always contain three C=O double bonds left over from the carboxyl group of fatty acids. Since this is an unsaturated triglyceride apart from these 3 double bonds, there will be more due to the presence of unsaturated fatty acids.
Heme groups present in hemoglobin also contains many double bonds. This can be seen from the image.



The structure of collagen also contains many double bonds. Collagen is a protein containing many amino acids like proline, hydroxyproline and glycine, all of which contain double bonds.

20. D



As it can be seen from the general structure of an amino acid, it is obvious that option D is correct

21. C

Hydrogen bonds are crucial in maintaining the secondary structure of proteins, such as alpha-helices and beta-pleated sheets. Hydrophobic interactions are significant in the tertiary structure, where the folding of the protein causes hydrophobic side chains to be buried away from the aqueous environment. Covalent bonds, specifically disulfide bonds (a type of covalent bond), play a significant role in stabilizing the tertiary structure and can also link different polypeptide chains in the quaternary structure. The primary structure is

held together by peptide bonds, which are a type of covalent bond, but they are not the same as the disulfide bonds referred to in this context.

22. B

1. Hydrogen Bonds: Weak interactions between electronegative atoms, helping maintain secondary and tertiary structures.
2. Disulfide Bonds (or Covalent Bonds): Strong covalent bonds between sulfur atoms of cysteine amino acids, stabilizing tertiary structure.
3. Ionic Bonds: Electrostatic attraction between oppositely charged ions, influencing interactions between charged side chains.
4. Hydrophobic interactions: Non-covalent forces driving hydrophobic side chains to cluster together, contributing to protein stability.
5. Peptide Bonds: Covalent bonds connecting amino acids, forming the primary structure of proteins.

Note: Covalent Bonds can refer to both peptide bonds and disulfide bonds, but the context helps distinguish between the two.

23. D

Saturated triglycerides are characterized by having no double bonds within their fatty acid chains. Collagen is a protein, and while it may have some double bonds in the amino acids that constitute it, it is not characterized by having at least three double bonds. Haemoglobin, also a protein, does not have a structure defined by multiple double bonds. Therefore, none of the regions overlapping with "saturated triglyceride" and "collagen" would be correct.

24. C

The tertiary structure of globular proteins, including enzymes, allows them to catalyze metabolic reactions. This is due to the specific arrangement of amino acid residues (R groups) that form bonds with substrates at the active site.

25. D

Knowledge of lipid structure and the composition of triglycerides is necessary. Molecule X must be analyzed to determine if it fits the description of a triglyceride, which typically consists of three fatty acids esterified to a glycerol backbone.

26. B

Spider silk has a secondary protein structure characterized by regions of β-pleated sheets, which contribute to its high tensile strength and elasticity. These sheets form from hydrogen bonds between backbone peptides in different silk protein strands.

27. D

A protein with two polypeptide chains joined by disulfide bonds indicates a quaternary structure, representing the highest level of structural organization in proteins.

28. B

Water molecule is formed when the COOH group of one amino acid reacts with the NH_2 group of another one. According to this then option B is the correct answer.

29. A

A polypeptide with n amino acids always has n-1 peptide bonds since the last amino acid isn't linked to any other amino acid.

30. C

Option C is the correct answer as the primary structure contain peptide bonds that are covalent in nature. The secondary structure involves hydrogen bonds. The tertiary structure is important to the function of enzymes and receptors due to the specific shapes involved. The quaternary structure is formed as a result of multiple polypeptide chains.

31. C

Bond 1 is a hydrogen bond that can hold together the quaternary structure. Bond 2 is a peptide bond that holds together the primary structure only. Bond 3 is a disulfide bond that can maintain the quaternary structure. Hence, option C is the correct answer.

32. C

Option C is the correct answer as the CH_3 is the R group that is different for each amino acid.

33. C

Option C is the correct answer as 1 is a hydrogen bond and 3 shows disulfide linkage that are both involved in the tertiary structure of the protein. 2 shows peptide bonds that hold together the primary structure not the tertiary.

34. A

Option A is the correct answer as the sequence of DNA nucleotides determines the sequence of amino

acids that determines the primary structure of the protein. The secondary structure is formed via hydrogen bonding between the C=O and the N–H groups. The tertiary structure is held by disulfide, ionic attraction, hydrogen bonds and hydrophobic interactions. The quaternary structure is formed always from 2 or more polypeptide chains.

35. C

Option C is the correct answer as collage molecules form triple helixes from polypeptide chains that link with other helixes to form microfibrils with high tensile strength.

