Biological molecules

Nur Hidayat

http://nurhidayat.lecture.ub.ac.id

Materi

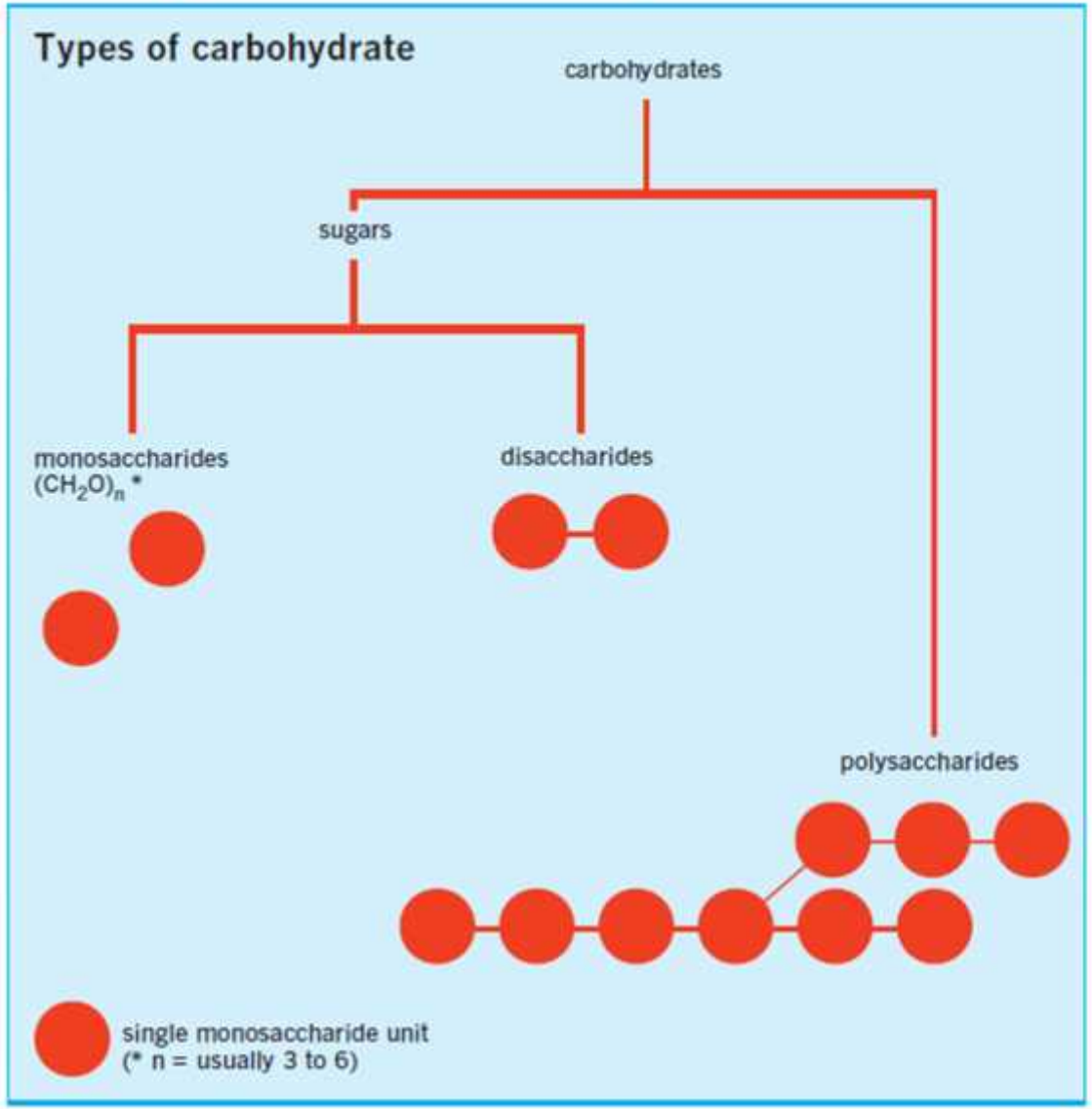
Karbohidrat

Protein

Lipid

Tugas Terstruktur

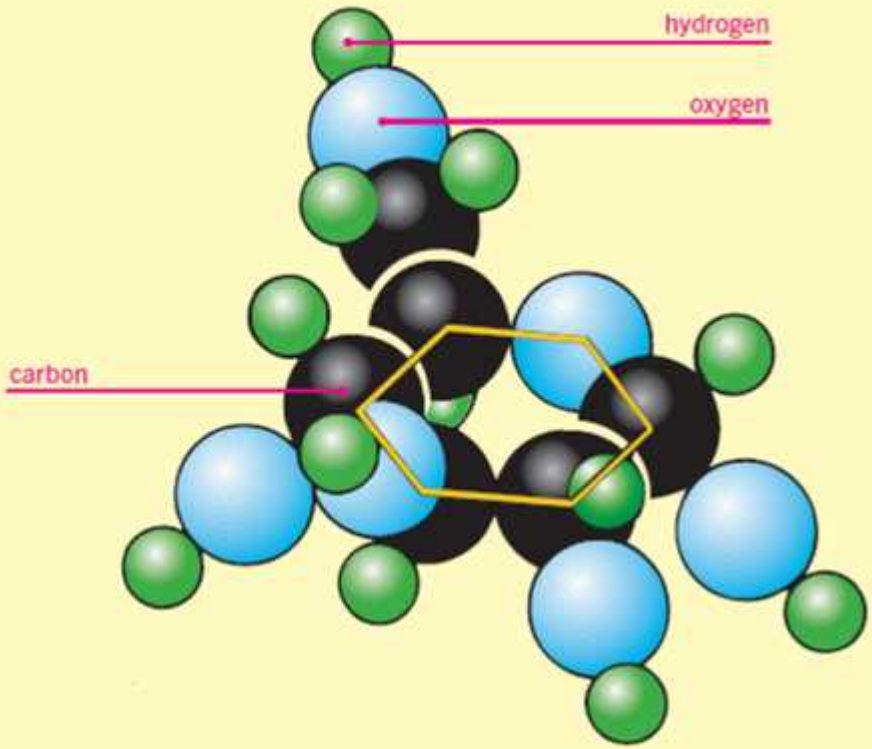
Simple carbohydrates



Types of carbohydrate

- Carbohydrates are chemical compounds that contain carbon and the elements of water: hydrogen and oxygen. A few also contain nitrogen or sulfur.
- There are two main groups of carbohydrates: *sugars* and *starches*.
- Sugars are small, water soluble molecules that taste sweet. Starches are very large, insoluble molecules.
- Carbohydrates may be monosaccharides, disaccharides, or polysaccharides.

