**Course Title: Biochemistry I**

**Micro 2nd Lab Assignment**

**Student Name: Arshad Khan**

**Student ID: 16928**

QNo.1

Ans: 01

**Discovery of the structure of DNA**

**Introduction**

Today, the DNA double helix is probably the most iconic of all biological molecules. It's inspired staircases, decorations, pedestrian bridges (like the one in Singapore, shown below), and more.

I have to agree with the architects and designers: the double helix is a beautiful structure, one whose form fits its function in a remarkable way. But the double helix was not always part of our cultural lexicon. In fact, until the 1950s, the structure of DNA remained a mystery.

Image credit: "[Double helix bridge](https://commons.wikimedia.org/wiki/File:Double-Helix-Bridge.jpg)," by William Cho, [CC BY-SA 2.0](https://creativecommons.org/licenses/by-sa/2.0/deed.en)

In this article, we'll briefly explore how the double-helical structure of DNA was discovered through the work of James Watson, Francis Crick, Rosalind Franklin, and other researchers. Then, we'll take a look at the properties of the double helix itself.



**The components of DNA**

From the work of biochemist Phoebus Levene and others, scientists in Watson and Crick's time knew that DNA was composed of subunits called **nucleotides**1^11start superscript, 1, end superscript. A nucleotide is made up of a sugar (deoxyribose), a phosphate group, and one of four nitrogenous bases: adenine (A), thymine (T), guanine (G) or cytosine (C).

C and T bases, which have just one ring, are called **pyrimidines**, while A and G bases, which have two rings, are called **purines**.

Left panel: structure of a DNA nucleotide. The deoxyribose sugar is attached to a phosphate group and to a nitrogenous base. The base may be any one of four possible options: cytosine (C), thymine (T), adenine (A), and guanine (G). The four bases have differences in their structure and functional groups. Cytosine and thymine are pyrimidines and have just one ring in their chemical structures. Adenine and guanine are purines and have two rings in their structures.

Right panel: a strand of linked DNA nucleotides. The sugars are connected by phosphodiester bonds. A phosphodiester bond consists of a phosphate group in which two of the oxygen atoms are bonded to other atoms - in this case, to carbon atoms of the neighboring deoxyribose sugars. The DNA strand consists of alternating phosphate groups and deoxyribose sugars (sugar-phosphate backbone), with the nitrogenous bases sticking out from the deoxyribose sugars.

Image credits: left panel, image modified from "[Nucleic acids: Figure 1](http://cnx.org/contents/GFy_h8cu@9.87:yxeAKc4X@8/Nucleic-Acids)," by OpenStax College, Biology ([CC BY 3.0](https://creativecommons.org/licenses/by/3.0/us/)). Right panel, image modified from "[DNA chemical structure](https://commons.wikimedia.org/wiki/File:DNA_chemical_structure.svg)," by Madeleine Price Ball ([CC0/public domain](https://creativecommons.org/publicdomain/zero/1.0/deed.en)).

DNA nucleotides assemble in chains linked by covalent bonds, which form between the deoxyribose sugar of one nucleotide and the phosphate group of the next. This arrangement makes an alternating chain of deoxyribose sugar and phosphate groups in the DNA polymer, a structure known as the **sugar-phosphate backbone**

**Watson, Crick, and Rosalind Franklin:**

In the early 1950s, American biologist James Watson and British physicist Francis Crick came up with their famous model of the DNA double helix. They were the first to cross the finish line in this scientific "race," with others such as Linus Pauling (who discovered protein secondary structure) also trying to find the correct model.

Rather than carrying out new experiments in the lab, Watson and Crick mostly collected and analyzed existing pieces of data, putting them together in new and insightful ways2^22squared. Some of their most crucial clues to DNA's structure came from Rosalind Franklin, a chemist working in the lab of physicist Maurice Wilkins.

Franklin was an expert in a powerful technique for determining the structure of molecules, known as **X-ray crystallography**. When the crystallized form of a molecule such as DNA is exposed to X-rays, some of the rays are deflected by the atoms in the crystal, forming a **diffraction pattern** that gives clues about the molecule's structure.

X-ray diffraction image of DNA. The diffraction pattern has an X shape representative of the two-stranded, helical structure of DNA.