36. D

Option D is the correct answer as the primary structure is the sequence of amino acids that are encoded by the mRNA molecule. The tertiary structure is formed as a result of the side chain interactions in the primary structure and the quaternary structure forms as a result of the different polypeptide chains interacting with each other.

37. C

Any option with the triglycerides can be eliminated since they contain 3 double bonds only. This makes option C the correct answer as collagen and hemoglobin are both proteins containing at least 4 double bonds.

38. B

Option B is the correct answer as glycine contains only 5 hydrogen atoms which is the lowest out of the other compounds. Glucose contains 12, glycerol has 8 and a saturated fatty acid with 8 carbon atoms would have 16 hydrogen atoms.

39. D

Option D is the correct answer as a collagen molecule contains three polypeptide chains that form a helix in which every third amino acid is glycine. Many of these molecules bind together with each other to form a fiber.

40. C

Option C is the correct answer as since there are 260 million hemoglobin molecules and each molecules contains 2 alpha chains that means that there are 520 million alpha chains which equates to 5.2×10^8.

41. D

Option D is the correct answer as peptide bonds contains carbon, oxygen, nitrogen and hydrogen atoms. It is important in the primary structure of proteins. Addition of water does not always break the bond as it is possible that the condensation reaction releases something other than water. The 2 amino acids joined are not always the same.

42. B

Option B is the correct answer as the peptide bonds is formed between the COOH and NH_2 groups that are attached to the chiral carbon atom meaning the carbon atom with 4 different groups attached to it.

43. C

Option C is the correct answer as from the option pool saturated fatty acids and fatty acids contain one double bonds. Collagen and hemoglobin on the other hand are proteins containing more than 3 double bonds.

44. D

Option D is the correct answer as the primary structure is the sequence of amino acids that are encoded by the mRNA molecule. The secondary structure is formed by hydrogen bonding between the amino acids that are part of the primary structure. The tertiary structure is formed as a result of the side chain interactions in the primary structure and the quaternary structure forms as a result of the different polypeptide chains interacting with each other.

45. C

Option A is incorrect as tissues containing collagen can stretch. Option B is incorrect as 3 polypeptide chains bind together to form a helix. Option D is incorrect as three polypeptide chains form a collagen microfibril. Hence, option C is the correct answer as the three helices of collagen are held together via hydrogen bonds.

46. D

The OH groups on both the amino acids can form hydrogen bonds. Hence, option D is the correct answer.

47. D

Option D is the correct answer as the primary structure is the sequence of amino acids that are encoded by the mRNA molecule. The tertiary structure is formed as a result of the side chain interactions in the primary structure and the quaternary structure forms as a result of the different polypeptide chains interacting with each other.

48. B

Both collagen and hemoglobin are proteins containing a quintenary structure meaning there is more that one polypeptide chain. Hemoglobin is the globular protein out of the 2. Hence, option B is the correct answer.

49. A

Option A is the correct answer as cellulose is used for support and is fibrous and has chains held together by hydrogen bonds but isn't branched. Triglyceride is an energy source with no fibrous properties, hydrogen bonds or branched chains.

