ASSIGNMENT (CLASS - 21.04.2020)

BIOMOLECULAR STRUCTURES

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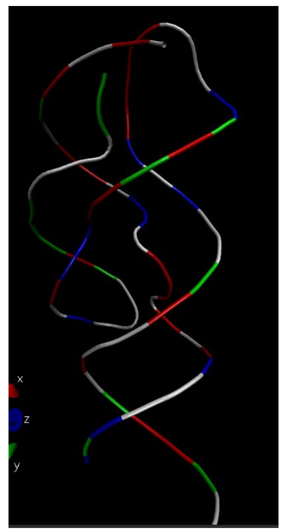
Examine the structure of the RNA (PDB ID: 1Y26) and identify all base pairing interactions. List each of them with illustrations.

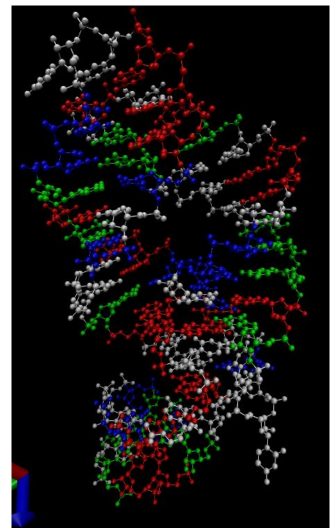
Structure of RNA:

It is visible that RNA has a hairpin structure. The four bases present are as follows:

- A = Red
- C = Blue
- G = Green
- U = White

RNA has folded upon itself, with the folds stabilized by short areas of complementary base pairing within the molecule, forming a three-dimensional structure.





Sequence of bases are:

The bases from 43 to 53 pair up to form the shorter side of the RNA as shown in the picture on the left i.e. the loop.

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13        23        33        43        53        63        73        83
CGCUUCAUAUAAUCCUAAUGAUAUGGUUUGGGAGUUUCUACCAAGAGCCUUAAACUCUUGAUUAUGAAGUG
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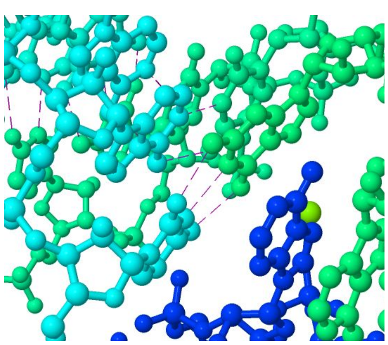
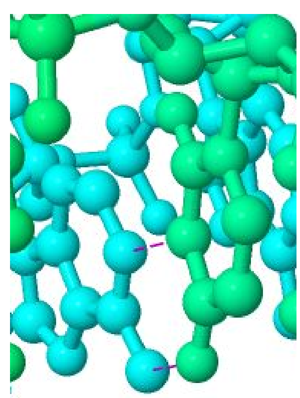
Base Pair interactions:

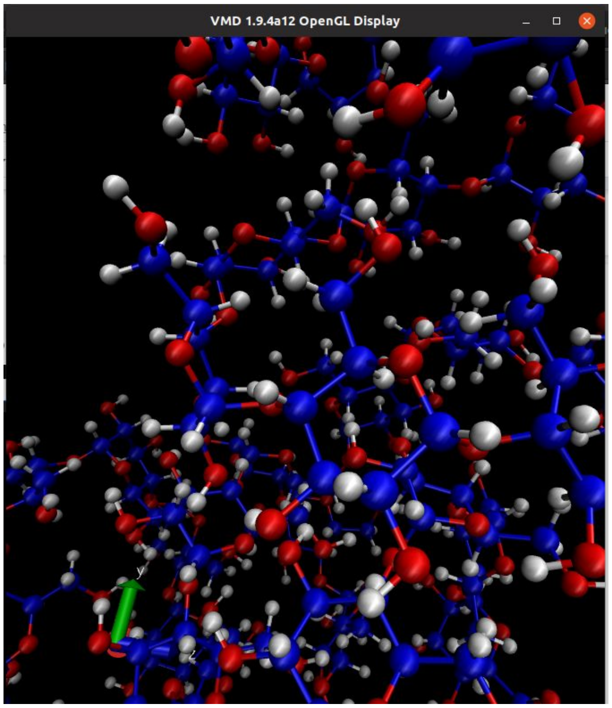


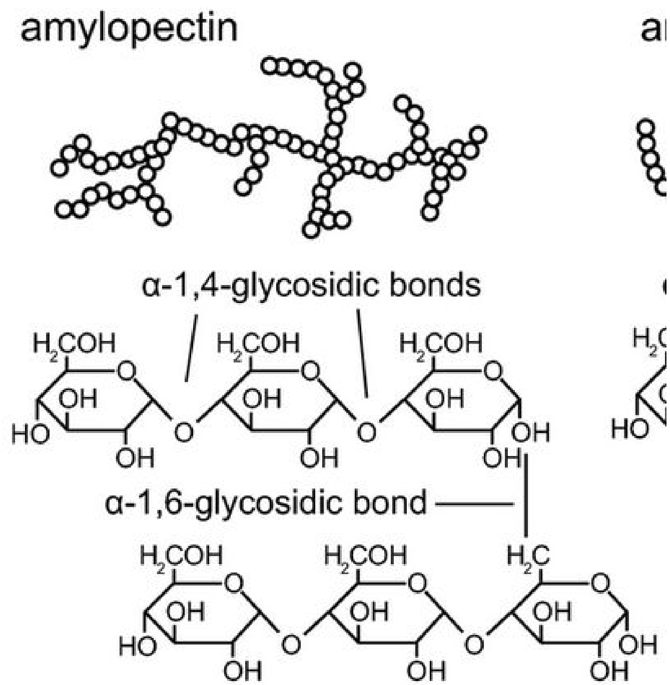
C - G (3 Hbonds)



