Chapter 5

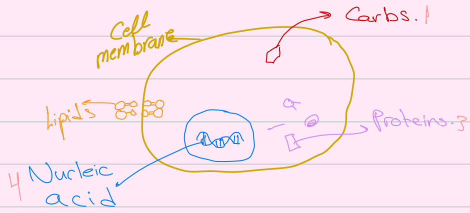
Molecules of life

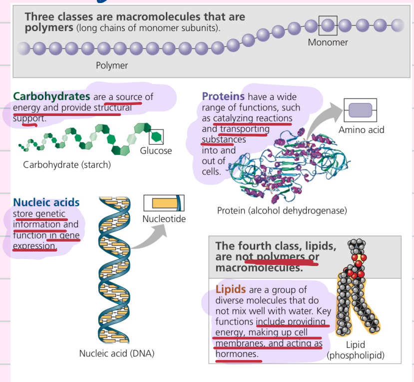
Biochemistry

organism > system > organ > tissues > Cells > organelle > molecules.

Four main Macro Molecules :- → they have unique properties
↓
because of its orderly arrangement of their atoms.

- Carbohydrates
- Proteins
- Nucleic acids
- Lipids





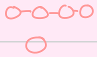
Most macro molecules are polymers Most not all

→ Carbohydrates
Proteins
Nucleic acids] → all are polymers

Lipids are not polymer
↳ It is monomer

Notes:-
Macro كبير
Micro صغير

Note 2:-
Polymer → تعدد القطع
monomer → قطعة واحدة



Concept 5.1:- Macromolecules are polymers, built from monomers:-

polymer is a long molecule consisting of many similar or identical building blocks linked by covalent bonds, much as a train consists of a chain of boxcars

monomer The repeating units that serve as the building blocks of a polymer are smaller molecules

> Note
> In addition to forming polymers, some monomers have functions of their own.

Macro molecules → are huge size
↳ chain like molecules.

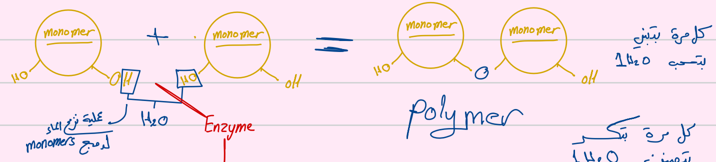
البناء

* Synthesis and breaking down polymers :-

[Dehydration] → occurs when two monomers bonds together through the loss of water molecule.

نزع ← الماء

↳ (Polymerization)



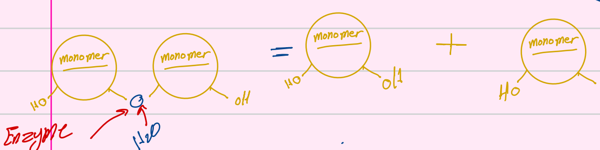
Enzyme ↳ are specialized macro molecules that speed up chemical reactions.
speed up = facilitate

The condensation reaction happen when two molecules are connected covelantly together with losing smaller molecules --→ like dehydration reaction

[Hydrolysis] → when polymers are disassembled to monomers
تفكيك
↳ (water breakage)

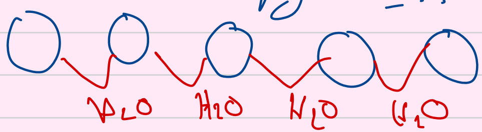
→ a reaction is essentially the reverse of dehydration reaction.

→ It is a type of Condensi reaction.



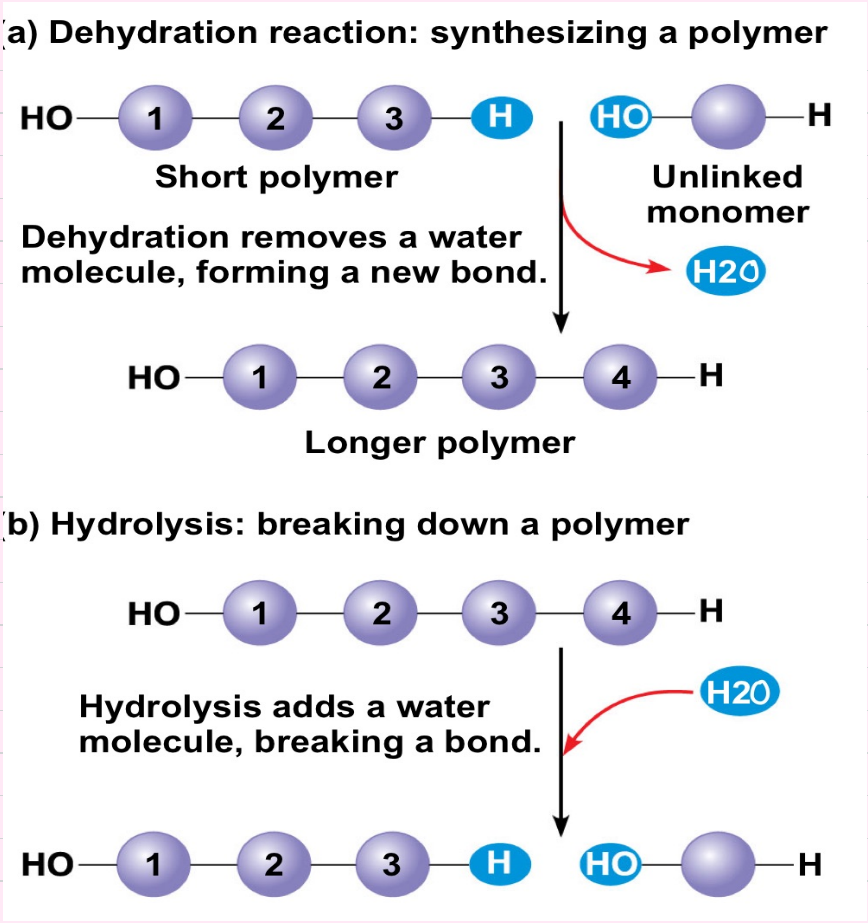
Example

5 polymer بني !