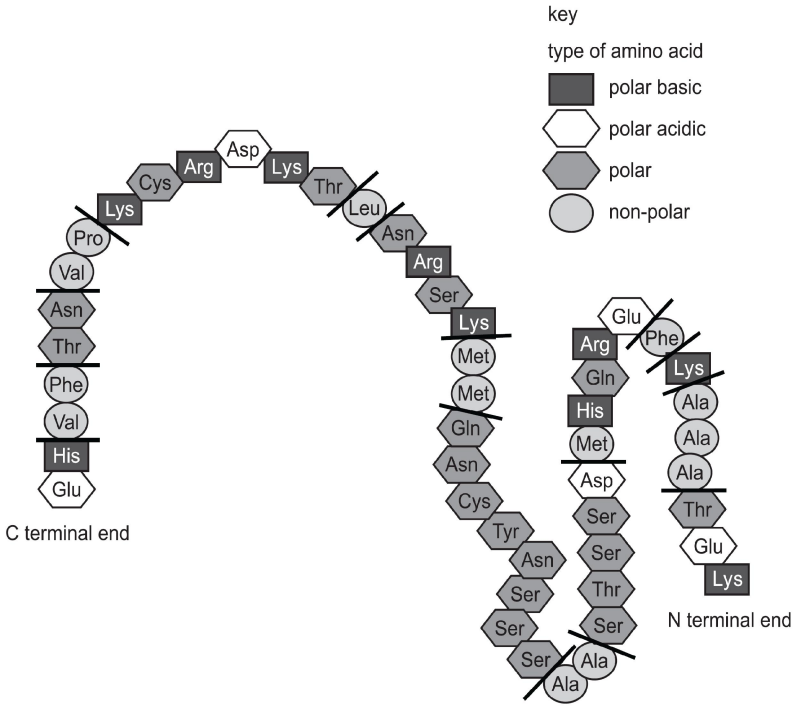
50. D

Both cohesion and latent heat of vaporization have no effect on the temperature changes on water. Specific heat capacity however does since it is the energy required for a 1 degrees increase in the temperature. Hence, option D is the correct answer.

51. D

A change in the amino acid sequence would result in changes in the primary, secondary, tertiary and the quaternary structure. Hence, option D is the correct answer.

52. D



Looking at the image we can see the lines are the points where the amino acids are broken. There are 13 peptide chains and 4 amino acids. Hence, option D is the correct answer.

53. C

Antibodies are produced as a result of immune response. The presence of lysozyme in tears and mucus suggests that it is not only extracellular but is an antibacterial since bacterial cell walls are made of peptidoglycan. Hence, option C is the correct answer.

54. B

In the formation of a peptide bond the OH group is removed from COOH and H is removed from NH_2 forming a water molecule. Hence, option B is the correct answer.

55. D

Hydrogen bonds provide a constant environment for aquatic organisms and help in temperature control due to evaporation. Hence, option D is the correct answer.

56. A

Unsaturated fatty acids contain double bonds whereas collagen and hemoglobin are proteins that contain double bonds. Hence, option A is the correct answer.

57. A

Option A is the correct answer as disulfide bonds are the strongest and require high temperatures to be broken.

58. A

2 alpha chains coil and there are 2 short polypeptides in the globular head with 2 more that bind to each globular head making 6 polypeptide chains in total. This forms the quaternary structure making option A the correct answer.

59. B

The polypeptide chains are held together by the hydrogen bonds and the triple helixes form the fibrils which in turn form the fibers. Hence, option B is the correct answer.

60. A

The hydrogen ions bind to the negatively charged R groups causing a change in the 3D structure of the protein. Hence, option A is the correct answer.

61. D

The carboxyl group in collagen and hemoglobin contains double bonds. Saturated fatty acids contain no double bonds. Hence, option D is the correct answer.

62. B

Statement 1 is correct as both contain ester linkages. Statement 2 is incorrect as the number of fatty acid chains is not fixed. Statement 3 is correct as they can have either saturated or unsaturated fatty acids. Statement 4 is incorrect as phospholipids are used in the cell membrane. Hence, option B is the correct answer.

63. D

Option D is the correct answer since it accurately shows the NH_2 and COOH groups on each amino acid as well as the R groups.

64. B

Hydrogen bonding ensures that enzymes denature at higher temperatures. Hydrogen bonding in water allows the plants to cool quickly at night using the latent heat of vaporization. The cohesion of water molecules in xylem is a result of hydrogen bonding. Hence, option B is the correct answer.

65. B

1 is correct as amino acids contain one OH group usually. 2 is correct as well since glucose does not contain COOH but does contain 2 or more OH groups. 3 is incorrect as glycerol contains 2 or more OH groups. 4 is correct as fatty acids contain COOH group but no OH groups. Hence, option B is the correct answer.

66. B

X shows a hydrogen bond whereas Y shows a peptide bond. Hence, option B is the correct answer.

67. B

Option B is the correct answer since all amino acids contain carbon surround by a hydrogen, COOH group and NH_2 group.

68. D

Option D is the correct answer as the primary structure is the sequence of amino acids that are encoded by the mRNA molecule. The tertiary structure is formed as a result of the side chain interactions in the primary structure and the quaternary structure forms as a result of the different polypeptide chains interacting with each other.

69. C

Collagen will require 3 genes since all the polymers are different. Hemoglobin requires 2 genes since there are only 2 different peptides that is alpha and beta hemoglobin. HIV protease requires one gene since there is only 1 protein. Hence, option C is the correct answer.

70. A

Option A is the correct answer as it shows the OH group of COOH being removed and the H from NH_2 being removed.

71. B

The primary, secondary and tertiary levels of protein structure are involved in forming the active site since the quaternary structure is the enzyme itself. Hence, option B is the correct answer.