Molecular structure of glucose



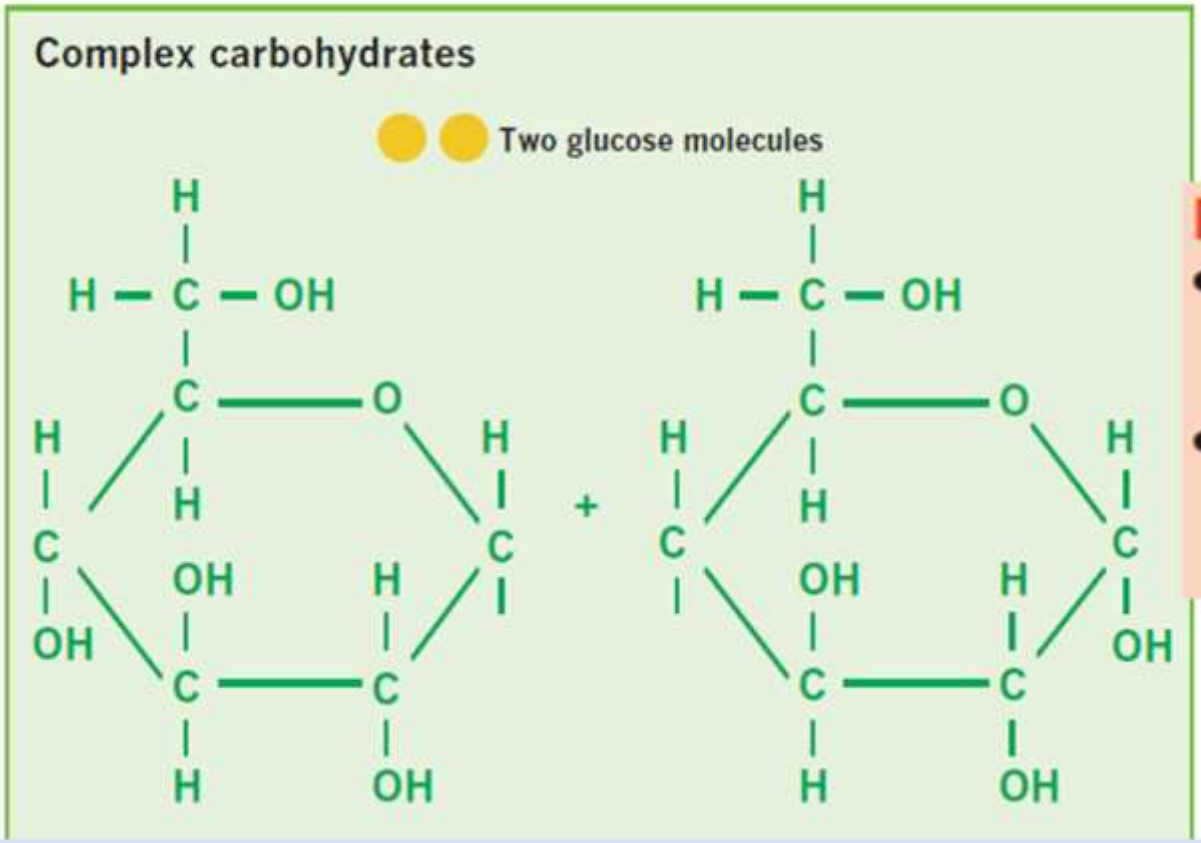
Monosaccharides

- Simple sugars all have the same general formula $C_n(H_2O)_n$. The simplest common sugar found in animals is glucose ($C_6H_{12}O_6$). Glucose has two molecular forms: a straight chain and a ring. About 98 percent of the sugar molecules in a solution are in ring form.

Disaccharides

- Disaccharides (see page 9) are sugars made by linking together two monosaccharide rings by a *condensation reaction*. An OH group from each monosaccharide unit reacts together to make water (H_2O) and form an oxygen bridge between the sugar rings.
- Maltose ($C_{12}H_{22}O_{11}$) is a disaccharide that is a product of starch digestion and is also found in some germinating seeds. It is formed by two glucose molecules joined together by a *glycosidic* (C-O-C) *bond*.
- OH groups at the end of a disaccharide molecule can link with more rings to make longer chains. However, most sugars have three rings or fewer.

Complex carbohydrates

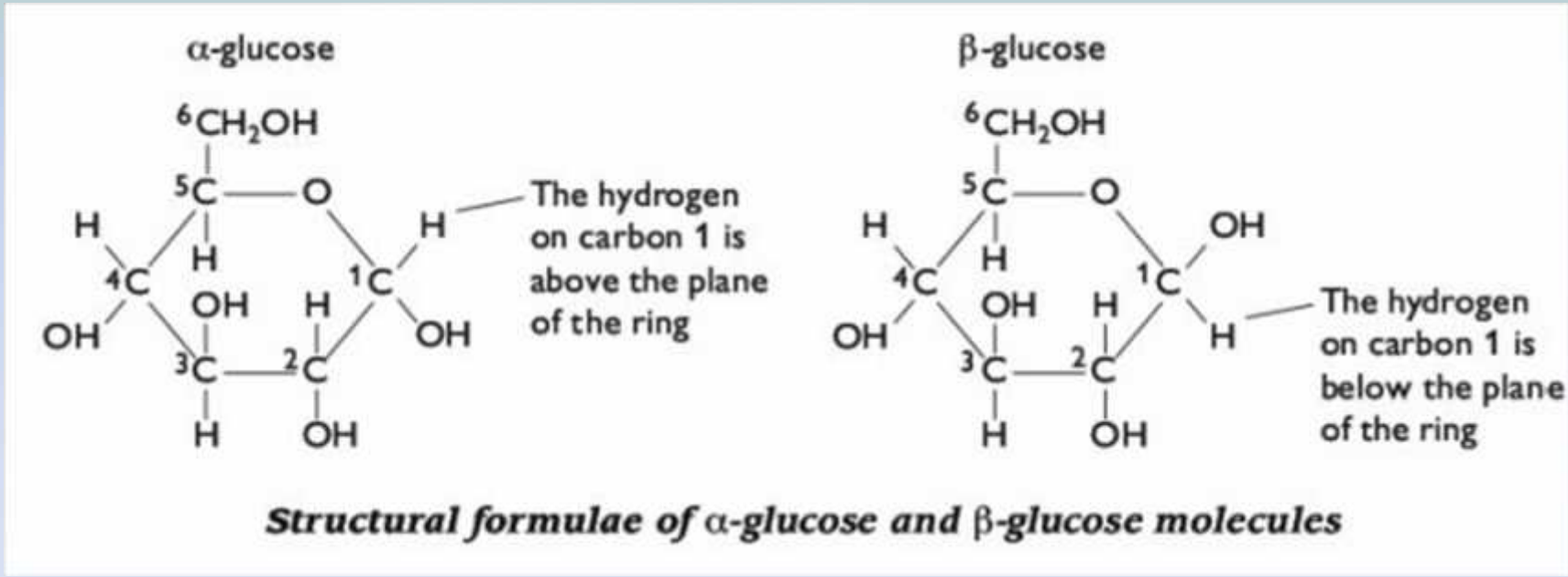


Polysaccharides

- Carbohydrates with large numbers of rings in their molecules are called *polysaccharides*.
- Polysaccharides are used in living things for energy storage and to build structures (see page 10).