no. H_2O = العدد - 1

Note
Each class of polymer is made upof a different typeof monomers
, But the chemical mechanisms are the same which done by the cell


(a) Dehydration reaction: synthesizing a polymer
HO 1 2 3 H
HO H
Short polymer
Unlinked monomer
Dehydration removes a water molecule, forming a new bond.
H20
HO 1 2 3 4 H
Longer polymer
(b) Hydrolysis: breaking down a polymer
HO 1 2 3 4 H
H20
Hydrolysis adds a water molecule, breaking a bond.
HO 1 2 3 H
HO H

[1] Carbohydrates

السكريات / الكربوهيدرات — includes sugars and polymers of sugars

- → An important source of energy (fuel)
- → Giving a structural support + building blocks

The monomers of Carbohydrates:-

1:- **monosaccharides** السكريات الاحادية

- → The simplest sugar / simplest carbohydrates.
- → serves as fuel for cells
- → raw material for building molecules

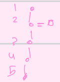
no. of Cs ≥ 3 عشان يكون سكر

OH — C — C=O: لو كان no.C = 2 هاد إسمه monohydroxy مش polyhydroxy، عشان هيك لازم no. ≥ 3

متعدد polyhydroxy (OH)

- → Aldehyde R—C(=O)—H: C=O / C—OH / C—OH → (Aldose) → like glucose
- → Ketone R—C(=O)—R: C—OH / C=O / C—OH → (Ketose) → like fructose

→ Bresufex:
$\overset{3}{\text{tri}}$, $\overset{4}{\text{tetra}}$, $\overset{5}{\text{Penta}}$, $\overset{6}{\text{hexa}}$

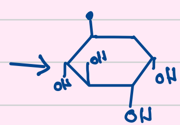


يعني ketose/Pentose/ سكر

the classifying by the location of the Carbonel Group

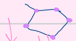
formula:- $C_nH_{2n}O_n$

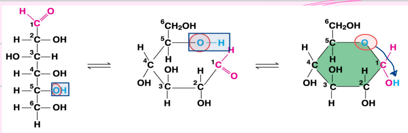
Example of monosaccharides

- 1- → Glucose →  $C_6H_{12}O_6$ (the most common)
- 2- → Fructose (سكر الفواكه)
- 3- → Galactose (سكر الحليب)

• Liner —في المحاليل المائية→ cyclic

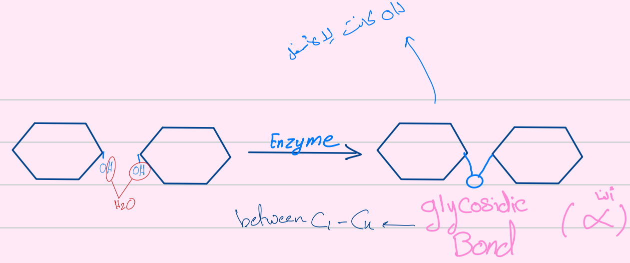
in aqueous solutions

more stable 



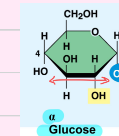
2:- Disaccharides.

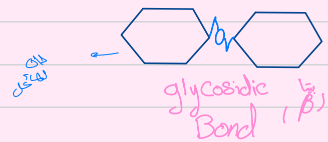
↳ is formed when a dehydration reaction joins two monosaccharides.



الانزيمات تستطيع كسر روابط α

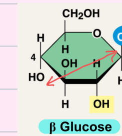
فيكون تكسيره أسهل





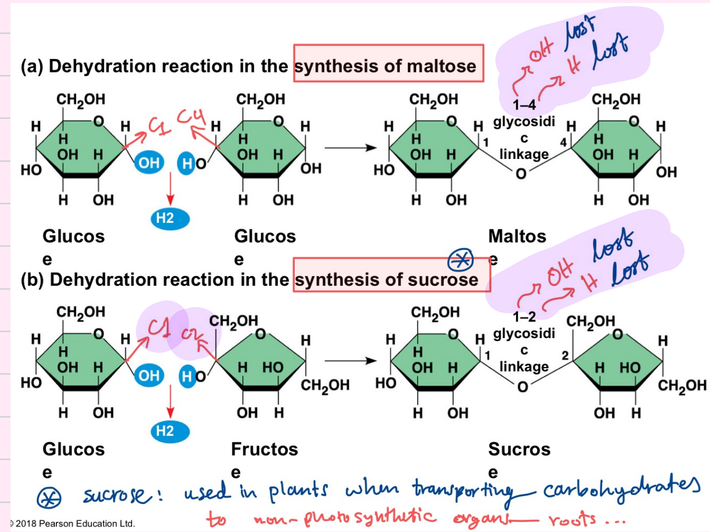
الأنزيمات لا تستطيع تكسير روابطا β

لذلك المركبات التي تحوي β تكون rigid.