72. B

Statements 1, 2 and 4 are correct as the helical structure of the chains paired with the R group interactions and the bonds between collagen molecules result in the formation of fibers that have high tensile strength. Hence, option B is the correct answer.

73. B

Each amino acid contains a central carbon atom and a carbon from the COOH group. Hence, the minimum number is 2 making option B the correct answer.

74. A

Statements 1 and 2 are correct since the fibrils are held together via bonds and the three stranded polypeptides form a helix by linkage through hydrogen bonds. Statement 3 is correct as well since collagen contains glycine which is small in size allowing for helixes to form. Statement 4 is incorrect as all proteins contain peptide bonds but not all of them have high tensile strength. Hence, option A is the correct answer.

75. D

Only the tertiary structure of the enzyme changes according to the induced fit hypothesis in order to secure the substrate. Hence, option D is the correct answer.

76. A

All the levels of protein structure determine the specificity of a protein since all of these combine together to produce a protein with a particular active site. Hence, option A is the correct answer.

77. D

Statement 1 is incorrect as beta pleated sheets do not occur in collagen. Statements 2 and 3 are correct as hydrogen bonds help in the formation of fibrils and fibers and repeated amino acid sequences from polypeptide chains that coil together in helixes to form fibrils. Hence, option D is the correct answer.

78. D

Statement 1 is incorrect as primary structure is always linear. Statements 2 and 3 are correct as the sequence of DNA bases determine the amino acid sequence and this sequence in unique to that protein. Statement 4 is correct as the primary structure determines the tertiary structure of the protein. Hence, option D is the correct answer.

79. A

Option A is the correct answer as it shows the OH group of COOH being removed and the H from NH_2 being removed.

80. C

In water the hydrogen are positively charged and the oxygens are negatively charged. Hence, the hydrogen from one molecule attract the oxygen from another resulting in the formation of a hydrogen bond. This is shown by the image in option C making it the correct answer.

81. D

This is the tertiary structure since there is a single polypeptide chains that has folded in a particular way to grant the protein its 3D shape. Hence, option D is the correct answer.

82. B

Both amino acids and fatty acids contain the COOH group with has the double bonded carbon. Hence, option B is the correct answer as glycerol does not have this group.

83. B

The dipeptide can be spilt into 2 parts with each part being an amino acid residue. In one part the OH from COOH is gone and in the other part the H from NH_2 is gone. This leaves us with lengths of 0.64 nm and 0.436 nm for the 2 parts. Lastly adding it the carbon single bond diameter for the peptide linkage as 0.154 and adding them all together gives 1.23 nm making option B the correct answer.

84. C

Collagen is stabilized by hydrogen bonds and this grants it high tensile strength. Its primary structure has repeat sequences of 3 amino acids and the helix has three polypeptide chains. Hence, option C is the correct answer.

85. A

The diagrams show alpha helixes and beta pleated sheets and both of them do not have any ionic interactions. Only hydrogen bonds are involved. Hence, option A is the correct answer.

86. D

Option D is the correct answer since it does not highlight the central carbon atom or the NH^{2+} or COO^{-} groups.

87. A

Option B is incorrect as 3 polypeptides form a helix not fibers. Option C is incorrect as not all polypeptides have a spiral arrangement. Option D is incorrect as hydrogen bonds are present between amino acids or different polypeptides. Hence, option A is the correct answer as collagen contains a large amount of glycine which is small and assists in hydrogen bonding.

88. B

The high latent heat of vaporization of water is due to hydrogen bonds between water molecules. These bonds require significant energy to break, making water effective in temperature regulation. Hence, B is the correct answer.

89. A

Option A is the correct answer as it shows the OH group of COOH being removed and the H from NH_2 being removed.

90. A

Amylase, hemoglobin and DNA polymerase are all globular proteins. Hence, option A is the correct answer.

91. B

The polypeptide will have n-1 peptide bonds since there is a first and last amino acid and there will be n R groups since these groups are not involved in peptide bonds. Hence, option B is the correct answer.

92. A

Since the amino acids in insulin were being compared that means it is the primary structure since the primary structure is the sequence of amino acids in a polypeptide chain. Hence, option A is the correct answer.