Monosaccharides and disaccharides

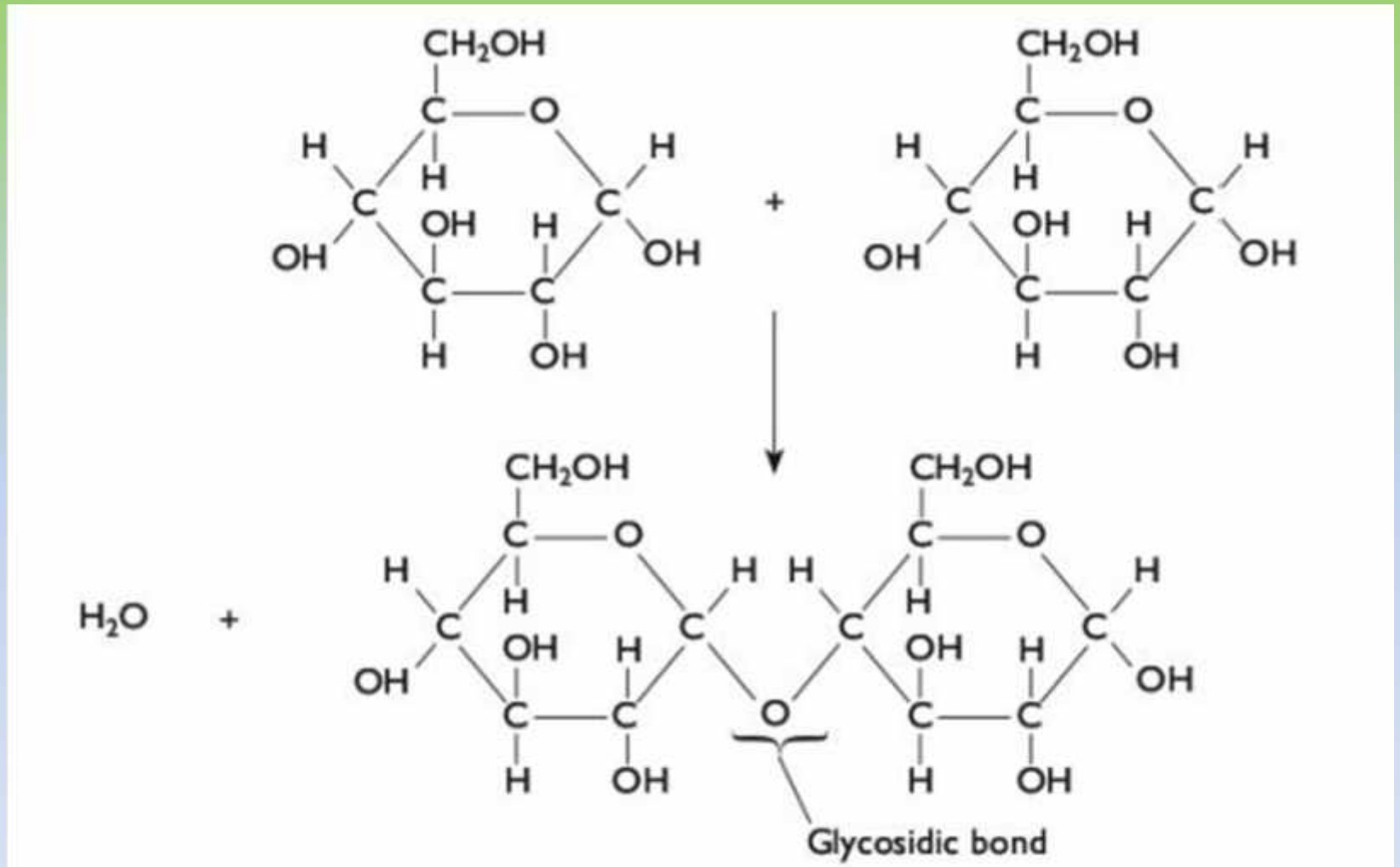
The simplest carbohydrates are **monosaccharides**. These are sugars. They include glucose, fructose and galactose. These three monosaccharides each have six carbon atoms, so they are also known as hexose sugars. Their molecular formula is $C_6H_{12}O_6$.



Structural formulae of α-glucose and β-glucose molecules

Two monosaccharides can link together to form a **disaccharide**. For example, two glucose molecules can link to produce **maltose**. The bond that joins them together is called a **glycosidic bond**. As the two monosaccharides react and the glycosidic bond forms, a molecule of water is released. This type of reaction is known as a **condensation reaction**. Different disaccharides can be formed by linking different monosaccharides.

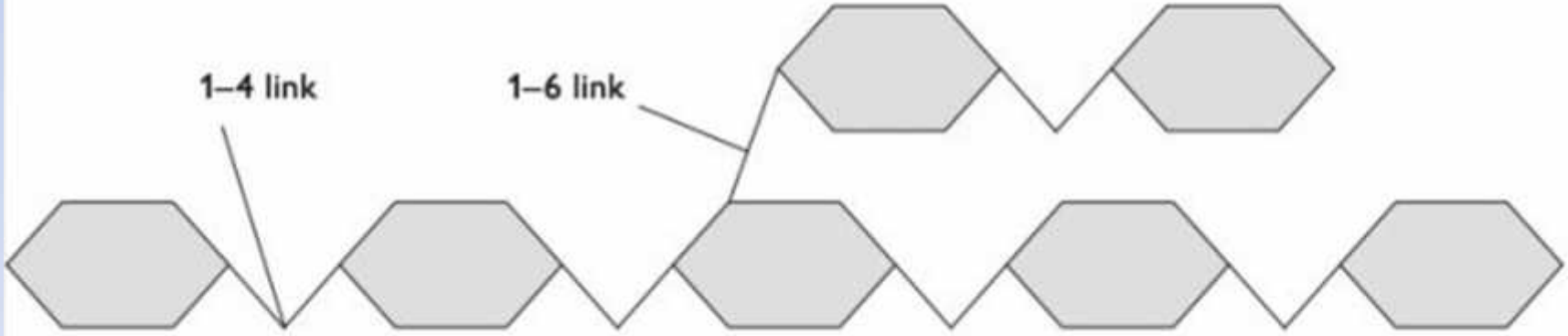
Disaccharide	Monosaccharides
Maltose	Glucose + Glucose
Lactose	Glucose + Galactose
Sucrose	Glucose + Fructose



Formation of maltose by a condensation reaction

Storage polysaccharides

In animals and fungi, the storage polysaccharide is **glycogen**. It is made of α-glucose molecules linked together by glycosidic bonds. Most of the glycosidic bonds are between carbon 1 on one glucose, and carbon 4 on the next, so they are called 1–4 links. There are also some 1–6 links, which form branches in the chain. When needed, the glycosidic bonds can be hydrolysed by carbohydrase enzymes to form monosaccharides, which can be used in respiration. The branches mean there are many 'ends', which increases the rate at which carbohydrases can hydrolyse the molecules.