Examples of Disaccharides:-

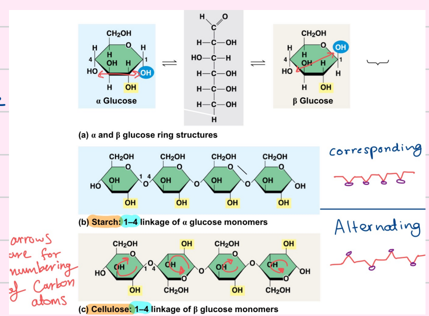
- Maltose — Glucose - Glucose — سكر الشعير
- Sucrose — Glucose - fructose — سكر المائدة / الأبيض
- lactose — Glucose - Galactose — سكر الحليب



⊛ sucrose: used in plants when transporting carbohydrates to non-photosynthetic organs — roots ...

The difference between α β:

Later:- It is the cause behind the difference in structure between glucose and cellulose
Glycogen



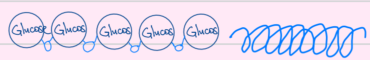
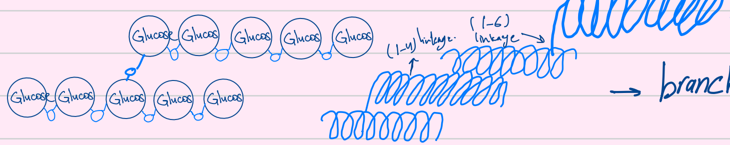
3 :-

Polysaccharides:-

- It is a polymers of sugars
- have a storage and structural roles.
  - لتجميع الجلوكوز في الجسم وتخزينه على شكل جلايكوجين لإستخدامه عند الحاجة.
  - الخشب هو مثـ.

→ the function of polysaccharides determined by
- its sugar monomers
- the position of its glycosidic linkage

Storage ← ① Starch   نشا نباتي   storage place in plastid.

- Amylose  → Unbranched (α كل روابطه)
- Amylopectin 

→ branched (α كل روابطه)   Carbonel and 6 are linkage

Storage ← ② Glycogen   النشا الحيواني

↑↑ extensively branched (α)

Storage places in liver  and muscles 

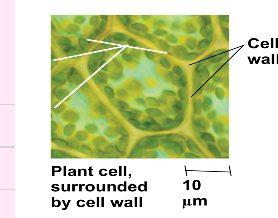
Why it is extensively branched ?
↳ to provide alot of ends able to hydrolysis and dehydration

3 Cellulose

structure

- Cell wall of plants
- rigid → صلب
- humans and most animals can't digest it.
  - because we lack to enzymes can break β bonds
- The most abundant component on earth

متوفر بكثرة على الأرض « خشب النبات »



Plant cell, surrounded by cell wall

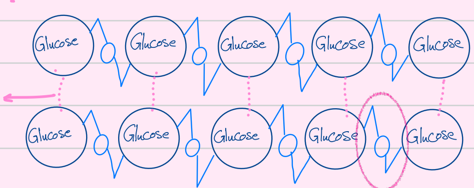
Examples of organisms can digest cellulose :-
- prokaryotes and protists in Cow's gut

ميكروبات في بطون الحيوانات والبقر ← علاقة تعايشية
symbiotic relationship

- Some fungi

unbranched

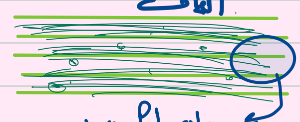
Cable like structure



hydrogen bonds
- occur between parallel monomers with hydroxyls

β
unbreakable bond
very strong bond.

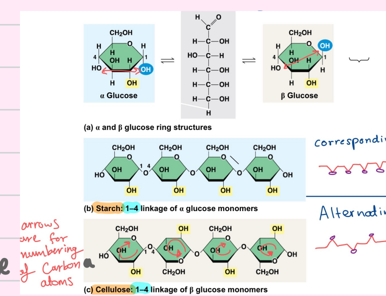
⇒ fibers
ألياف



micro fibrils
Cable like

cellulose enzyme الأنزيم الذي يهضم ال cellulose يسمى بـ

The difference between α / β :-



(a) α and β glucose ring structures
(b) Starch: 1–4 linkage of α glucose monomers
(c) Cellulose: 1–4 linkage of β glucose monomers

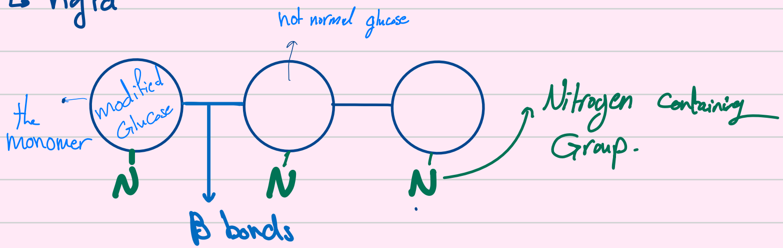
≠ the structure of cellulose differ from other polymers
- because the position of hydroxyl group of C1 in the glucose ring either bellow or above
  - so the glycosidic bond will form as β bond not α → it give the cellulose distant 3D shape