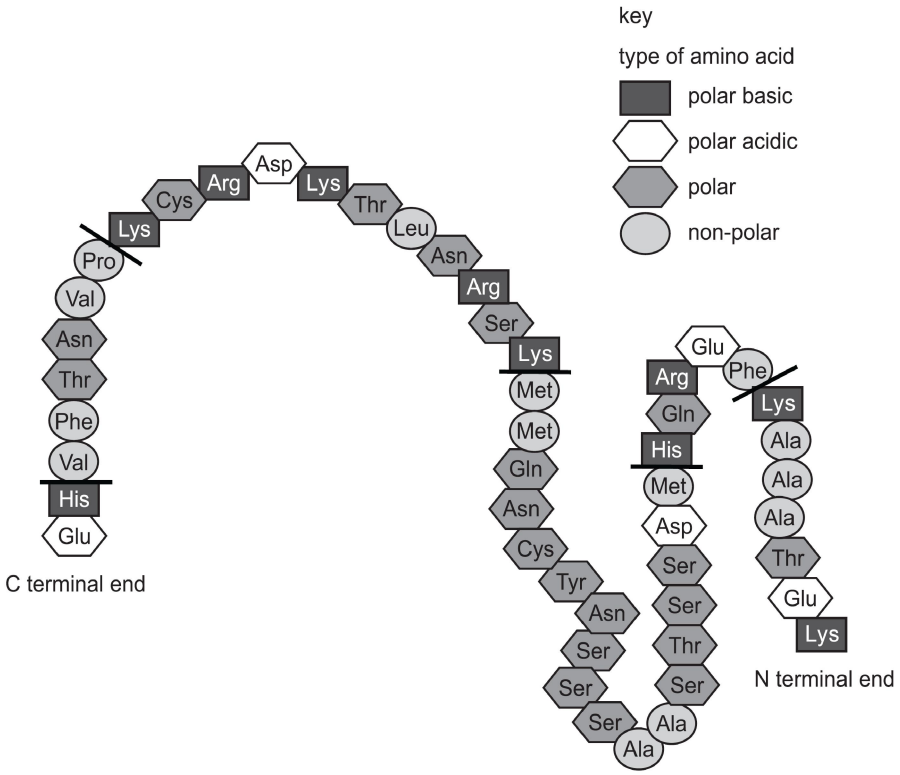
93. B

Disulfide bonds maintain the tertiary and the quaternary structure of the protein only. Hence, option B is the correct answer.

94. C

Boiling the protein causes the hydrogen bonds holding together the fibrils and the fibers to break resulting in the collagen molecules unwinding. Hence, option C is the correct answer.

95. B



Looking at the black cuts in the chain these are the points where the enzyme will act. Counting the chains brings us to the number 6 making option B the correct answer.

96. D

Option D is the correct answer as hemoglobin and collage are both proteins and collagen and cellulose both are structural substances.

97. B

Option B is the correct answer as 3 shows alpha helixes. 4 shows hydrophobic amino acids since they are inside the protein and that means 2 shows hydrophilic amino acids since they are present externally on the protein. This makes 1 the binding site.

98. D

The primary structure of a protein is the specific order of amino acids that make up a polypeptide chain. Hence, option D is the correct answer. Option A is the secondary structure and option C is the tertiary structure. Option B is not any structure.

99. D

1 does not contain any molecules that have nitrogen atoms. 2 has antibodies which are proteins and adenine which is a nitrogenous base. 3 contains hemoglobin which is a protein and mRNA that contain nitrogenous bases. Hence, option D is the correct answer.

100. C

Option C is the correct answer since it shows accurately the NH_2 and COOH groups in the amino acid residues as well as the correct side chains for each amino acid.

101. C

Since there is a change in amino acids involved all the structures from primary to quaternary will be affected since the primary structure affects all subsequent structures. Hence, option C is the correct answer.

102. D

Option D is the correct answer as collagen molecules consist of 3 polypeptide chains that form a triple helix being held by hydrogen bonds. Collagen fibers and collagen molecules lying parallel and cross linked to each other via hydrogen bonds.

103. B

1 and 5, 2 and 4 can form a peptide bond since the groups are not in the R groups. Hence, option B is the correct answer.

104. A

Collagen is a fibrous protein and each helix contains 3 polypeptide chains. Collagen is insoluble in water. Hence, option A is the correct answer.

105. A

Primary, secondary, tertiary and quintenary levels control the shape of the active site since a change in even one of the amino acids can cause the 3D structure to change. Hence, option A is the correct answer.

106. A

Option A is the correct answer as it shows not only the correct side chains of each of the amino acids but also shows that the COOH of threonine reacts with the NH_2 group of valine.

