SBI3C 1.5 – Biological Chemistry Worksheet

Organic Chemistry

Organic compounds contain _____ atoms bound to (mostly) _____, _____, and _____. Most organic compounds contain _____ or _____ of C-atoms with _____ _____ attached. _____ _____ between organic molecules usually involve the molecules' _____ _____.

Table 1 on P. 25 lists the five most important functional groups:

Functional Group	Structural Formula	Ball and Stick Diagram

Biological Compounds

Because of their _____ size, containing several _____ and many _____ groups, organic molecules are called _____.

There are _____ major groups of biologically important molecules: _____, _____, _____, and _____ _____. Examples of these are shown in Fig. 2 on P. 26.

Carbohydrates

Carbohydrates contain _____, _____, and _____, and are used mainly as a source of _____. Plants and _____ produce carbohydrates by the process of _____. They are mainly sugars and starches and provide short-term energy to cells.

Monosaccharides (Simple Sugars)

The simplest sugars are _____-tasting and the name comes from the Greek for "_____" and "_____". The most important monosaccharides have _____ carbon atoms and a number of _____ groups. Glucose has the chemical formula _____. _____ and _____ are examples of other simple sugars.

Disaccharides (Double Sugars)

Two simple sugars may link together to form a _____. Sucrose (_____ _____) is formed when a molecule of _____ links to a molecule of _____ in a process called **dehydration synthesis**. This occurs when the _____ groups of glucose and fructose react, leaving an _____ link and creating a _____ molecule (see Fig. 4, P. 26).

Maltose is formed by linking two glucose molecules.

Show the dehydration synthesis of maltose in the space below by using Fig. 4 on P. 26 (replacing fructose with glucose).

Polysaccharides (complex carbohydrates)

Monosaccharides and disaccharides are _____ in water because their hydroxyl groups form _____ bonds with the _____ and _____ atoms of water (see Fig. 5, P. 26). However, when sugars are attached together in long chains they become _____ in water. Plants store the chemical energy in sugar they make during photosynthesis by forming _____, made of _____ and _____, which are both composed of repeating subunits of _____. Animal starch is called _____, formed from chains of glucose that are highly _____.

Molecules composed of many linked subunits are called _____, while the individual subunits of polymers are called _____ (i.e. glucose is a monomer of _____, _____, and _____. Starch is a common component of _____, found in large quantities in _____, _____, _____, and _____. To be small enough to be absorbed in the digestive system, the _____ between the glucose _____ in polysaccharides must be _____ in a process called _____.

Cellulose makes up plant _____ _____. It is similar to _____, but the monomers are bonded in a way that humans cannot _____. Cellulose can be digested by _____, is the major component of _____ , _____ and _____ (for clothing). Cellulose is important for human health because it attracts _____ and _____ in the digestive system, and aids in the elimination fo _____ _____, helping to prevent _____.

Chitin is a modified form of _____ found in _____ and _____ exoskeletons as well as _____. It is very difficult to digest, but is used in _____ _____ and self-decomposing _____.

Lipids: Long-Term Energy Storage

Lipids are also molecules made up of carbon, hydrogen, and oxygen, but have a higher proportion of _____ atoms. They store more chemical energy than _____, and are used by _____ as major _____-_____ molecules (cells in _____ tissue are full of lipid molecules). Lipids are solubler in _____ and other _____ solvents, but are insoluble in _____ and _____ solutions. Lipids include _____, _____, _____, _____, and _____.

Oils and fats are composed of lipid molecules called _____. A triglyceride contains _____ subunits: _____ and _____ _____ _____ (see Fig. 9, P. 28). Glycerol is a _____ _____ molecule with a _____ attached to each _____ atom. Fatty acids are long-chain _____ with a _____ group at one end. To form a triglyceride, a _____ _____ is attached to each of the _____ _____ _____ of glycerol (Fig. 10)

Saturated and Unsaturated Fats

Fatty acids with only single bonds between carbons are called _____ and form a _____ _____ (see Fig. 11a) and c) on P. 29), while fatty acids with at least one double-C bond are called _____ and produces “kink” (Fig. 11 b) and d)) that prevents molecules form packing together, so they are _____ at room temperature and have a _____ melting point. Plants produce large numbers of _____ fats (i.e. many double C-bonds) which are are used in _____. Margarine is a _____ fat produced from plant oils. **Hydrogenation** adds _____ gas, reducing the number of double C-bonds and making the fatty acids more _____, which makes them _____ at room temperature. These so-called **trans-fatty acids** have beeen shown to affect health, and other _____ (i.e. animal) fats may contribute to clogged arteries leading to _____ and _____.

