Topic 2 Molecular Biology

Skills:

- 2.1.S1 Drawing molecular diagrams of glucose, ribose, a saturated fatty acid and a generalized amino acid.
- 2.1.S2 Identification of biochemicals such as sugars, lipids or amino acids from molecular diagrams.

I. Drawing Molecular Diagrams

A. Basics of drawing diagrams

1. Write out the chemical formula if it not given.
2. Draw the carbons first (the carbon backbone of the molecule).
3. Add functional groups that are found as a part of the molecule.
4. Review over the structure to ensure that all of the different atom types are showing the correct number of covalent bonds for that type of element.
5. Check the structure against the chemical formula by counting the numbers of each type of atom.

I. Drawing Molecular Diagrams

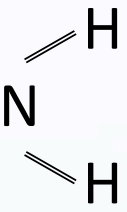
B. Covalent bonds between atoms are as follows:
   1. Single – 2 pairs of electrons shared: 1 line
   2. Double – 4 pairs of electrons shared: 2 lines
   3. Triple – 6 pairs of electrons shared: 3 lines

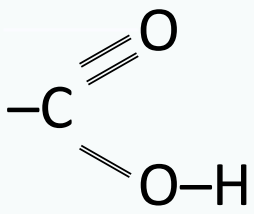
C. All atoms must have 8 valence electrons through bonding except for hydrogen which must have 2 valence electrons.
   1. Carbon will form single, double, and triple bonds, with combinations of the three types of bonds.
   2. Hydrogen only will have 1 single bond.
   3. Oxygen will often have 2 single or 1 double bond.
   4. Nitrogen will usually have 3 single bonds, but may have any combination of single, double and or triple bonds.

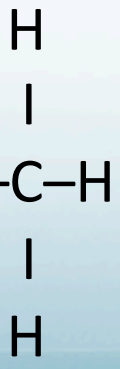
I. Drawing Molecular Diagrams

C. Memorizing functional groups make drawing easier:

1. hydroxyl: –O–H or –OH

2. amine:  or $–NH_2$

3. carboxyl:  or –COOH

4. methyl:  or $–CH_3$

I. Drawing Molecular Diagrams

D. Carbohydrates:

1. The carbon backbone in water form rings instead of a long chain.
2. The top most portion of the ring will be an oxygen atom, to the right is the alpha (α) carbon or carbon 1 (C_1).
3. Continue drawing carbons as a pentagon for ribose (a pentose sugar) or a hexagon for glucose (a hexose sugar).
4. The last carbon will not be included in the ring, but placed above the last carbon in the ring.
5. Each carbon in the ring will have one hydroxyl group and one hydrogen. The lone carbon will have a hydroxyl group and two hydrogen atoms. Note their positions, up and down on the ring.