distinct 3D shape

structure ↙

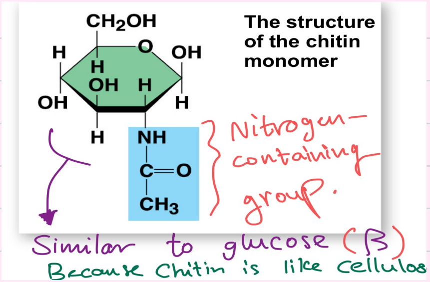
4) Chitin كايتن

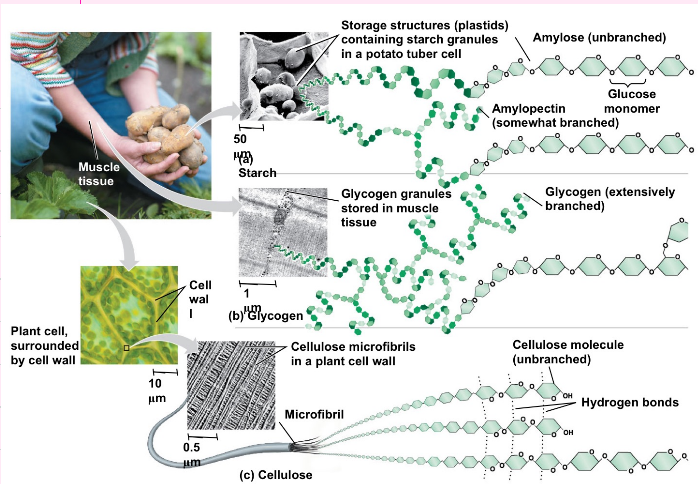
↳ rigid



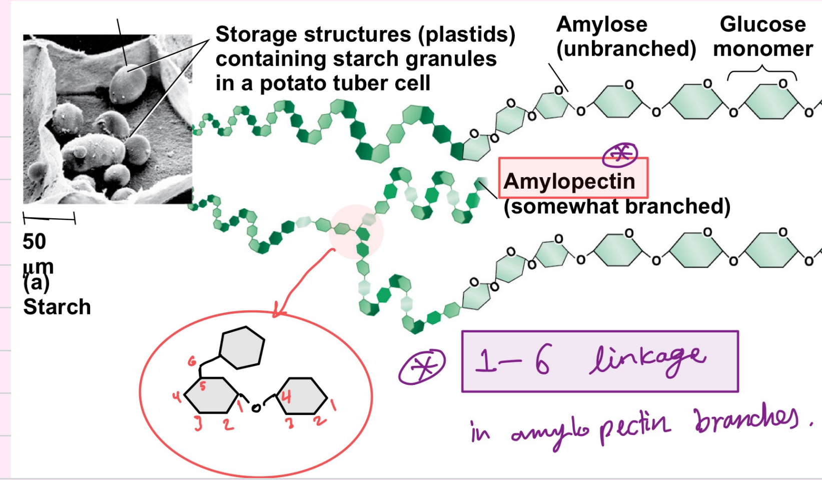
↳ it found in → the cell wall of Fungi (الفطريات)
↳ المفصليات arthropod's exo skeleton → to protect the soft body
↳ Surgical threads → Can decompose by it self.
↳ Flexible
↳ stretchable

IMP → Chitin is decomposed using different enzymes called → chitinase

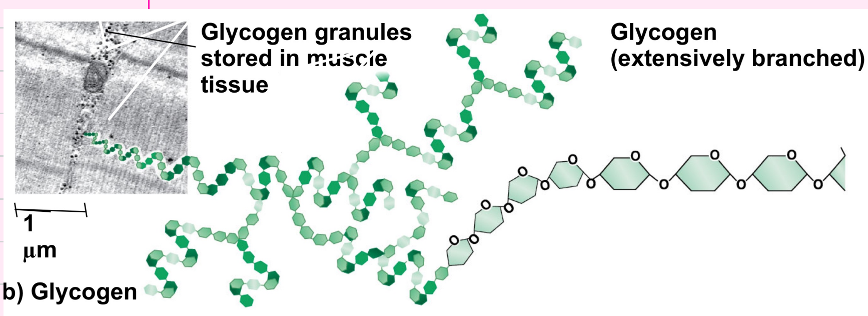




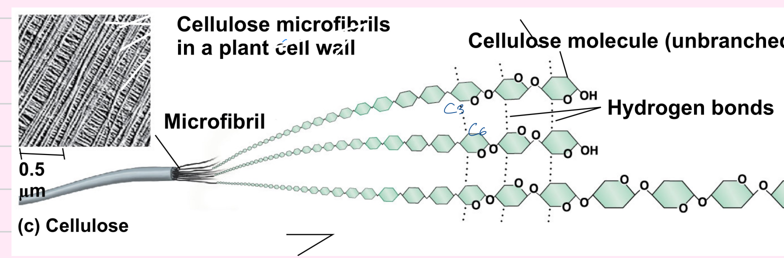
Storage structures (plastids) containing starch granules in a potato tuber cell
Amylose (unbranched)
Glucose monomer
Amylopectin (somewhat branched)
50 µm
(a) Starch
Muscle tissue
Glycogen granules stored in muscle tissue
Glycogen (extensively branched)
1 µm
(b) Glycogen
Cell wall
Plant cell, surrounded by cell wall
10 µm
Cellulose microfibrils in a plant cell wall
Cellulose molecule (unbranched)
Hydrogen bonds
Microfibril
0.5 µm
(c) Cellulose



Storage structures (plastids) containing starch granules in a potato tuber cell
Amylose (unbranched)
Glucose monomer
Amylopectin (somewhat branched)
50 µm
(a) Starch
1–6 linkage
in amylo pectin branches.