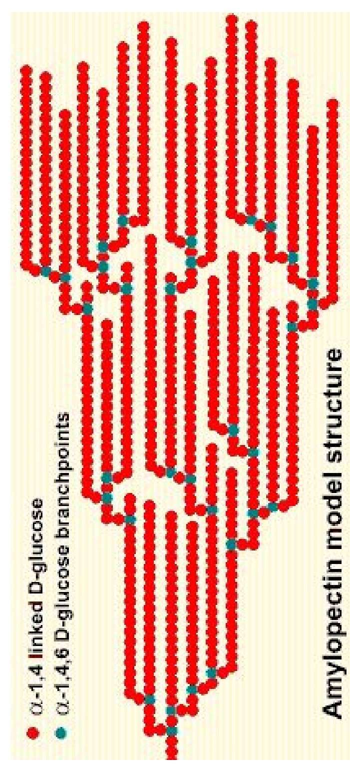
A - U (2 Hbonds)

Discuss the structure of amylopectin in detail with illustrations.





Starch contains two main structural components, polysaccharides called amylose and amylopectin. By weight more than 80% of amylopectin makes up a starch molecule.



Amylopectin is a type of polysaccharide that has a structure built from multiple glucose units. It is structurally similar to glycogen (Blue - Carbon, Red - Oxygen, White - Hydrogen). It has α 1-4 glycosidic linkages and α 1-6 glycosidic linkages. It is a water-soluble polysaccharide as it has lots of free hydrogens for hydrogen bonding.

This is the general structure of amylopectin. The glucose units are linked in a linear way with α glycosidic bonds in the branch chain. Amylopectin is highly branched, being formed of 2000 to 200000 glucose units. This molecule of amylopectin has branch points occurring about every 25–30 units. It has helical branches and its overall helical structure is disrupted by the branching of the chain. This branching gives it a cluster structure.There are two main fractions of long and short internal B-chains with the longer chains (greater than about 23-35 residues) connecting between clusters and the shorter chains similar in length to the terminal A-chains.

What are glycoproteins? Take a protein whose experimental structure is known, discuss the structural features and its functional aspects.

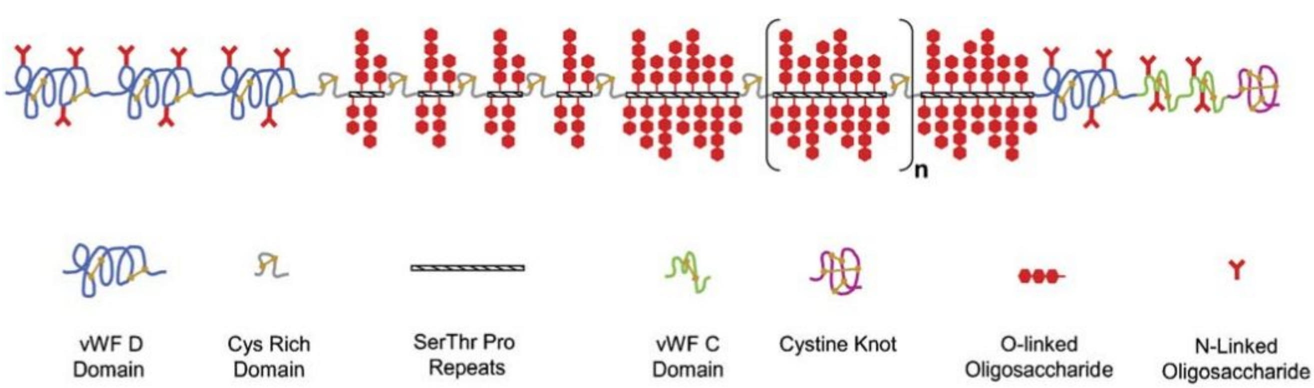
Glycoproteins are proteins with a sugar/carbohydrate attached to them by post-translational modification. They are involved in nearly every process in cells and have diverse functions in our immune system to our reproductive systems. Glycoproteins are always found on the outside of the plasma membrane, with the sugar facing out.