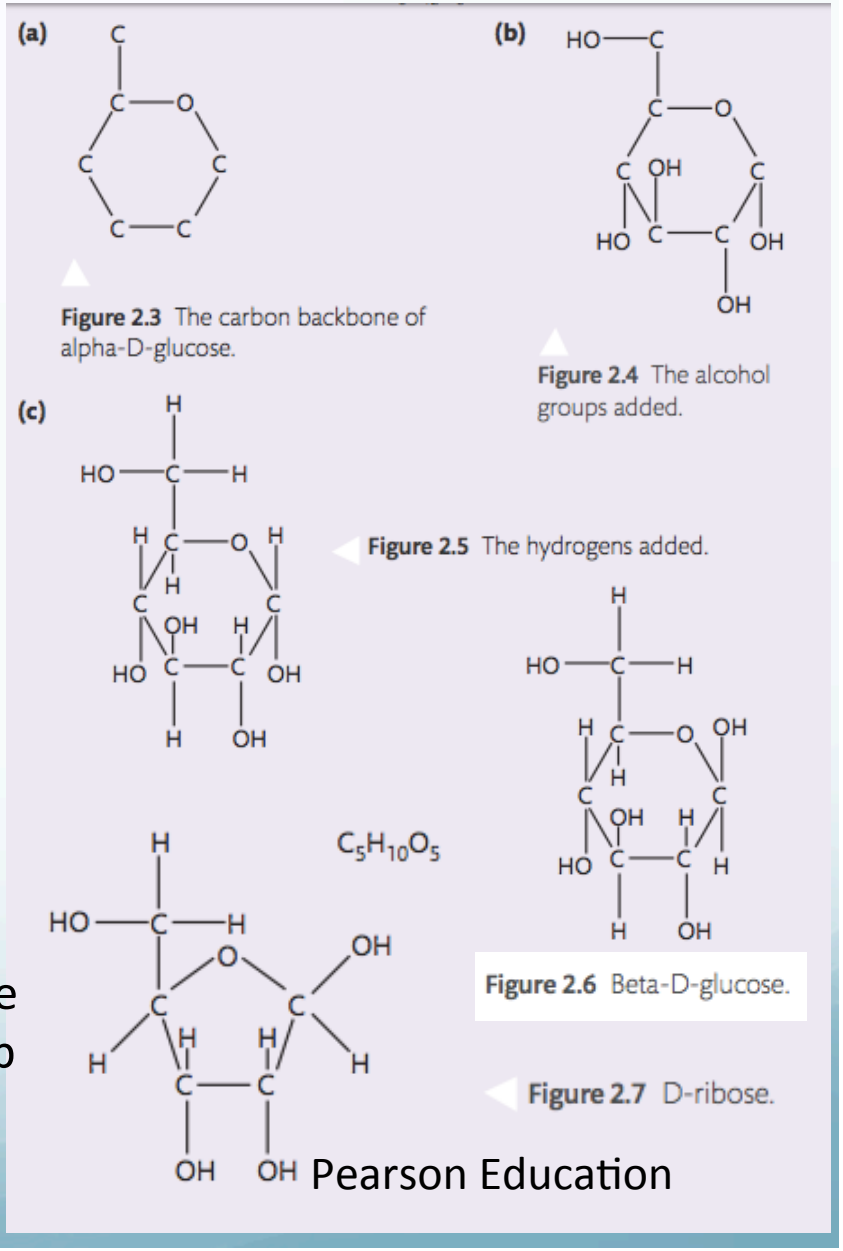


Figure 2.3 The carbon backbone of alpha-D-glucose.

Figure 2.4 The alcohol groups added.

Figure 2.5 The hydrogens added.

Figure 2.6 Beta-D-glucose.

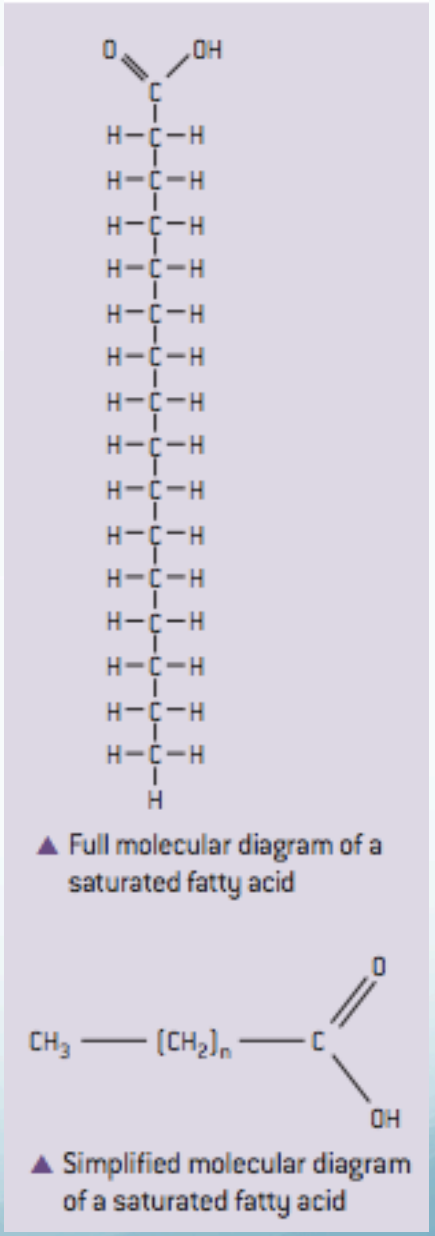
Figure 2.7 D-ribose.