Glycogen granules stored in muscle tissue
Glycogen (extensively branched)
1 µm
b) Glycogen



Cellulose microfibrils in a plant cell wall
Cellulose molecule (unbranched)
Hydrogen bonds
Microfibril
0.5 µm
(c) Cellulose

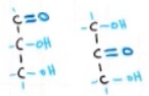
Molecules of Life

Carbohydrates السكريات

fuel + building (structure) ++

① monosaccharides

- Poly hydroxy (OH) → Aldehyde / Ketone
- # of Cs ≥ 3 — tri, tetra, Penta, hexa (3, 4, 5, 6)

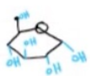


- formula $C_n H_{2n} O_n$

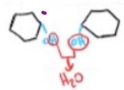
$C_5H_{10}O_5$ $C_3H_6O_3$ $C_7H_{14}O_7$

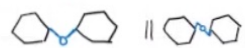
- linear → Cyclic

ex
1. Glucose
2. Fructose
3. Galactose



② Disaccharides





ex
1. Maltose Glu-Glu الشعير
2. Sucrose Glu-Fru الأبيض
3. Lactose Glu-Gala الحليب

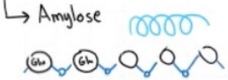
③ Polysaccharides

Storage + structure

نشا نباتي

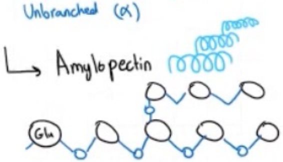
Storage — 1 Starch (Plastid)

↳ Amylose



Unbranched (α)

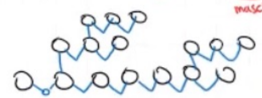
↳ Amylopectin



Branched (α)

نشا حيواني

Storage — 2 Glycogen



↑↑ Branched (α)

structure — 3 Cellulose

Cell wall of Plants

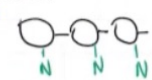
rigid قوي

unbranched

fibers

humans cannot digest

Structure — 4 Chitin



- Cell wall of fungi فطريات
- exo skeleton خارجي

From Karam Darweesh lecture ♥

Lipids :-

waxes
Pigments.

→ large Molecules, but not big enough to be considerd as macromolecules

→ not polymers.

→ all Lipids are (hydrophobic) → no afinity to water

↳ This behavior based on lipids' structure " carbonate "

→ lipids consist hydroCarbon regions.

why are lipids are excluded from macromolecules

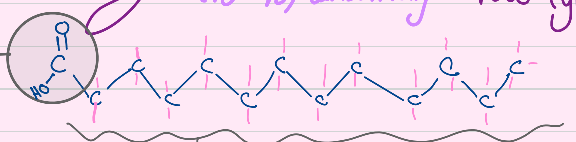
↳ because → lipids are not large enough.
→ lipids don't have true polymers.

✱ Fatty acids. Carboxylic acid.

(16–18) carbon long

two types → saturated مشبع
بالنسبة للهيدروجين
→ unsaturated غير مشبع

carboxel group ←



↳ hydrocarbon chain

all single bonds

easy to arrange

double bond. رابطة ثنائية

⇓

Caused in (kink) طعجة

hard to arrange because of the kink

affect the consistancy ← occurrence in bending.

solid ↔ liquid

kink

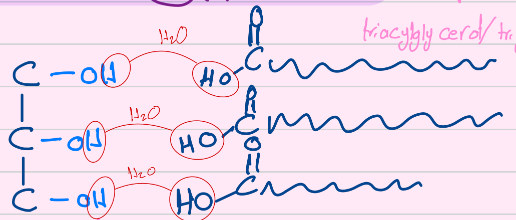
if it naturally happened → Cis bond
صحي
if it happened by human → trans bond

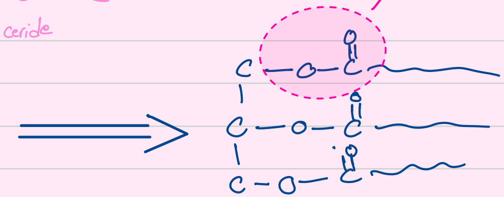
↳ strait and un-branched.

↳ It is too long Carbolicclic acid (16-18) Carbon

* Fat or Oil [TAG]

triacylglycerol / triglyceride





This fatty acids could by the same or different kinds

إنتبه إنها أحادية
لو أنها ثنائية لأصبحت سكريات

glycerol — 3 Fatty acids

↳ 3 carbon alcohol with hydroxyl group attached to each one (tri)

Functions: long term energy / Isolation (ميكانيكي / حراري / كهربائي) (الكسرة)

- 1g Fat → 9 Cal
- 1g sugar → 4 Cal

إذا أكلت سكريات بشكل كبير ← يخزن ما يستطيع بشكل جلايكوجين
ولكن جزء كبير منه يخزن بشكل دهون
في الـ "Adipose tissue"

two types of Fats

according to no. of Carbons. type of fatty acids (saturated / unsaturated).

at least 1 double bond in H – C skeleton.