Waxes, Phospholipids, and Steroids

Waxes are commonly used by _____ and sometimes by _____ as _____ coatings (Fig. 12).

Phospholipids are similar to _____, except one of the fatty acids is replaced by a functional group containing a _____ group (Fig. 13 a). Their polar head is **hydrophilic** (“water-loving”), dissolving in water, while the non-polar fatty acid tails are **hydrophobic** (“water-fearing”)(Fig. 11 b), so they play a key role in the structure of _____ _____. Phospholipids allow for cell membranes to **regulate passage of fat-soluble or small molecules** in and out of the cell.

Steroids are composed of 4 _____ (base unit) + side chains. _____ (formation of cell membrane, breakdown of fats), _____ and _____ (sex hormones)(Fig. 14) are all steroids.

Anabolic steroids are artificial testosterones which increases strength and muscle mass, but also **weakens the immune system**, causes **liver damage**, **stops bone growth**, **stops menstruation**, causes **head hair loss/facial hair growth in females**, and causes **shrinking of testes, head hair loss** in males.

Proteins

Proteins are the most _____ and among the most _____ molecules, essential to the structures and activities of living organisms. Proteins are unbranched _____ of _____ _____.

Amino acids contain a _____ _____ _____ to which is attached an _____ group (NH_2), a _____ group (COOH), an _____, and a _____ _____ (labelled “R” in Fig. 16). _____ different side chains determines the structure and function of each amino acid (see some common ones in Fig. 17) and _____ of them are called _____ because they can only be obtained in _____. The _____ and _____ of amino acids produce many different _____ (amino acid chains), formed by a link between the _____ and _____ groups of amino acids to form a _____ bond (Fig. 18) during the process of _____ synthesis. As the polypeptide gets longer, forces of _____ and _____ between _____ groups cause it to fold into _____ like keratin and _____, and wrap into _____, which form globular proteins like _____ in RBC. Proteins with the same _____ will fold into the same _____ and therefore have the same function, which can be altered by a single misplaced _____ _____. **Enzymes** are biological _____ that speed up chemical reactions, while other proteins (i.e. hormones like insulin) act as chemical _____, and others (like collagen) give structural _____ to _____, _____, and _____. The _____ of amino acids in functional proteins are separated during food _____.

Denaturation of proteins happens when they are subjected to high _____ or exposed to _____, _____, or _____ environments. A denatured protein loses its _____, but the change can be _____ as long as the _____ bonds are not broken. Denaturation of protein in the _____ can be dangerous, while pickling foods in vinegar denatures _____ in food spoilage _____. Protein in _____ can be denatured to curl or straighten it, and the denaturation of _____ protein in meat makes it easier to chew.

Nucleic Acids

Nucleic acids form **DNA**, **RNA** (→ **protein synthesis**) and **ATP** (→ **CELLULAR RESPIRATION**). They are _____ formed from _____ monomers (Fig. 20). Each nucleotide is formed from
3 subunits: a _____ _____ **pentose** _____**,** a _____ group, and a _____ base.

Use the information in the three paragraphs at the bottom of P. 33 to fill in the following chart:

	Sugar	**Nitrogenous bases**	**Complementary Base Pairs**
DNA			
RNA			

Polymers of nucleic acids form by **dehydration synthesis**, sugar-phosphate groups forming sides of "ladder", _____ ('rungs") facing inwards, linked to each other by formation of weak _____ bonds so that only specific pairings are possible (**complementary base pairs**). **DNA** is always _____-stranded; "unzipping" and rebuilding by attachment of **complementary nucleotides** allows for exact **replication** of molecule (i.e. reproduction). DNA stores the information for making _____. The set of instructions in DNA that codes for a complete protein is called a _____. The Human _____ Project, which sequenced all the nucleotides in all 46 chromosomes, showed there are _____ base pairs, and between _____ and _____ genes in the human genome.
RNA is usually _____-stranded, but can form H-bonds and a **double helix**.
_____ RNA (mRNA) take the genetic information in DNA out of the _____ to _____ in the _____ where _____ are produced. DNA stays _____ in the nucleus. Copy Table 2 on P. 34 → **Section 1.5 Questions – P. 34, #1-14**