Image modified from "[DNA structure and sequencing: Figure 2](http://cnx.org/contents/GFy_h8cu@9.87:U7tPDRxK@7/DNA-Structure-and-Sequencing)," by OpenStax College, Biology ([CC BY 3.0](http://creativecommons.org/licenses/by/3.0/))

Franklin’s crystallography gave Watson and Crick important clues to the structure of DNA. Some of these came from the famous “image 51,” a remarkably clear and striking X-ray diffraction image of DNA produced by Franklin and her graduate student. (A modern example of the diffraction pattern produced by DNA is shown above.) To Watson, the X-shaped diffraction pattern of Franklin's image immediately suggested a helical, two-stranded structure for DNA3^33cubed.

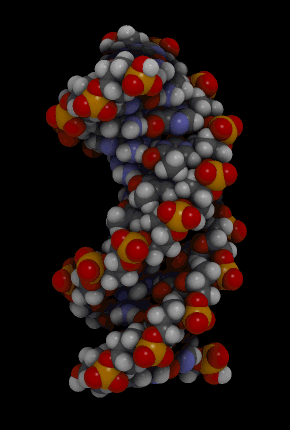
[[Did Watson and Crick steal Franklin's data?]](javascript:void(0))

Watson and Crick brought together data from a number of researchers (including Franklin, Wilkins, Chargaff, and others) to assemble their celebrated model of the 3D structure of DNA. In 1962, James Watson, Francis Crick, and Maurice Wilkins were awarded the Nobel Prize in Medicine. Unfortunately, by then Franklin had died, and Nobel prizes are not awarded posthumously.

**Watson and Crick's model of DNA:**

The structure of DNA, as represented in Watson and Crick's model, is a double-stranded, antiparallel, right-handed helix. The sugar-phosphate backbones of the DNA strands make up the outside of the helix, while the nitrogenous bases are found on the inside and form hydrogen-bonded pairs that hold the DNA strands together.

In the model below, the orange and red atoms mark the phosphates of the sugar-phosphate backbones, while the blue atoms on the interior of the helix belong to the nitrogenous bases.



Animation of DNA double helix 3D molecular structure.

Image credit: "[Bdna cropped](https://commons.wikimedia.org/wiki/File:Bdna_cropped.gif" \t "_blank)," by Jahobr, public domain.

Left panel: illustration of the antiparallel structure of DNA. A short segment of DNA double helix is shown, composed of two DNA strands held together by hydrogen bonds between the bases. The strand on the left has a phosphate group exposed at its top (5' end) and a hydroxyl group exposed at its bottom (3' end). The strand on the right has the opposite orientation, with a phosphate group exposed at its bottom (5' end) and a hydroxyl exposed at its top (3' end). The 5' end of one strand thus ends up next to the 3' end of the other, and vice versa.

Right panel: structure of a nucleotide, illustrating the 5' phosphate group and 3' hydroxyl group. These groups get their names from their positions on the deoxyribose sugar's ring. The ring

**Right-handed helix**

In Watson and Crick's model, the two strands of DNA twist around each other to form a **right-handed helix**. All helices have a handedness, which is a property that describes how their grooves are oriented in space.

[[How can I tell that DNA is a right-handed helix?]](javascript:void(0))

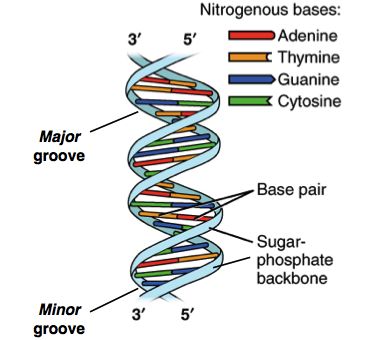


Image of a DNA double helix, illustrating its right-handed structure. The major groove is a wider gap that spirals up the length of the molecule, while the minor groove is a smaller gap that runs in parallel to the major groove. The base pairs are found in the center of the helix, while the sugar-phosphate backbones run along the outside.

\_Image modified from "[DNA structure and sequencing: Figure 3](http://cnx.org/contents/GFy_h8cu@9.87:U7tPDRxK@7/DNA-Structure-and-Sequencing)," by OpenStax College, Biology ([CC BY 3.0](http://creativecommons.org/licenses/by/3.0/)).\_

[[Are DNA helices always right-handed?]](javascript:void(0))

The twisting of the DNA double helix and the geometry of the bases creates a wider gap (called the **major groove**) and a narrower gap (called the **minor groove**) that run along the length of the molecule, as shown in the figure above. These grooves are important binding sites for proteins that maintain DNA and regulate gene activity.