107. C

1 and 3 are incorrect since they represent the secondary and primary structures respectively. 2 and 4 represent the tertiary structure of the protein making option C the correct answer.

108. C

Hemoglobin is soluble since the hydrophilic side chains are arranged on the outside shielding the hydrophobic chains. Hence, option C is the correct answer.

109. C

Option A is incorrect since not all quaternary structures contain four subunits. Option B is incorrect as not all proteins contain metal ions. Option D is incorrect since alpha and beta units make up the secondary structure of the protein. Hence, option C is the correct answer since the quaternary structure of the protein is dependent on the amino acid sequence.

110. A

1 is ionic attraction, 2 is disulfide linkage, 3 is a peptide bond, 4 is hydrogen bonding. 1, 2, 3 and 4 are all present in proteins with a tertiary structure.

111. A

Option C is incorrect since the molecule is globular not spherical. Option B is incorrect since there is one iron ion not four. Option D is incorrect since hemoglobin is not spherical. Hence, option A is the correct answer.

112. D

The peptide bond will be the last to break since it stronger than hydrogen, ionic and hydrophobic bonds. Hence, option D is the correct answer.

113. A

1 and 3 form the peptide bond since these groups are not in the R group of the amino acids. Hence, option A is the correct answer.

114. C

The coiled region form the secondary structure of the protein since they are coiled up amino acid sequences that are held together with hydrogen bonds. Hence, option C is the correct answer.

115. D

Changes in solvents are due to amino acid interacting with the solvent. This results in the primary structure changing that affects all other subsequent structures. Hence, option D is the correct answer.

116. C

The R group is different in all amino acids. Hence, option C is the correct answer since H, NH_2 and COOH groups are present in all amino acids.

117. A

1 and 3 explain how mineral nutrients are brought to the surface as they are dissolved in water and when the lake heats up to 4 degrees the water settles down and this allows the less dense nutrients to rise to the surface. Hence, option A is the correct answer.

118. D

The high surface tension and latent heat of vaporization are not required for fish to survive. The high thermal capacity of the water ensures that the temperature does not fall below freezing which sustains life and the density of the water at freezing temperatures is not the highest allowing fish to survive. Hence, option D is the correct answer.

119. A

Option A is the correct answer as the primary structure is held together by peptide bonds which are covalent bonds.

120. B

Change in the amino acid sequence means that the primary structure of the protein is affected since the primary structure is the sequence of amino acids coding for the protein. Hence, option B is the correct answe

121. B

Option B is the correct answer as the alpha helixes and beta pleated sheets form the secondary structure of the protein which is held together by hydrogen bonds.

122. D

The quintenary structure of hemoglobin consists of four polypeptide chains that are joined together. Hence, option D is the correct answer.

123. C

The ability of insects to rest on the surface of the pond is due to the high surface tension of water which is a result of the hydrogen bonding in water. Hence, option C is the correct answer.

124. A

Option B is incorrect as 3 polypeptides form a helix not fibers. Option C is incorrect as not all polypeptides have a spiral arrangement. Option D is incorrect as hydrogen bonds are present between amino acids or different polypeptides. Hence, option A is the correct answer as collagen contains a large amount of glycine which is small and assists in hydrogen bonding.

125. A

The polarity of water molecules assists in its ability to be a good solvent, have high specific heat capacity, high surface tension and its cohesive ability. Hence, option A is the correct answer.

126. C

A molecule of collagen is the triple helix formed from the 3 polypeptide chains held together by hydrogen bonds. Hence, option C is the correct answer as it shows the helix.

127. B

Since the biuret and benedict's test are positive this means that protein and reducing sugars are present only. 1 is a protein and 3 is glucose which is a reducing sugar. Hence, option B is the correct answer.

128. D

Option D is the correct answer since peptide bonds hold together only the primary structure of the polypeptide chain.

129. D

The ability of water to form hydrogen bonds with other water molecules and other polar molecules help in translocation in the phloem. Hence, option D is the correct answer.

130. A

Disulfide bonds are the strongest of the tertiary interactions which means that they are less likely to break if the temperature for the protein increase above the optimum. Hence, option A is the correct answer.

131. B

Glycine and Alanine have no overall charge since the number of positive charges is the same as the number of negative charges. Hence, option B is the correct answer.

132. A

The ability of water to require a lot of heat to evaporate is important in transpiration as it prevent enzymes from being denatured. Statements 2, 3 and 4 have no correlation with this since transpiration is not dependent on the ability of water to retain heat or form hydrogen bonds. Hence, option A is the correct answer.