A small part of a glycogen molecule

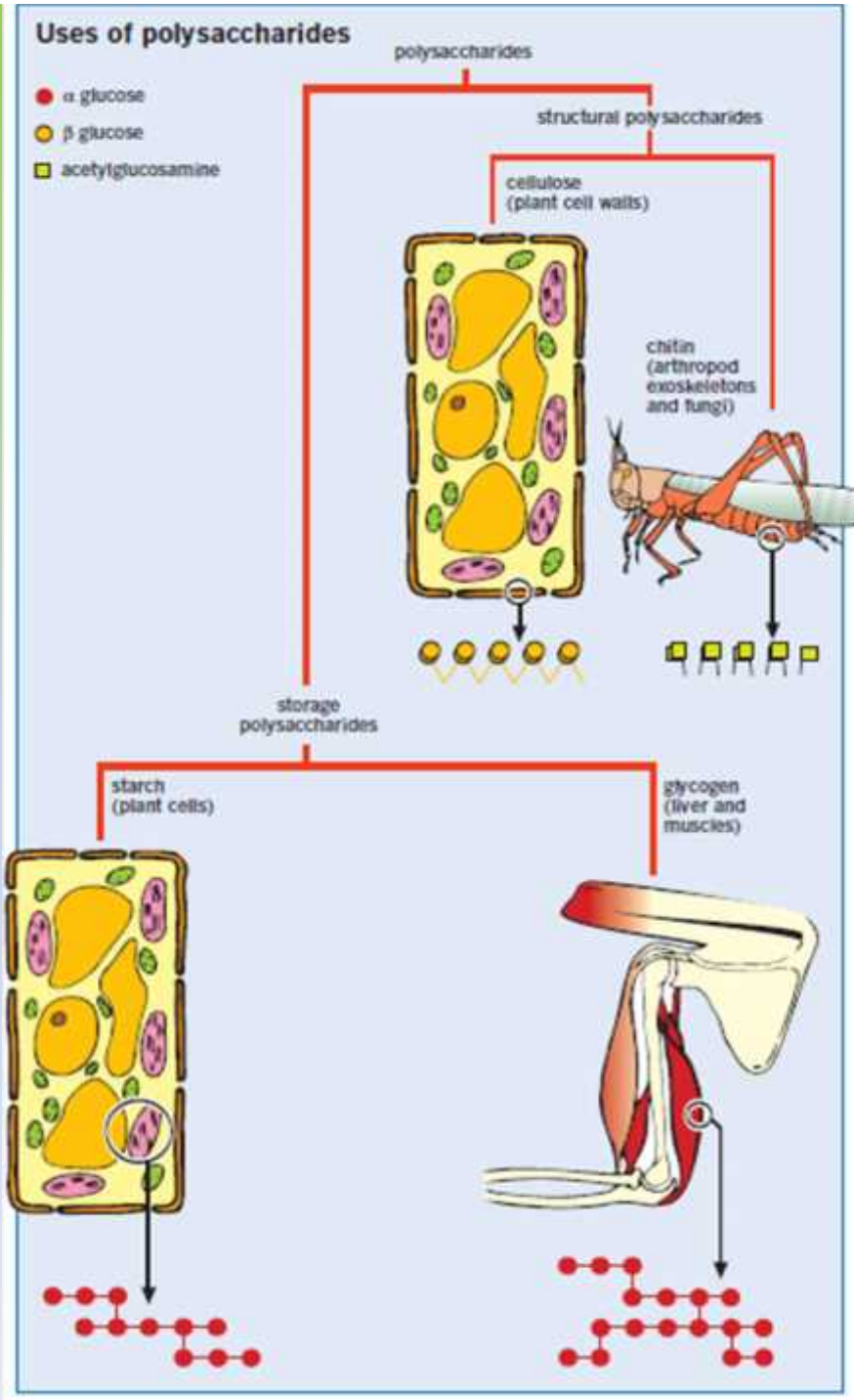
Important polysaccharides

Polysaccharides in animals

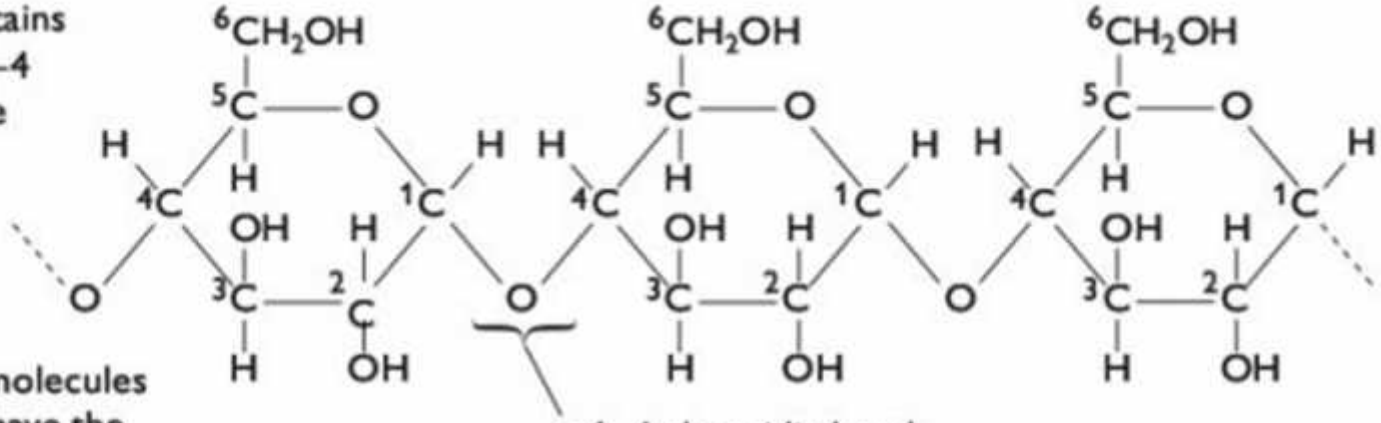
- In animals *polysaccharides* are mainly used for energy storage. In humans up to 10 percent of the weight of the liver can be *glycogen*—an instant store of energy that is easier to mobilize than fat, which is used for long-term energy storage.
- A typical glycogen molecule may contain 300 to 400 *glucose* units in a branching molecule.
- Glycogen also occurs in yeasts and bacteria.
- Chitin is made of acetylglucosamine, glucose units with an amino group attached. It is common in shellfish (the edible crab can be 70 percent chitin) where it is an important part of the shell.
- Chitin is also found in the *exoskeleton* of insects.
- Chitin is a structural polysaccharide and is not used as an energy store.

Polysaccharides in plants

- Plants store starch as granules inside their cells. Roots such as potatoes and carrots are often rich in starch, which provides the energy needed for the next generation to develop before it can produce its own food by photosynthesis.
- *Cellulose* is a structural polysaccharide and gives the cell wall its strength. Animals cannot digest cellulose, and so it passes through the *gut* largely untouched as roughage.