Q No. 2

Ans. 2

# Disaccharides

We generally associate sugar with glucose. But did you know the table sugar we use every day is not glucose? It is, in fact, a disaccharide known as sucrose. Let us have a detailed look at disaccharides and their [structures](https://www.toppr.com/guides/business-management-entrepreneurship/organizing/structure-of-organization/) and properties.

* **Fructose**

**Fructose**, or **fruit sugar**, is a simple [ketonic](https://en.wikipedia.org/wiki/Ketose) [monosaccharide](https://en.wikipedia.org/wiki/Monosaccharide) found in many plants, where it is often bonded to [glucose](https://en.wikipedia.org/wiki/Glucose) to form the [disaccharide](https://en.wikipedia.org/wiki/Disaccharide) [sucrose](https://en.wikipedia.org/wiki/Sucrose). It is one of the three dietary monosaccharides, along with glucose and [galactose](https://en.wikipedia.org/wiki/Galactose), that are absorbed directly into blood during [digestion](https://en.wikipedia.org/wiki/Digestion). Fructose was discovered by French chemist [Augustin-Pierre Dubrunfaut](https://en.wikipedia.org/wiki/Augustin-Pierre_Dubrunfaut) in 1847.[[5]](https://en.wikipedia.org/wiki/Fructose#cite_note-5)[[6]](https://en.wikipedia.org/wiki/Fructose#cite_note-6) The name "fructose" was coined in 1857 by the English chemist [William Allen Miller](https://en.wikipedia.org/wiki/William_Allen_Miller).[[7]](https://en.wikipedia.org/wiki/Fructose#cite_note-Miller-7) Pure, dry fructose is a sweet, white, odorless, crystalline solid, and is the most water-soluble of all the sugars.[[8]](https://en.wikipedia.org/wiki/Fructose#cite_note-Hyvonen&Koivistoinen1982-8) Fructose is found in [honey](https://en.wikipedia.org/wiki/Honey), tree and vine fruits, flowers, [berries](https://en.wikipedia.org/wiki/Berry), and most [root vegetables](https://en.wikipedia.org/wiki/List_of_root_vegetables).

Commercially, fructose is derived from [sugar cane](https://en.wikipedia.org/wiki/Sugar_cane), [sugar beets](https://en.wikipedia.org/wiki/Sugar_beet), and [maize](https://en.wikipedia.org/wiki/Maize). [High-fructose corn syrup](https://en.wikipedia.org/wiki/High-fructose_corn_syrup) is a [mixture](https://en.wikipedia.org/wiki/Mixture) of glucose and fructose as monosaccharides. Sucrose is a [compound](https://en.wikipedia.org/wiki/Chemical_compound) with one molecule of glucose covalently linked to one molecule of fructose. All forms of fructose, including fruits and juices, are commonly added to foods and drinks for [palatability](https://en.wikipedia.org/wiki/Palatability) and [taste](https://en.wikipedia.org/wiki/Taste) enhancement, and for browning of some foods, such as baked goods. About 240,000 [tonnes](https://en.wikipedia.org/wiki/Tonne) of crystalline fructose are produced annually.[[9]](https://en.wikipedia.org/wiki/Fructose#cite_note-9)