Pearson Education

I. Drawing Molecular Diagrams

D. Saturated fatty acids:

1. Draw a carboxyl group at the head.
2. The attached carbon atoms will form an unbranched chain.
3. Typically the number of carbons in the chain will be from 14 to 20 in length.
4. Add 2 hydrogen atoms to each carbon in the chain.
5. At the end of the chain add 3 hydrogen atoms to the carbon.



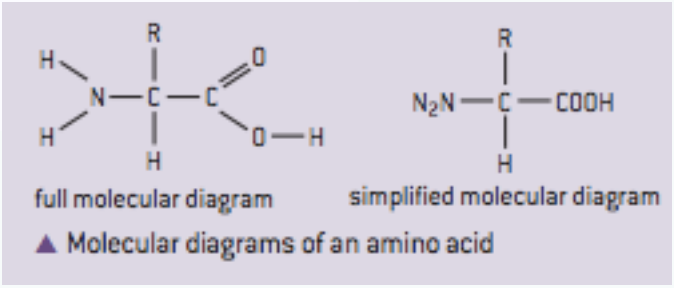
▲ Full molecular diagram of a saturated fatty acid

▲ Simplified molecular diagram of a saturated fatty acid

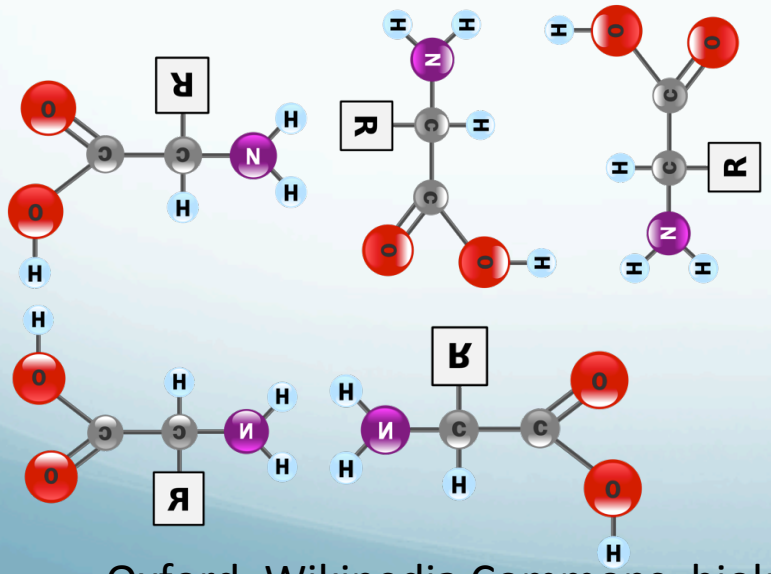
I. Drawing Molecular Diagrams

E. Amino acids:

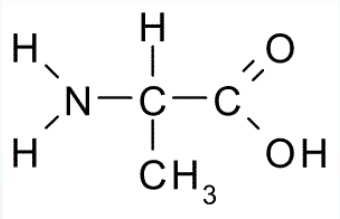
1. Draw a single carbon atom.
2. Add an amine group (amino).
3. Add a carboxyl group (an acid) opposite the amine group.
4. Add a hydrogen atom.
5. Add the appropriate R group.