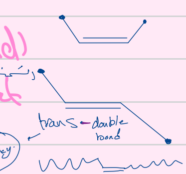
Solid — Liquid

Saturated fatty acids — unsaturated fatty acid

"The Trans fat"

un Sat. (liquid) ~ hydrogenation ~ Sat. fat (Solid) { Trans. Fat

هدرجة



without kink

↑ cardiovascular disease

They are packed ← Saturated fat — Semisolid (مرجرين)

الدهن الحيواني / الزبدة — Lard.

unSaturated fat → unpacked fats. — better for health

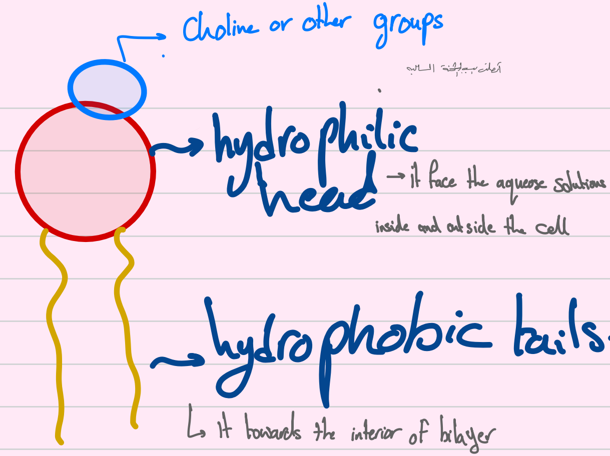
الزيت النباتي / fatts of fishes.

* Phospholipids

functions

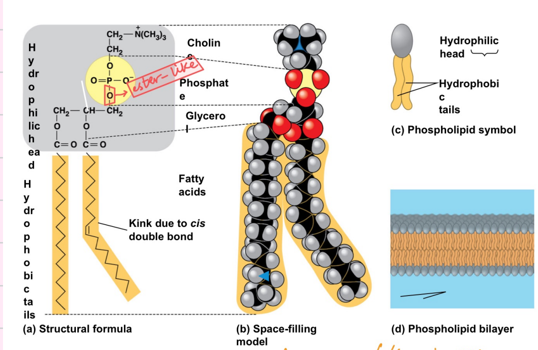
the major constituent of cell membranes.

سلوك متضارب
ambivalent behavior to water



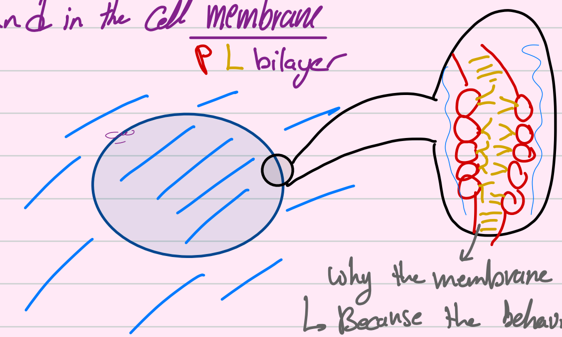
Note:- the Phosphate has the negative charge of the cell

↳ It found in the cell membrane
PL bilayer



(a) Structural formula (b) Space-filling model (c) Phospholipid symbol (d) Phospholipid bilayer

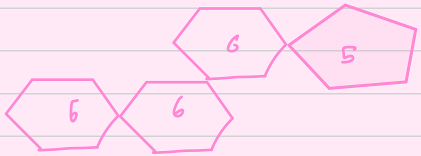
* Next 3 slides are fake: images
send to back to see Highlights



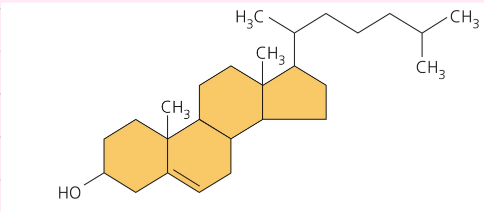
why the membrane is bilayer?
↳ Because the behavior of phospholipids with water.
↳ hydrophobic and hydrophilic in the same time → it will self assemble into double layers sheet.

it found in Plasma membrane and internal membrane

* Steroids



Steroids are lipids characterized by a carbon skeleton consisting of four fused rings. Different steroids are distinguished by the particular chemical groups attached to this ensemble of rings.



→ Cholesterol

↳ it is a part of every animal ~~cell~~ plasma. membrane

↳ increasing the risk of cardio vascolar disease.

↳ serve as precursor to form hormones.

Examples → sex hormones (not all hormons are steroids)

↳ It is synthaised in liver

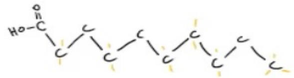
the high level of cholesterol cause atherosclerosis.