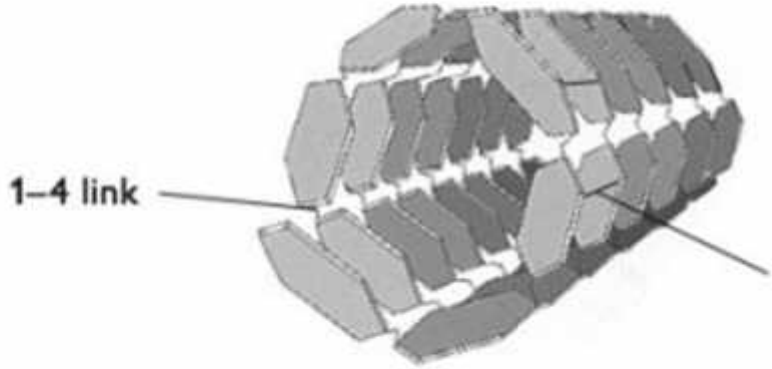


Amylose contains chains of α 1–4 linked glucose



The glucose molecules in a chain all have the same orientation

α 1–4 glycosidic bond



1–4 link

Hydrogen bond — many of these hold the amylose in a spiral shape

A small part of an amylose molecule

Ringkasan Karbohidrat

Materi

Karbohidrat

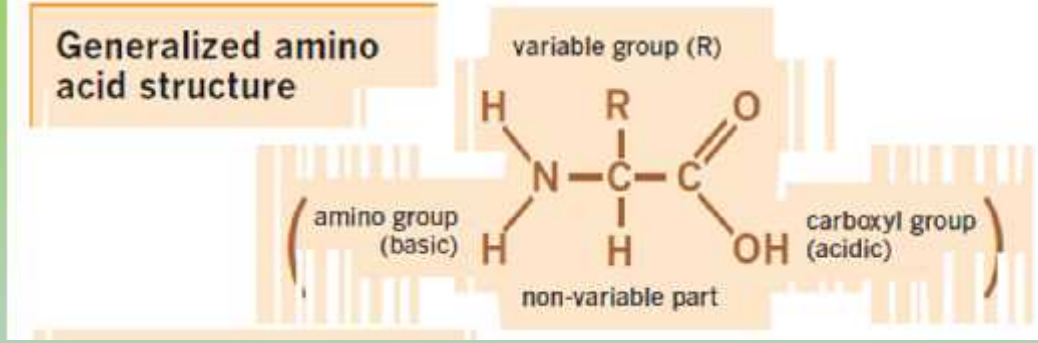
Protein

Lipid

Tugas Terstruktur

Amino acids

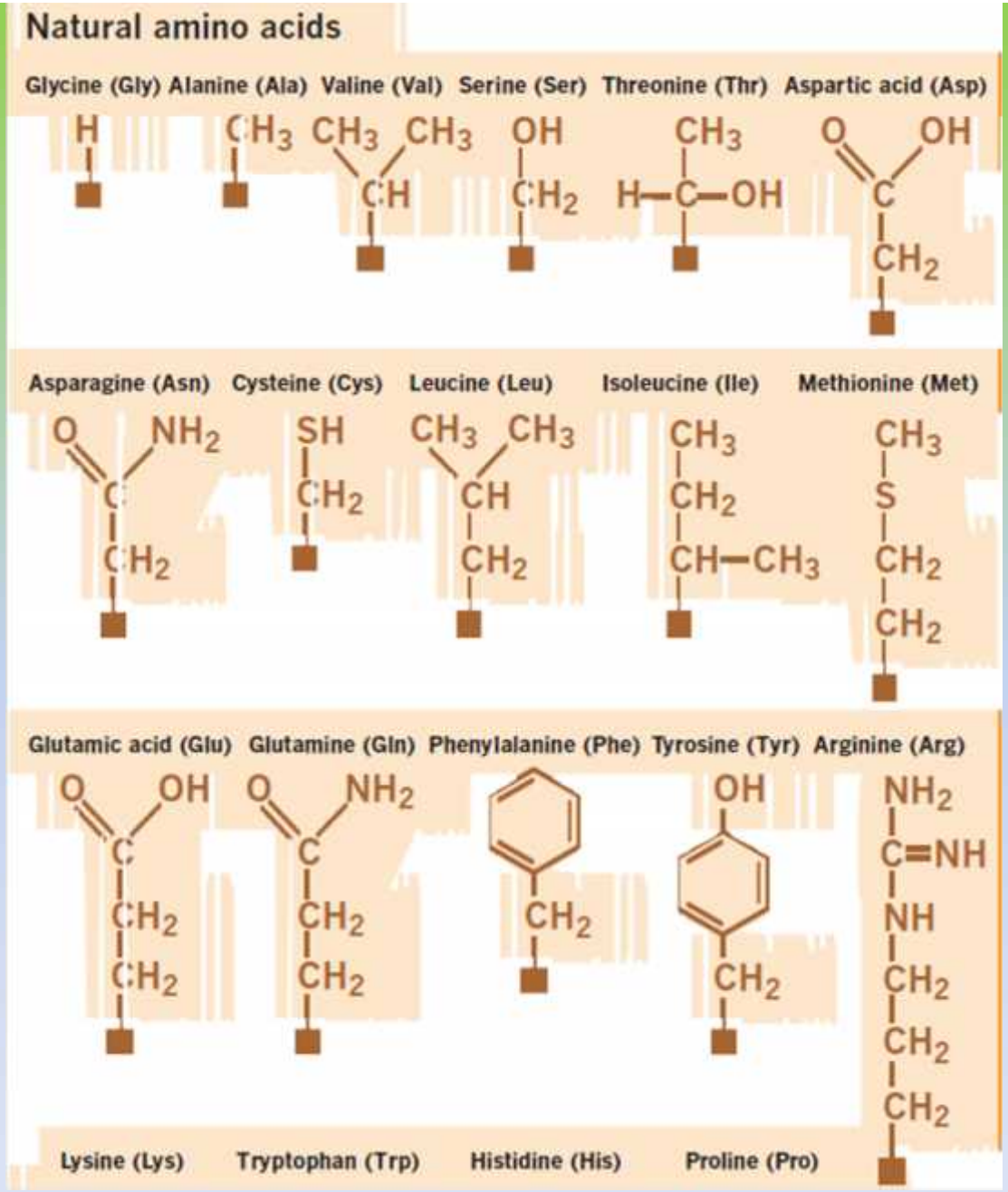
Generalized amino acid structure



Chemical structure

- *Amino acid* molecules are made of four groups bonded with a single carbon atom. Three of these groups are non-variable.
- The amino group NH_2 is a basic group which means it behaves as an alkali in solution.
- At the other end of the molecule is a carboxyl group (COOH), which acts as an organic acid.
- The third group is a hydrogen atom.
- The fourth group is variable. It is often shown in diagrams by the letter R. Different amino acids have different R groups.