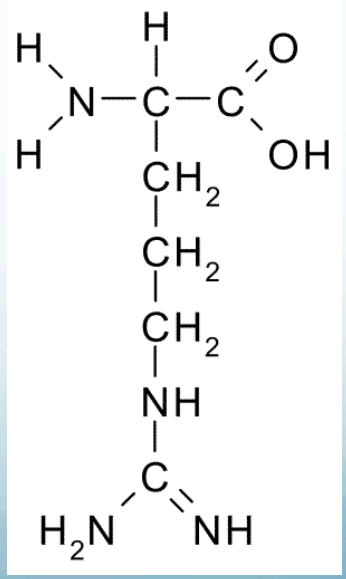
▲ Molecular diagrams of an amino acid



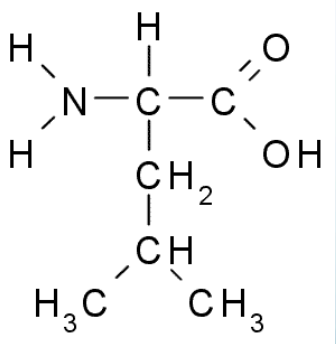
Alanine



Arginine



Leucine

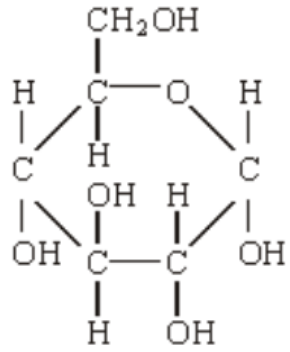


Oxford; Wikipedia Commons; bioknowledgy.net

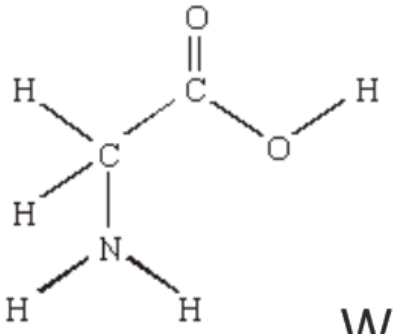
Which molecule represents ribose?

Past paper question

A.

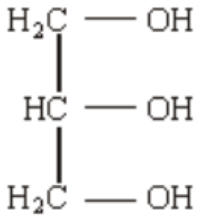


B.

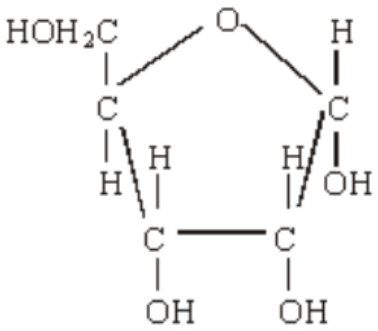


What is molecule B?

C.



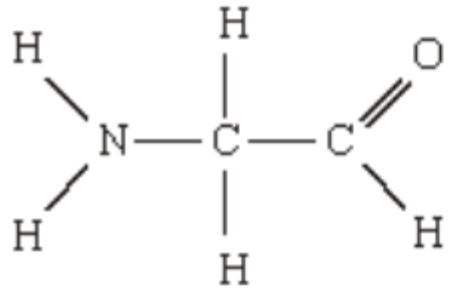
D.



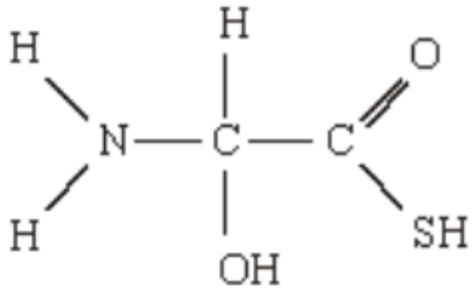
What is molecule C?

Which structure represents an amino acid?

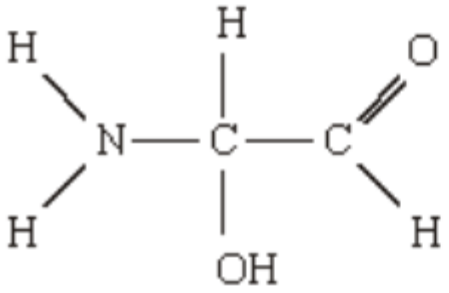
A.



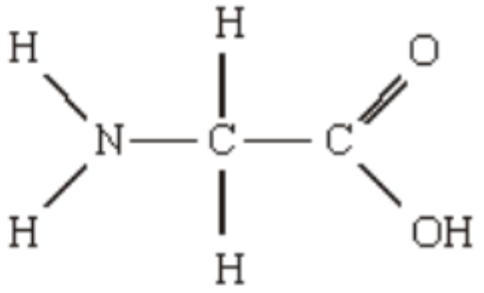
B.