Lipids

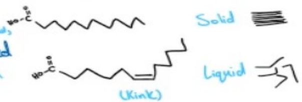
large molecules — الدهنيات
not polymer

(hydrophobic)

⊛ Fatty Acids



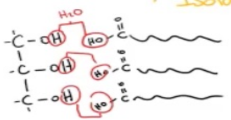
- Saturated — all single bonds — Solid
- Unsaturated — double bond — Liquid



⊛ Fat or Oil [TAG]

· Long term Energy
· Isolation

نسيج دهني
"Adipose"



glycerol — 3 FA

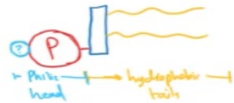
* Ester bond

- Sat. — Solid
- UnSat. — Liquid
  "Oil"
  better for health

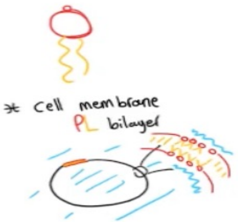
دهون متحولة
:C "Trans Fat"

UnSat. ~ hydrogenation → Sat. → trans

⊛ Phospholipid



* cell membrane
PL bilayer



⊛ Steroids

* cholesterol
Part of every animal cell membrane

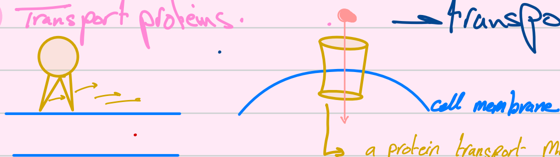
:C ↑ risk of CV disease

Proteins

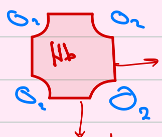
- unlimited functions. = unlimited structure.
- It presents 50% of dry mass
- most diverse.

Some types:-

1- Transport proteins. → transporting substances



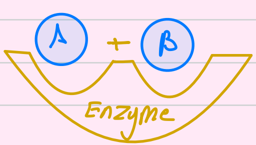
→ a protein transport molecules through the cell membrane.



→ the iron-containing of vertebrate blood → transport oxygen from lungs to other parts of body.

hemoglobin. → storage of O_2

2- Enzyme (protein catalyst)



→ A-B

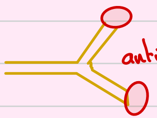
→ selective acceleration (speedup) of chemical reaction

it called chemical agents
- because enzymes can perform its function over and over again

Ex: Digestive enzyme such as

Maltose → catalyze (Maltose + H_2O → 2 glucose)

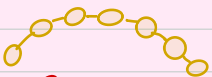
3- Defensive proteins



→ Protection against disease

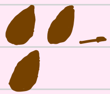
antibodies → inactivate viruses and bacteria

4- Storage of Amino Acids proteins



Casein → milk protein → the major source of amino acids for baby mummales → humans don't have this type of proteins.

بروتين تعطيه الأمهات للأطفال لاستخدام الأحماض الأمينية في صناعة بروتينات ← antibodies صناعة الانزيمات - transport ...

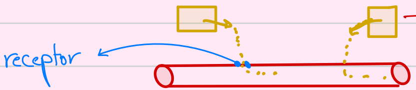


Seeds of Plants → storage proteins.

→ Ovalbumin is the protein of egg while used as a source of amino acids for developing embargo تعطيه الدجاجة للجنين

5- Hormonal proteins

→ Coordination of an organism's activities.



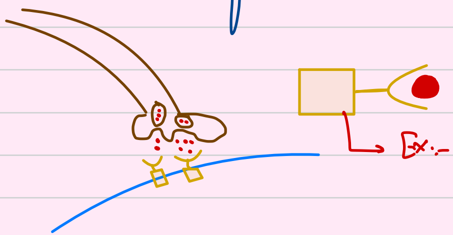
→ Insulin → hormone is secreted by pancereas.

↳ Cause other tissue to take up glucose.

↳ regulating blood sugar concentration.

6- Receptor proteins:-

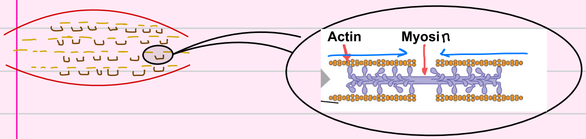
↳ Response of cell to chemical stimuli



↳ Ex.:- Receptors built into the membrane of nerve cell detect signaling molecules released by other nerve cells.

7- Contraction proteins:-

↳ Function → movement.



→ Myosin and Actin are responsible about the contraction of muscles

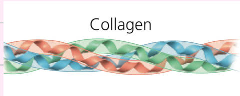
→ Motor proteins are responsible about the undulation (تموجات) of cilia (اهداب) and flagella (اسواط)

7- Structural proteins :-

↳ Function → support.

Ex → keratin → it is the protein of hair, horns (قرون), feathers (ريش) and Skin

↳ Insects and spiders use silk fibers to make their cocoons and webss.



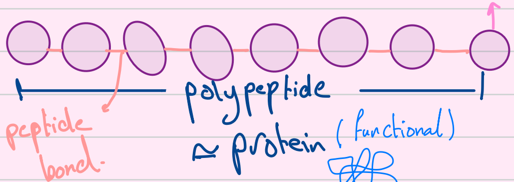
Collagen and elastin proteins provide fibrous framework in animal connective tissues.

⇓ strength

البروتين الأكثر وجودًا في الجسم
يعطي قوة أينما كان

البروتينات أستطيع إستخدامهم للطاقة في حالة الحاجة حيث أولوية الإستهلاك هي للسكريات والدهون في الجسم

⇒ Protein's structure :-



≃ protein (functional)

- protein is a polymer
- and it's monomer are the amino acids. (organic molecule)

ما الفرق بين مسمى الـ polypeptide و الـ protein ؟
تسمى سلسلة الأحماض الأمينية polypeptide
ولكن عندما تأخذ الشكل المحدد والوظيفة المحددة تسمى protein

Amino Acids

ترتيب الذرات ثابت
$NH_2 - C_\alpha - C(=O) - OH$
ع اليسار — ع اليمين

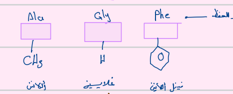
α asymmetric Carbon (غير متماثل)

$$NH_2 - \overset{H}{\underset{R}{C}} - \overset{O}{\overset{\|}{C}} - OH$$

→ Carboxyl group

→ back bone
ثابت بكل الأحماض الأمينية

Ex:-



Gly → asymmetric protein.