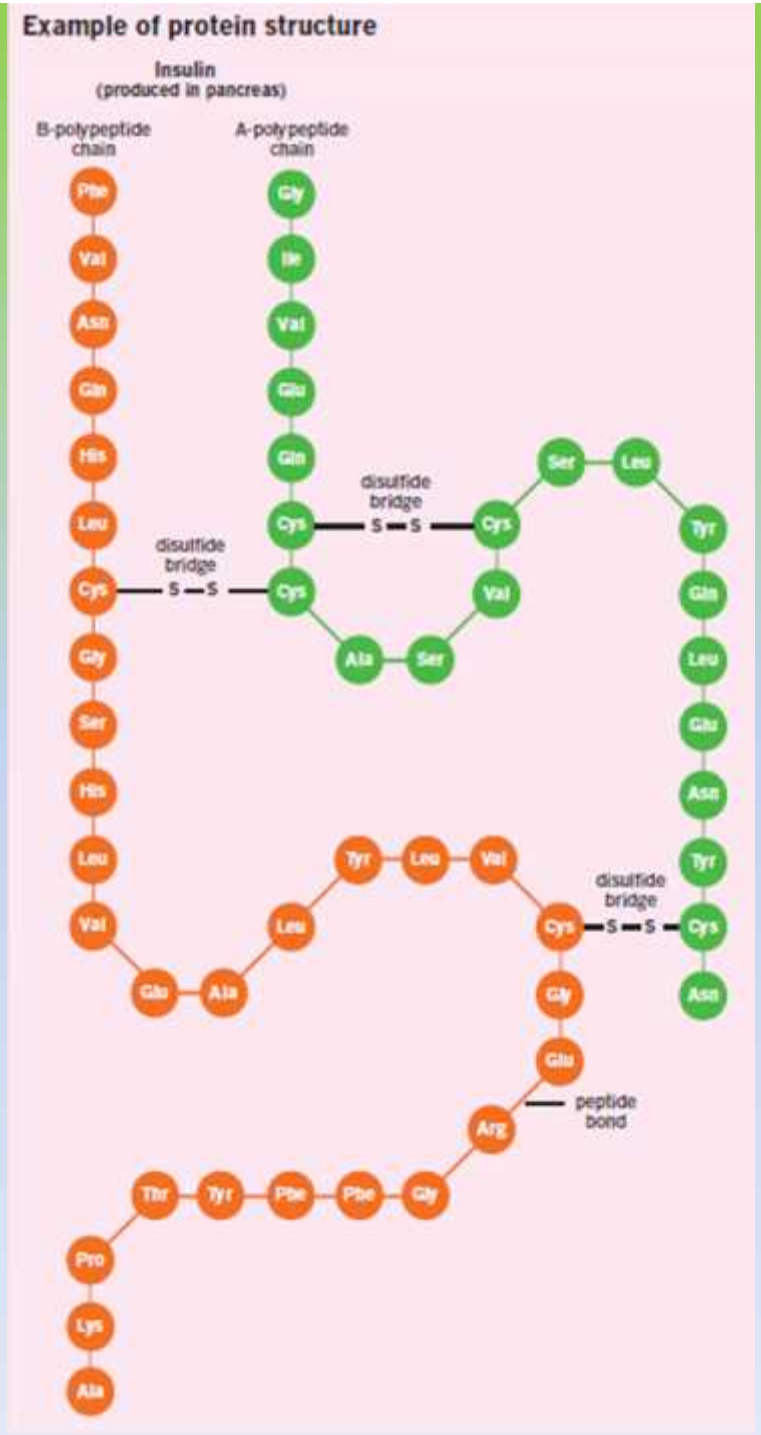
Natural amino acids



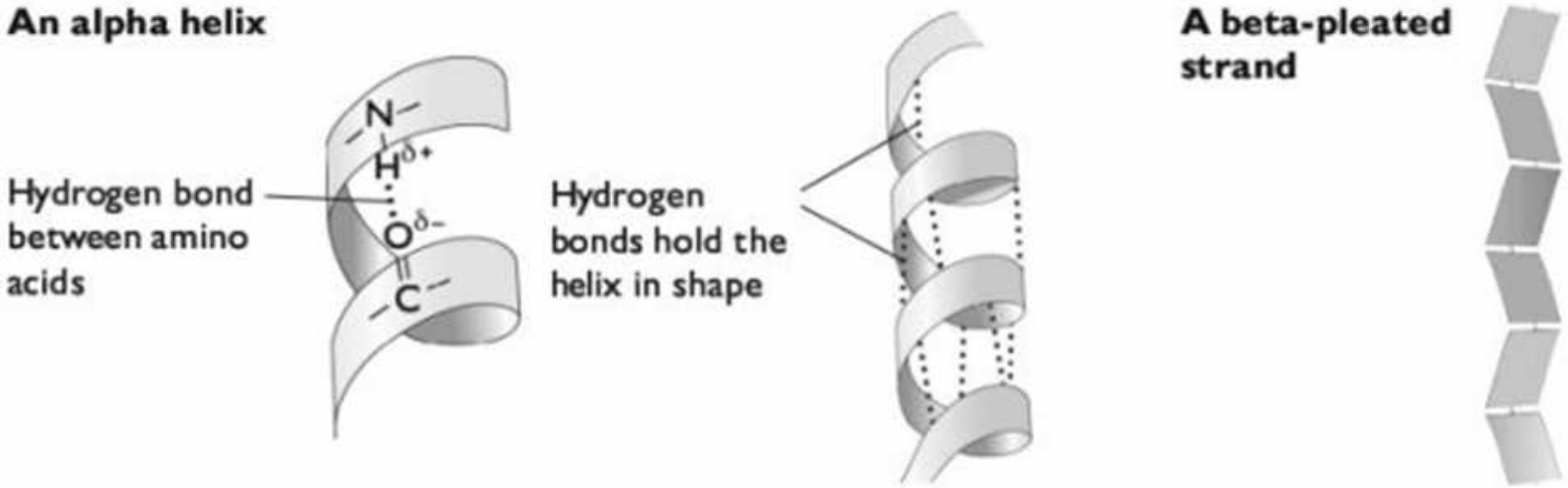
Lysine (Lys) Tryptophan (Trp) Histidine (His) Proline (Pro)

Protein structure

- All *proteins* are made of small *amino acid* molecules linked by *peptide bonds* in long chains resembling a string of beads.
- The number and order of amino acids in the chain decides how the protein will behave.
- Some proteins have more than one chain of amino acids and some have extra groups of atoms added. For example, *hemoglobin*, which transports oxygen from the lungs to cells throughout the body, is a protein with four amino acid chains wrapped around a central group containing iron.



The chain of amino acids often folds or curls up on itself. For example, many polypeptide chains coil into a regular 3D shape called an **alpha helix**. This is held in shape by **hydrogen bonds** between amino acids at different places in the chain. This regular shape is an example of **secondary structure** of a protein. Another example is the beta-pleated strand.

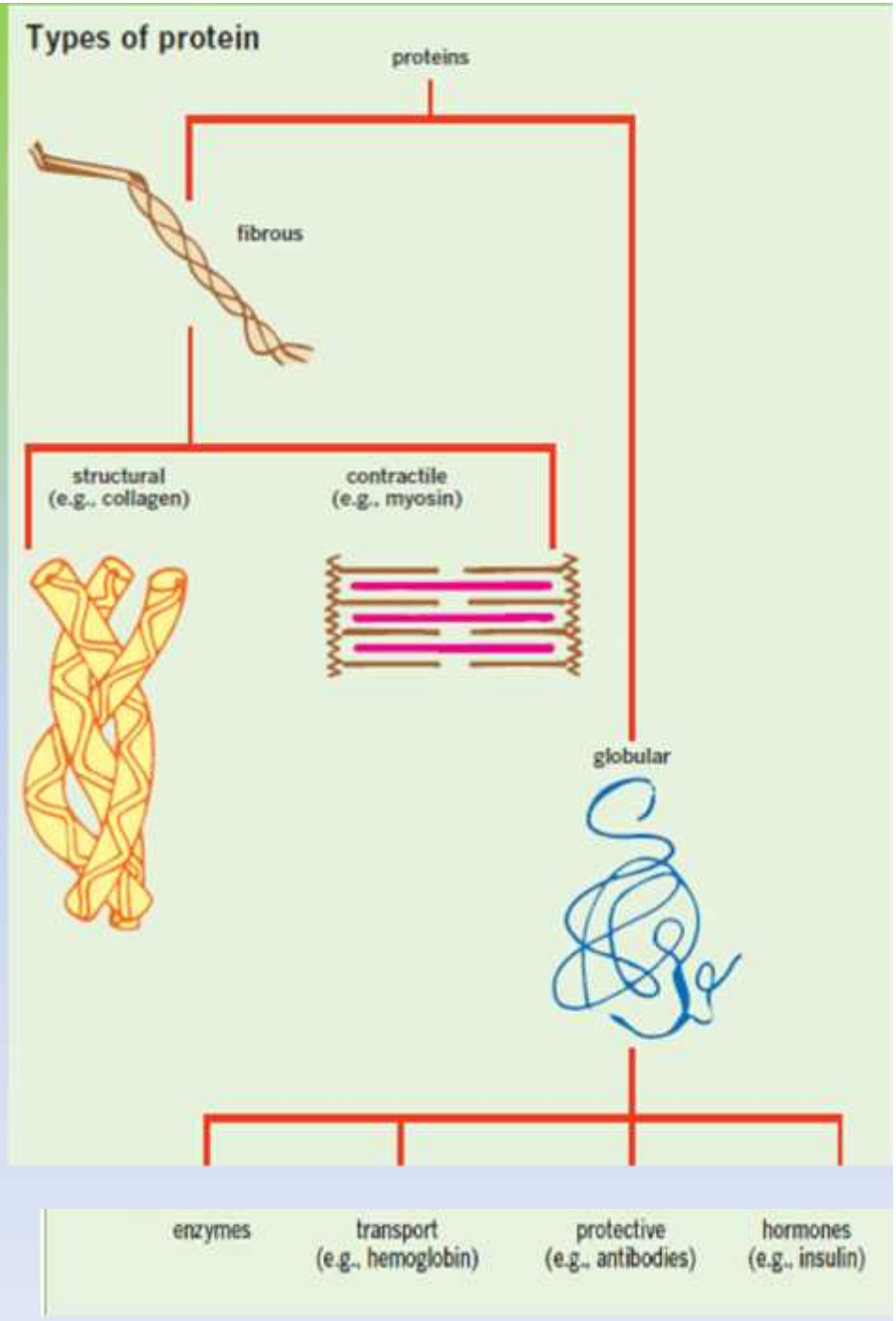


Examples of secondary structure

Classification of proteins

Types of protein

- There are two main groups of proteins: fibrous and globular.
- Both groups have the same basic structure—they are long chains of amino acids joined by *peptide bonds*.
- The difference between the two groups depends on the way the protein chains are arranged.