Excessive consumption of fructose (especially from sugar-sweetened beverages) may contribute to [insulin resistance](https://en.wikipedia.org/wiki/Insulin_resistance), [obesity](https://en.wikipedia.org/wiki/Obesity), elevated [LDL cholesterol](https://en.wikipedia.org/wiki/Low-density_lipoprotein) and [triglycerides](https://en.wikipedia.org/wiki/Triglyceride), leading to [metabolic syndrome](https://en.wikipedia.org/wiki/Metabolic_syndrome).[[10]](https://en.wikipedia.org/wiki/Fructose#cite_note-MalikHu2015-10) The [European Food Safety Authority](https://en.wikipedia.org/wiki/European_Food_Safety_Authority) stated that fructose may be preferable over sucrose and glucose in sugar-sweetened foods and beverages because of its lower effect on [postprandial](https://en.wikipedia.org/wiki/Postprandial) [blood sugar](https://en.wikipedia.org/wiki/Blood_sugar) levels, and noted that "high intakes of fructose may lead to metabolic complications such as [dyslipidaemia](https://en.wikipedia.org/wiki/Dyslipidaemia), insulin resistance, and increased visceral adiposity".[[11]](https://en.wikipedia.org/wiki/Fructose#cite_note-efsa11-11) The UK's Scientific Advisory Committee on Nutrition in 2015 disputed the claims of fructose causing metabolic disorders, stating that "there is insufficient evidence to demonstrate that fructose intake, at levels consumed in the normal UK diet, leads to adverse health outcomes independent of any effects related to its presence as a component of total and free sugars."[[12]](https://en.wikipedia.org/wiki/Fructose#cite_note-12)

* **Maltose**

From Wikipedia, the free encyclopedia

**Maltose** ([/ˈmɔːltoʊs/](https://en.wikipedia.org/wiki/Help:IPA/English)[[2]](https://en.wikipedia.org/wiki/Maltose#cite_note-2) or [/ˈmɔːltoʊz/](https://en.wikipedia.org/wiki/Help:IPA/English)[[3]](https://en.wikipedia.org/wiki/Maltose#cite_note-3)), also known as **maltobiose** or **malt sugar**, is a [disaccharide](https://en.wikipedia.org/wiki/Disaccharide) formed from two units of [glucose](https://en.wikipedia.org/wiki/Glucose) joined with an α(1→4) [bond](https://en.wikipedia.org/wiki/Glycosidic_bond). In the [isomer](https://en.wikipedia.org/wiki/Isomer) [isomaltose](https://en.wikipedia.org/wiki/Isomaltose), the two glucose molecules are joined with an α(1→6) bond. Maltose is the two-unit member of the [amylose](https://en.wikipedia.org/wiki/Amylose) [homologous series](https://en.wikipedia.org/wiki/Homologous_series), the key structural motif of [starch](https://en.wikipedia.org/wiki/Starch). When [beta-amylase](https://en.wikipedia.org/wiki/Beta-amylase) breaks down starch, it removes two glucose units at a time, producing maltose. An example of this reaction is found in [germinating](https://en.wikipedia.org/wiki/Germination) seeds, which is why it was named after [malt](https://en.wikipedia.org/wiki/Malt).[[4]](https://en.wikipedia.org/wiki/Maltose#cite_note-Stoker-4) Unlike [sucrose](https://en.wikipedia.org/wiki/Sucrose), it is a [reducing sugar](https://en.wikipedia.org/wiki/Reducing_sugar).[[5]](https://en.wikipedia.org/wiki/Maltose#cite_note-Fruton-5)

* + **Table sugar**

|  |  |  |
| --- | --- | --- |
| **:** Table sugar is pure sucrose derived from sugar beet or sugar cane. Sucrose is a disaccharide consisting of -> glucose and -> fructose. It is produced by green plants in the process of photosynthesis. About 900 B.C., Arabs introduced the sugar cane into the mediterranean region. Much later, at the beginning of the 19th century, sugar beet was used to isolate sucrose. Sugar cane is grown mainly in the southern hemisphere, whereas sugar beets are grown in the cooler climates of the northern hemisphere. | | |
| **Dietetics:**The normal table sugar causes a slower rise of the blood sugar level than glucose. For diabetics: if you are well adjusted, the intake of up to 30 g/day is allowed. Tip: 4 sugar cubes (each 3 g) are equivalent to one bread unit (carbohydrate unit). One unit equals 10-12 g sucrose. | | |
|  | | **Chemistry:** Sucrose belongs to the disaccharides, which each consist of two monosaccharides. Table sugar (sucrose) has the elemental formula C12H22O11. The yellowish raw sugar has to be cleaned of rests of syrup in order to become the pure white sugar used as foodstuff. Soluted in water, sucrose rotates polarized light clockwise (+65°). |
| Hydrolysed sucrose is called invert sugar and consists of glucose and fructose in equal amounts. This mixture rotates polarized light counter clockwise (-20°). Thus a conversion of the rotation direction can be observed after hydrolysis of sucrose (= inversion). **Usage:** Lots of different table sugars consist mainly of pure sucrose (examples are given below). | |  |
|  | |