133. **C**
4 oxygen molecules can bind to hemoglobin at full saturation. Hence, option C is the correct answer.

134. **D**
Option D is the correct answer since ionic attractions can be found in the quaternary, tertiary and the secondary levels of protein structure. Options A, B and C are incorrect since the secondary, tertiary and quaternary do not contain peptide bonds.

135. **C**
Since the Benedict's test was negative no reducing sugar is present meaning X can be eliminated. The positive Biuret and ethanol emulsion tests indicate the presence of proteins and fats which are W and Z respectively. Since reducing sugars are not present it is possible that disaccharides are present such as the one shown in Y. Hence, option C is the correct answer.

136. **D**
The secondary structure of proteins contains alpha helixes and beta pleated sheets. Hence, option D is the correct answer.

137. **A**
The peptide bond is formed between the COOH group and the NH_2 group that are attached directly to the central carbon atom and are not present in the R group. Hence, 1 and 4 form a peptide bond making option A the correct answer.

138. **B**
Hemoglobin is said to have a quaternary structure since there are 4 polypeptide chains that from the protein. Hence, option B is the correct answer.

139. **C**
Lysine and Aspartate have an overall charge since lysine has 2 positive charges and 1 negative charge and Aspartate has 2 negative charges and 1 positive one. Hence, option C is the correct answer.

140. **A**
The DNA molecules codes for the specific sequence of amino acids of a protein. The arrangement of the amino acids forms the primary structure of the protein making option A the correct answer.

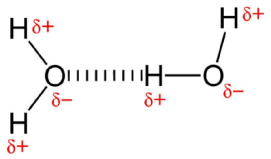
141. **D**
Option D is the correct answer since the side chain is not found in any known amino acid.

2.4: Multiple topics

1. **D**
Peptide bond formation is crucial for growth and development, and it involves the removal of a water molecule in a condensation reaction. Statements 1 and 2 are incorrect.

2. **A**
A condensation reaction forms bonds, such as glycosidic bonds or peptide bonds, and produces water. The breaking of a glycosidic bond occurs during hydrolysis, not condensation.

3. **A**
Between 2 same water molecules, there can be only one hydrogen bond. Please refer to the image below for clarification:



4. **B**
The temperature of blood plasma, and indeed the body's overall temperature, is maintained by the thermal properties of water, which is a major component of plasma. Water has a high specific heat capacity, which means it can absorb a lot of heat before its temperature rises significantly. This property is critical for maintaining homeostasis and temperature regulation in the body.

5. **B**
Cohesion is the correct term used to describe the intermolecular attraction between like molecules, such as the hydrogen bonding that occurs between water molecules. This property is what allows water to have a high surface tension and enables processes such as water transport in plants through capillary action.

Adhesion refers to the attraction between different types of molecules, osmosis is the diffusion of water across a semipermeable membrane, and diffusion is the movement of particles from an area of higher concentration to an area of lower concentration.

6. **B**
Hydrogen bonds in water molecules occur between the slightly positive hydrogen atom of one water molecule and the slightly negative oxygen atom of another. The correct diagram would show this interaction, with dotted lines representing the hydrogen bonds.

7. **D**
Option D is the correct answer as phospholipids contain ester bonds while cellulose fibrils are held together via hydrogen bonds and antibodies are proteins that contain disulfide bonds.

8. **D**
Peptidoglycan consists of β-1,4 linkages between sugars, and four peptide bonds are visible in the diagram, linking amino acids in the structure.

9. **A**
Option A is the correct answer as cellulose fibers are cross linked using hydrogen bonds. The secondary structure of hemoglobin is stabilized using hydrogen bonds and the properties of cohesion and adhesion of water molecules are due to hydrogen bonding.

10. **B**
Statements 1 and 3 are correct as the high specific heat capacity helps in temperature regulation and the partial positive charge on hydrogen is attracted to negative ions. The high latent heat of vaporization of water is what helps to keep mammals cool and non-polar molecules are pushed together when surrounded by water. Hence, option B is the correct answer.

11. **B**
Option A is incorrect as microfibrils are formed from 3 parallel amino acid chains. Option C is incorrect as 1 third of the amino acids are glycine not valine. Option D is incorrect as collagen fibers are held together using hydrogen bonds not ionic. Hence, option B is the correct answer as collagen fibers are insoluble fibrous proteins that have a quaternary structure.