Ringkasan Protein (Video)

Materi

Karbohidrat

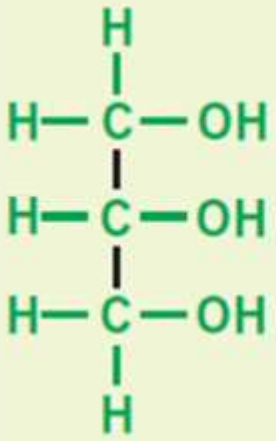
Protein

Lipid

Tugas terstruktur

Fatty acids and glycerol

Glycerol: molecular structure

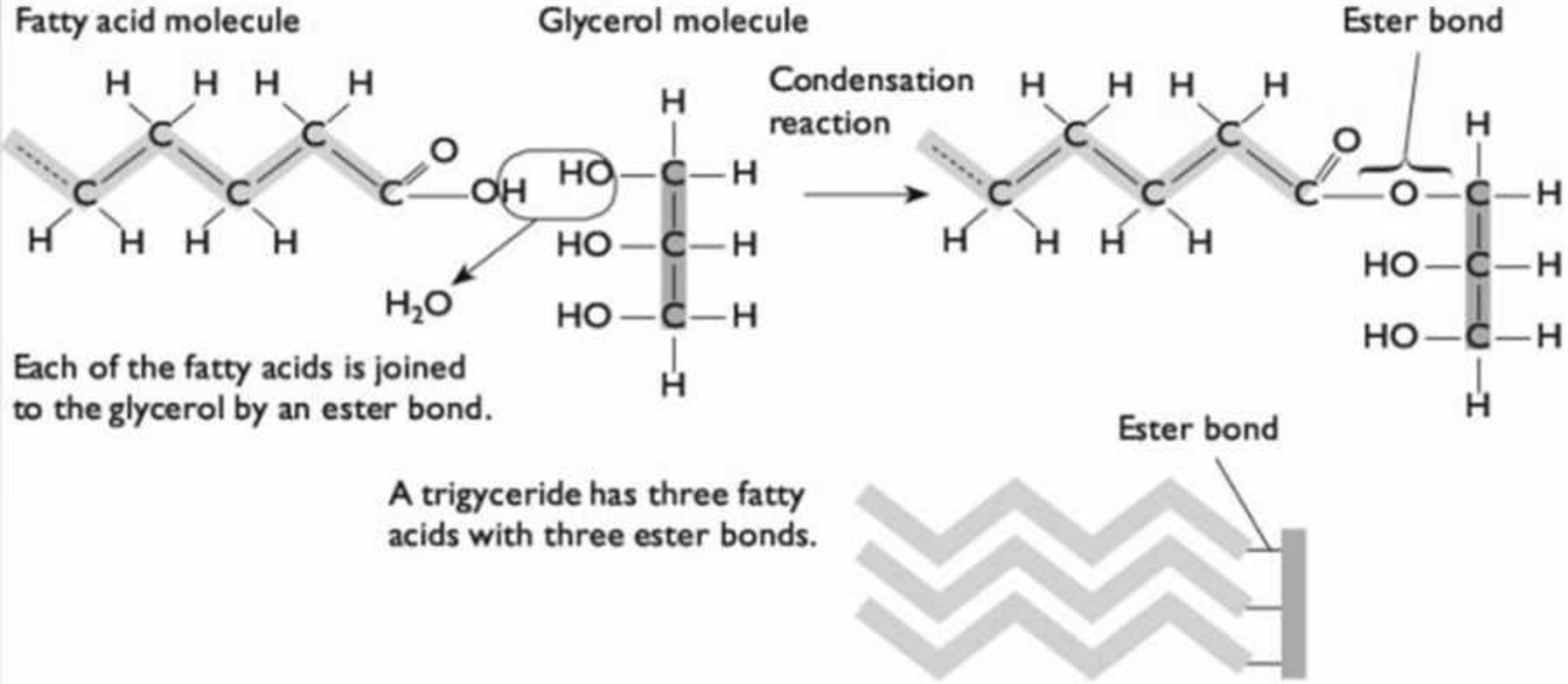


Stearic acid (saturated): model

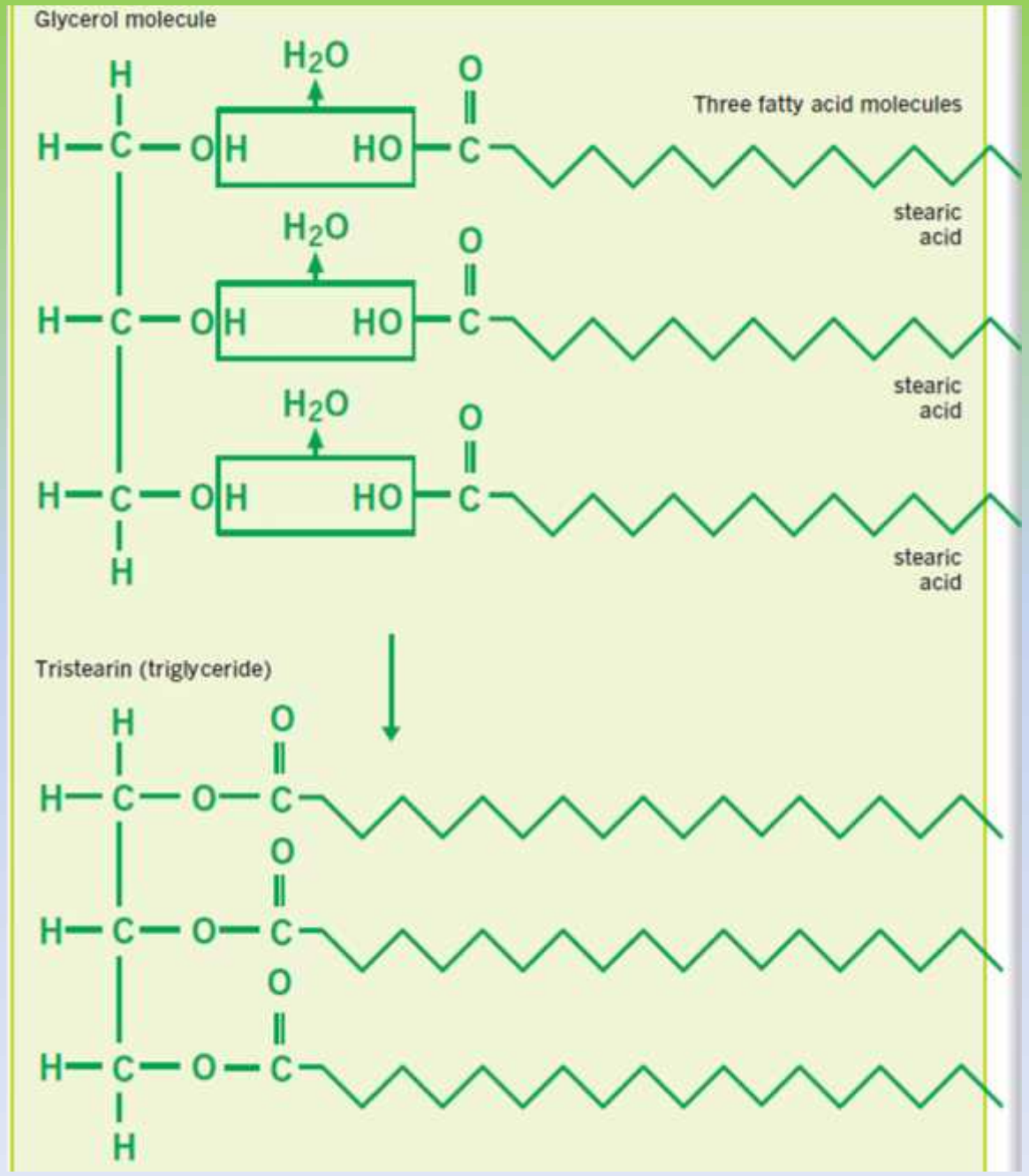
Oleic acid (unsaturated): model

Triglycerides

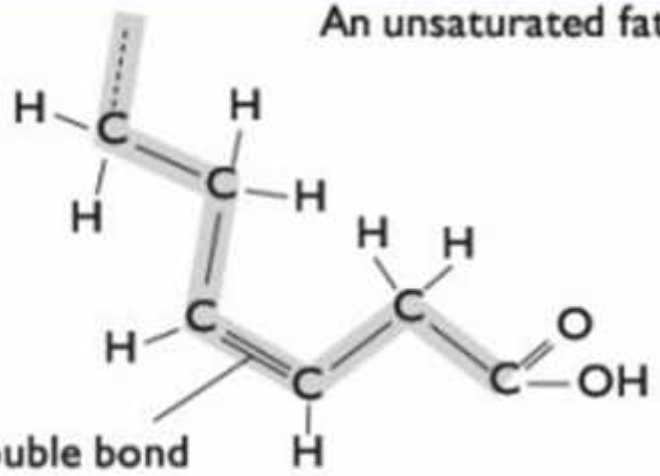
A triglyceride molecule is made of a 'backbone' of glycerol, to which three fatty acids are attached by ester bonds.



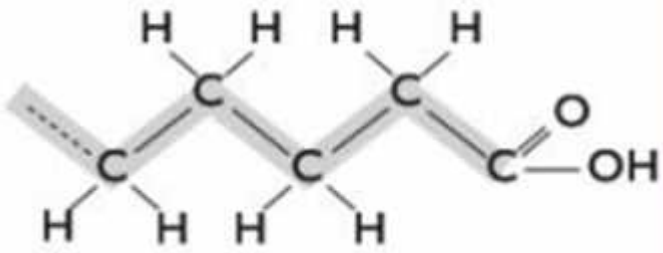
The formation of a triglyceride molecule


Glycerol molecule
H_2O
Three fatty acid molecules
stearic acid
stearic acid
stearic acid
Tristearin (triglyceride)

An unsaturated fatty acid



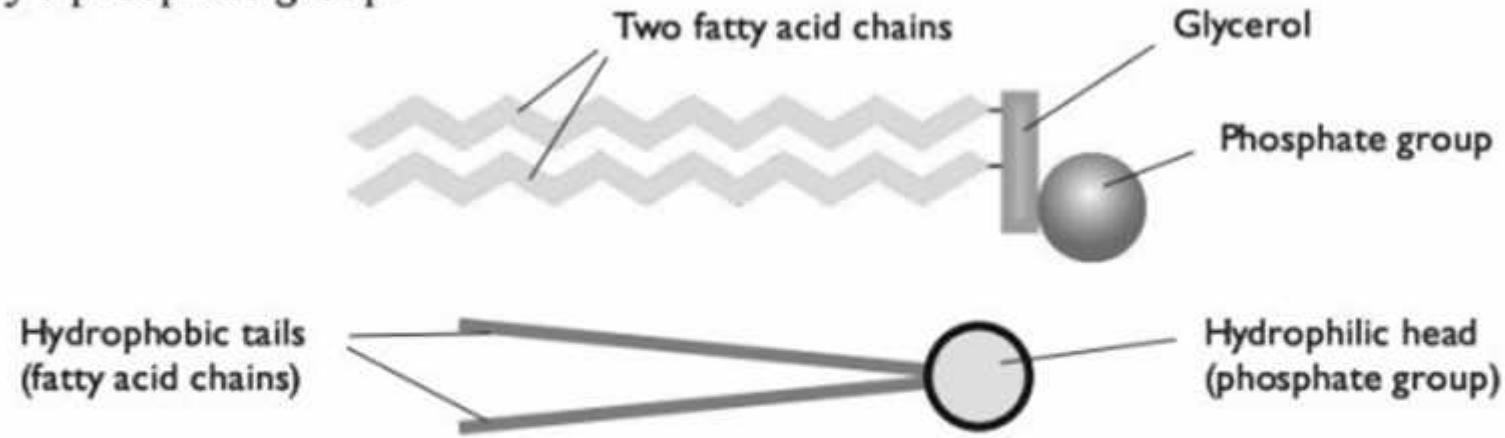
A saturated fatty acid



Unsaturated and saturated fatty acids

Phospholipids

A phospholipid molecule is like a triglyceride in which one of the fatty acids is replaced by a phosphate group.

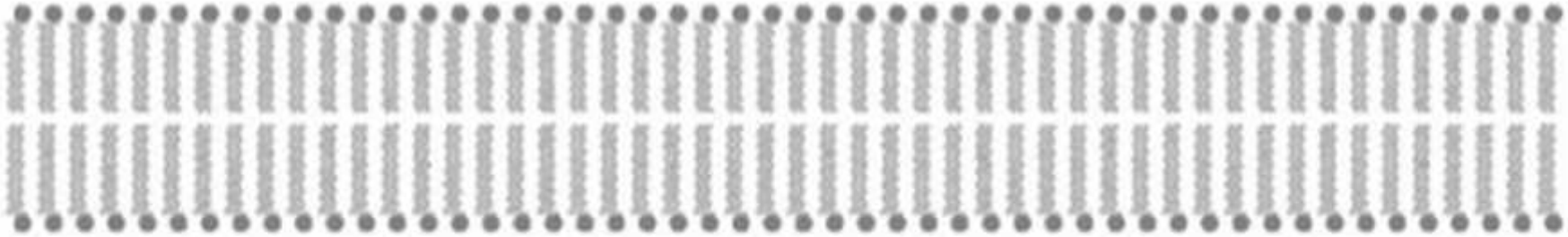


Phospholipid molecules

The fatty acid chains have no electrical charge and so are not attracted to the dipoles of water molecules (see page 45). They are said to be **hydrophobic**.

The phosphate group has an electrical charge and is attracted to water molecules. It is **hydrophilic**.

In water, a group of phospholipid molecules therefore arranges itself into a bilayer, with the hydrophilic heads facing outwards into the water and the hydrophobic tails facing inwards, therefore avoiding contact with water.



A phospholipid bilayer

Video LIpid

Pustaka

- Jones, M. 2010. Biology. Hodder education. London
- Price,G. 2006. Biology: An Illustrated Guide to Science. Infobase Publishing. New York

Materi

Karbohidrat

Protein

Lipid

Tugas terstruktur

Tugas Individu

- Buat review dari jurnal tentang salah satu material biologik (karbohidrat, Protein, ataupun lipid) pada suatu produk pertanian ataupun pangan
- Artikel dapat berupa nutrisi, fungsi, pembentukan dsb
- Dari Jurnal yang diterbitkan tahun 2005 ke atas (jurnal berbahasa Inggris) dilampirkan
- Dikumpulkan pada kuliah hari berikutnya, sebelum kuliah dimulai.