* + **Stachyose**

**Stachyose** is a [tetrasaccharide](https://en.wikipedia.org/wiki/Tetrasaccharide) consisting of two α-D-[galactose](https://en.wikipedia.org/wiki/Galactose" \o "Galactose) units, one α-D-[glucose](https://en.wikipedia.org/wiki/Glucose) unit, and one β-D-[fructose](https://en.wikipedia.org/wiki/Fructose) unit sequentially linked as gal(α1→6)gal(α1→6)glc(α1↔2β)fru. Together with related [oligosaccharides](https://en.wikipedia.org/wiki/Oligosaccharide) such as [raffinose](https://en.wikipedia.org/wiki/Raffinose), Stachyose occurs naturally in numerous [vegetables](https://en.wikipedia.org/wiki/Vegetable) (e.g. [green beans](https://en.wikipedia.org/wiki/Green_bean), [soybeans](https://en.wikipedia.org/wiki/Soybean) and other beans) and other plants.

Stachyose is less sweet than [sucrose](https://en.wikipedia.org/wiki/Sucrose), at about 28% on a weight basis. It is mainly used as a bulk sweetener or for its functional oligosaccharide properties.[[1]](https://en.wikipedia.org/wiki/Stachyose#cite_note-1)[[*additional citation(s) needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] Stachyose is not completely digestible by humans and delivers 1.5 to 2.4 [kcal](https://en.wikipedia.org/wiki/Calorie)/g (6 to 10 [kJ](https://en.wikipedia.org/wiki/Kilojoule)/g).

* + **Milk sugar**
* **Examples of *milk sugar* in a Sentence**
* Recent Examples on the Web And a recent Natian tap list featured a vertical flight of its Case & Desist milk stout, a big, chewy offering with a deep *milk sugar* sweetness and spicy coffee and chocolate notes. — [*oregonlive*, "Natian Brewery relies on hard work, creative twists: Portland Breweries Series," 13 Dec. 2019](https://www.oregonlive.com/beer/2019/12/natian-brewery-relies-on-hard-work-creative-twists-portland-breweries-series.html) The process of evaporating milk will give a slightly off-white color, caused by a caramelization of the natural *milk sugars*. — [Darlene Zimmerman, *Detroit Free Press*, "Overnight Pumpkin Breakfast Casserole recipe is easy, time-saving," 23 Nov. 2019](https://www.freep.com/story/life/food/2019/11/23/breakfast-casserole-easy-recipe/4247759002/)
* These example sentences are selected automatically from various online news sources to reflect current usage of the word 'milk sugar.' Views expressed in the examples do not represent the opinion of Merriam-Webster or its editors. [Send us feedback](https://www.merriam-webster.com/contact-us?ref=freshexamples&hw=milk+sugar&url=https%3A%2F%2Fwww.merriam-webster.com%2Fdictionary%2Fmilk%2520sugar).
  + **Glyceraldehyde**

**Glyceraldehyde** (**glyceral**) is a [triose](https://en.wikipedia.org/wiki/Triose) [monosaccharide](https://en.wikipedia.org/wiki/Monosaccharide) with [chemical formula](https://en.wikipedia.org/wiki/Chemical_formula) [C](https://en.wikipedia.org/wiki/Carbon)3[H](https://en.wikipedia.org/wiki/Hydrogen)6[O](https://en.wikipedia.org/wiki/Oxygen)3. It is the simplest of all common [aldoses](https://en.wikipedia.org/wiki/Aldose). It is a [sweet](https://en.wikipedia.org/wiki/Sweet), colorless, [crystalline](https://en.wikipedia.org/wiki/Crystal) [solid](https://en.wikipedia.org/wiki/Solid) that is an intermediate compound in [carbohydrate](https://en.wikipedia.org/wiki/Carbohydrate) [metabolism](https://en.wikipedia.org/wiki/Metabolism). The word comes from combining [glycerol](https://en.wikipedia.org/wiki/Glycerol) and [aldehyde](https://en.wikipedia.org/wiki/Aldehyde), as glyceraldehyde is glycerol with one [alcohol group](https://en.wikipedia.org/wiki/Alcohol_group) oxidized to an aldehyde.