Mucins:

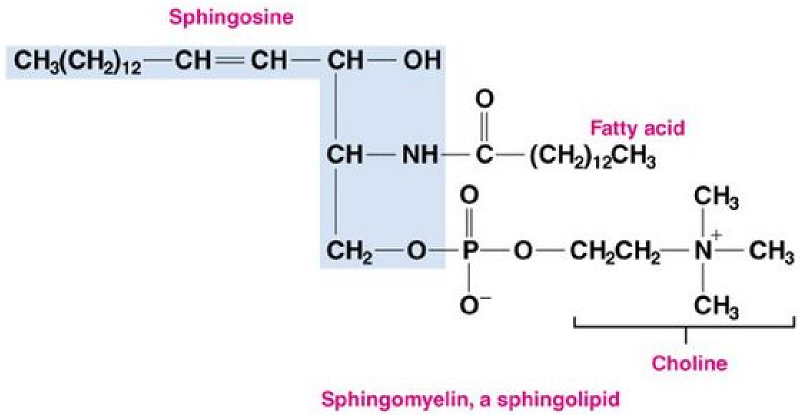
Mucins are large high-molecular-weight glycoproteins, which are synthesized by major glands (except parotid gland) and various minor salivary glands. They can be membrane bound mucins or secreted mucins. They are both highly glycosylated consisting of 80% carbohydrates. The oligosaccharide chains consisting of 5 –15 monomers that exhibit moderate branching and are attached to the protein core. O-glycosidic bonds to the hydroxyl side chains of serine and threonines and arranged in a "bottle brush" configuration about the protein core.

The protein core is arranged into distinct regions:

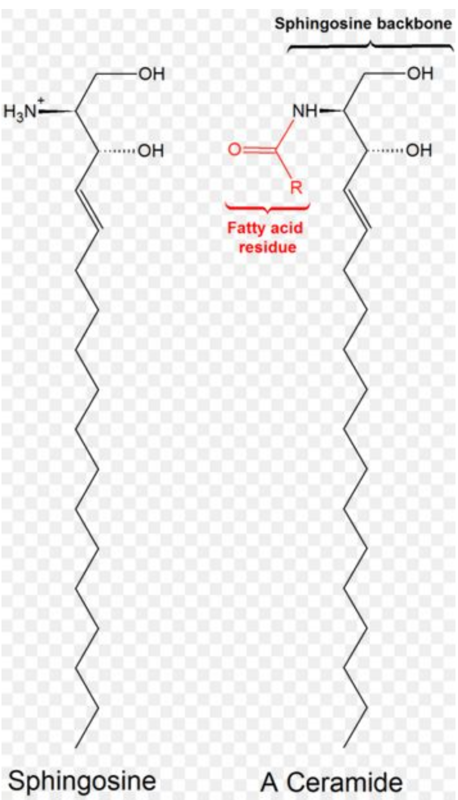
1. Central glycosylated region - Has of a large number of tandem repeats that are rich in serine, threonine and proline (STP repeats),
2. Located at the amino and carboxy terminals, and sometimes interspersed between the STP-repeats - are regions with an amino acid composition more representative of globular proteins, relatively little O-glycosylation and a few N-glycosylation sites (these are post translational modifications) and a high proportion of cysteine.



What are sphingolipids



Sphingolipids, like ceramide, are important phospholipids that have an amide bond between a fatty acid and sphingosine. Sphingosine is an amino alcohol that has 18 carbons. They are present in the plasma and ER membranes. These lipids have a backbone of sphingoid bases, a set of aliphatic amino alcohols that includes sphingosine. They help define the structural properties of membranes



They play an important role in maintaining membrane function and integrity, preserving lipoprotein structure and functions, and preventing or promoting many diseases.

The sphingo base is a hydrocarbon chain containing double bonds, an amino group in position 2, and two to three hydroxyl groups in positions 1, 3, and 4. They are 2-amino-1,3-dihydroxy-alkanes. Sphingoid bases are the characteristic structural unit of the sphingolipids, which are important structural and signalling lipids of animals and plants.

Why does the composition of types of lipid molecules change with respect to cell type? Take some examples and discuss.

Lipids have 3 functionalities:

1. Used for energy storage
2. Formation of membranes
3. Act as in signal transduction and molecular recognition processes

Lipid composition varies as it has different functionalities in different cells, it affects membrane physical properties like the lipid composition affects membrane protein functions, such as ion channels.

The polyunsaturated fatty acids in **phospholipids** reduce membrane rigidity and affect processes that accompany membrane deformation. **Triglycerides** store unused calories and provide your body with energy. **Cholesterol** is used to build cells and certain hormones.

Examples:

1. White Blood Cells - Phospholipids are maximum, followed by triglycerides. Cholesterol is very less in comparison to the first two. WBCs defend the body against infections and diseases by ingesting foreign materials and cellular debris and hence need a very rigid membrane so that they don't rupture easily, and will need energy next provided by sufficient triglycerides. It follows why the content of cholesterol is the least.
2. Red Blood Cells - Majorly contain Cholesterol esters followed by triglycerides and the least is phospholipids. This is because RBCs don’t need much membrane rigidity as they float in plasma but need energy for its other functions.
3. Bone Cells - A high content of apolar lipids, including triglycerides and cholesterol esters are found in bone marrow. Apolar lipids are known to form spheres of lipid droplets or lipoproteins. Main function here is to mediate the mineral deposition onto the fibers.