C.

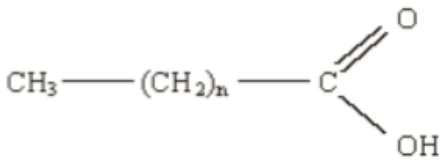


D.

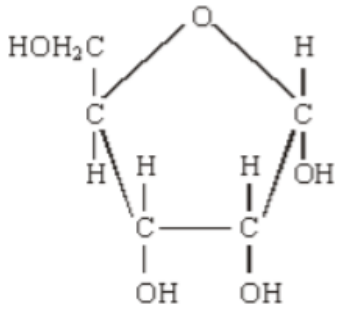


Past paper question

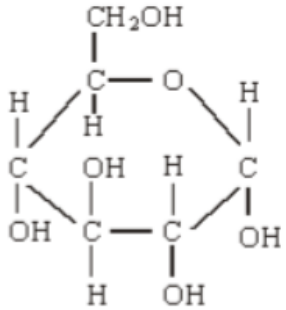
I.



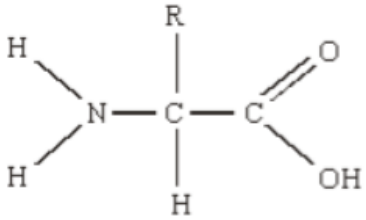
II.



III.



IV.



Which molecule is:

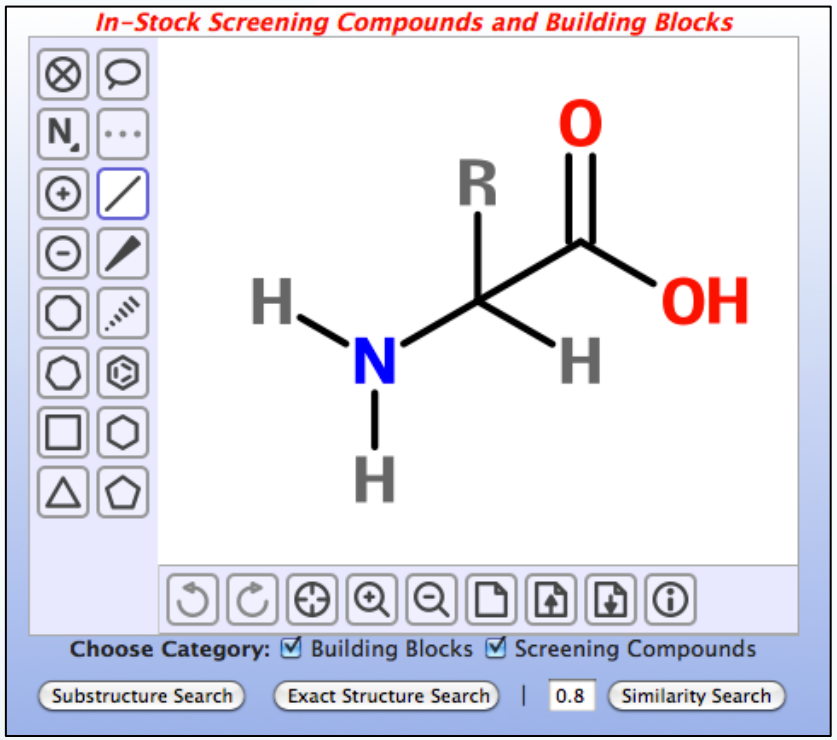
i. ribose

ii. generalised fatty acid

iii. generalised amino acid

Discuss which two molecules are most similar in structure.

Practice



Try drawing by hand (or on eMolecules, ChemSpider, etc.) the following molecules:

A. alpha D and beta D Glucose
B. Ribose
C. A generalized saturated fatty acid
D. A generalized amino acid
E. An example of an amino acid e.g. Alanine (the simplest)

You need to test yourself.

- *Practice drawing all 5.*
- *Then draw all 5 in 15 minutes.*
- *Come back and try it again one week later to make sure you remember.*