12. **C**
Cellulose forms hydrogen bonds with adjacent molecules. Hemoglobin forms hydrogen bonds to carry oxygen and water forms hydrogen bonds with other water molecules. Hence, option C is the correct answer.

13. **D**
Option D is the correct answer as phospholipids contain ester bonds, cellulose contains hydrogen bonds between adjacent molecules and antibodies are proteins that contain disulfide linkage. Option A is incorrect since amylase is a protein and does not contain ester linkage. Option B is incorrect since glycerol does not contain ester linkage. Option C is incorrect since amylopectin does not contain hydrogen bonds.

14. **B**
Cell membrane proteins and RNA as well as DNA and peptidoglycan must be synthesized for binary fission as the membrane and peptidoglycan form the outer layers of the bacteria and the DNA and RNA can form the enzymes and cellulose. Hence, option B is the correct answer.

15. **A**
1 represents bonds formed via condensation since all of these bonds during formation release a molecule of water. 2 represents carbohydrates and 3 represents lipids since they contain ester bonds. Hence, option A is the correct answer.

16. **A**
Option A is the correct answer as cellulose is used for support and is fibrous and has chains held together by hydrogen bonds but isn't branched. Triglyceride is an energy source with no fibrous properties, hydrogen bonds or branched chains.

17. **A**
Option A is the correct answer as glycosidic bonds form as a result of condensations reactions.

18. **B**
Option A is incorrect since starch contains 1, 6 bonds as well. Option C is incorrect since glycogen is an alpha glucose polymer. Option D is incorrect since cellulose contains only 1, 4 bonds. Hence, option B is the correct answer as amylopectin is a polymer of alpha glucose containing 1, 4 and 1, 6 bonds.

19. **D**
Option A is incorrect as sucrose is formed via a condensation reaction. Option B is incorrect as in collagen the chains are linked via hydrogen bonds not ionic bonds. Option C is incorrect since sucrose is formed via condensation of 2 non-identical monosaccharides. Hence, option D is the correct answer as collagen is a fibrous protein, hemoglobin has all 4 levels of protein structure and sucrose digestion yields glucose and fructose in equal proportions.

20. C

Option A is incorrect as cellulose does not contain nitrogen. Option B is incorrect as lipids do not contain nitrogen. Option D is incorrect as starch does not contain nitrogen. Hence, option C is the correct answer as enzymes are proteins meaning that they always contain nitrogen. mRNA and tRNA are nucleic acids that also always contain nitrogen since they are made up of nitrogenous bases.

21. B

Statements 1 and 2 are correct as fatty acids are part of the cell membrane and form storage droplets. Statement 3 is incorrect since lipids are synthesized by the Golgi body. Hence, option B is the correct answer.

22. B

In polynucleotides a bond forms between the phosphate of one monomer and the sugar of the next. In cellulose beta 1,4 linkages give a linear molecule and in polypeptides the hydroxyl group of a carboxyl group is removed alongside the H of the NH_2 to form a peptide bond. Hence, option B is the correct answer.

23. B

1 is cellulose that is the component that makes up plant cell walls. 2 refers to phospholipids which are a part of the cell membrane in both eukaryotes and prokaryotes. 3 refers to glycogen which is a storage compound in eukaryotes. Hence, option B is the correct answer.

24. C

Statement 1 is incorrect since hemoglobin also contains amino acids. Statement 3 is incorrect since amylopectin does not contain beta glucose. Hence, statement 2 correct as hydrolysis of sucrose produces alpha glucose and fructose whereas the hydrolysis of cellulose produces beta glucose only. Hence, option C is the correct answer.

25. C

Option C is the correct answer since glycogen contain alpha 1, 4 and 1, 6 glycosidic bonds whereas glycoprotein are modified proteins that contain peptide bonds. Hence, option C is the correct answer.

26. C

Cellulose forms hydrogen bonds with adjacent molecules. Hemoglobin forms hydrogen bonds to carry oxygen and water forms hydrogen bonds with other water molecules. Hence, option C is the correct answer.

27. B

Cellulose forms hydrogen bonds with adjacent molecules. Hemoglobin forms hydrogen bonds to carry oxygen and water forms hydrogen bonds with other water molecules. Hence, option B is the correct answer since glycogen has no dependence on hydrogen bonds.

28. D

Option A is incorrect as sucrose is formed as a result of condensation not hydrolysis. Option B is incorrect since in hemoglobin each polypeptide chain contains a haem group which is iron. Option C is incorrect as there are no identical monosaccharides in sucrose. Hence, option D is the correct answer.