R side chain. ← سبب اختلاف الأحماض الأمينية عن بعضها لأنها تحدد الخصائص الفيزيائية والكيميائية للحمض الأميني

- Polar hydrophilic ← مبادئًا ع ذلك يتم تقسيم الأحماض الأمينية
  تم يوجد تشابه بين بعض الأحماض ولكن كلهم بالأخير بينهم إختلاف جيد
  - non charged ($-\delta$, $+\delta$)
  - charged
    - + Basics
    - − Acidic
- non.Polar hydrophobic
  - خطي
  - حلقي

Proteins are unbranched

the classification of amino acids depends on side chain

the naming of amino acids
- full name.
- 3 letters abbreviation
- 1 letter abbreviation

There is a huge no. of amino acids, but just 20 amino acids are used in our proteins

كم حمض اميني في جسم الإنسان؟ أكثر من 20 // كم حمض أميني يدخل في تصنيع البروتينات؟ 20.

خصائص الأحماض الأمينية تحدد بـ R-side chain

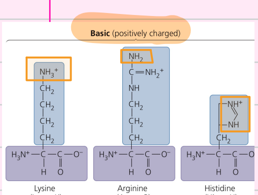
Polar
hydrophilic

Polar → Polar = قطبي اي هنالك شحنات تشكل أقطاب

charged

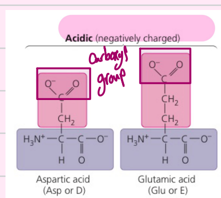
Positive
Basics

بسبب وجود Amino group في ال side chain



Negative
Acids

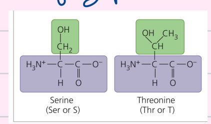
بسبب وجود Carboxyl group في ال side chain

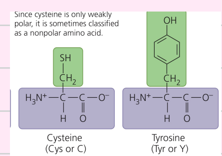


No charge
but we have δ^- δ^+

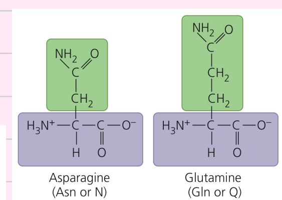
slightly (-) slightly (+)

Slightly positive



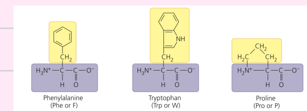


Slightly negative

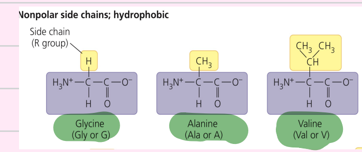


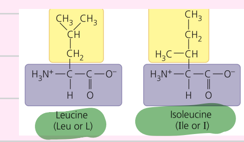
Non-polar
hydrophobic

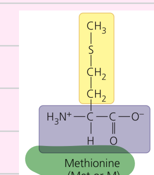
ring side chain



liner Slide chain

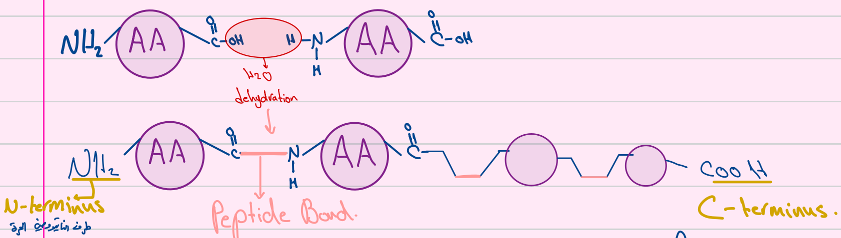






أولاً ChatGPT من إمتحانات الحفظ ⇐ رح يبدع

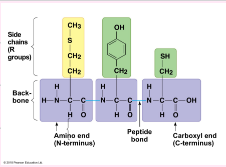
Building a protein:-

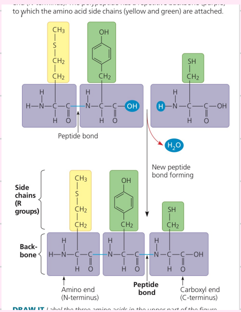


Every specific polypeptide has a unique linear sequence of amino acids.

If you were asked about the no. of H_2O that are released →

no. peptide bond = no. H_2O = no. amino acids − 1





The function depends on 3d shape.

↳ 3d shape depends on AA sequence.

models:-

space filling — Ribbon — Wire frame

the sequence of amino acids → detairmine the 3D shape of proteins.

the 3D shape structure → determine how the protein works

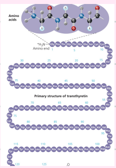
the function of proteins → depends on the ability to recognise other molecules.

Protein structure :-

↳ There are 4 stages of structures:-

the sequence of AA —determine→ the 3d shape of the proteins. —determine→ the function of the protein

Primary → the sequence of AA

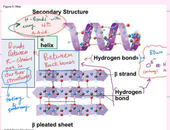


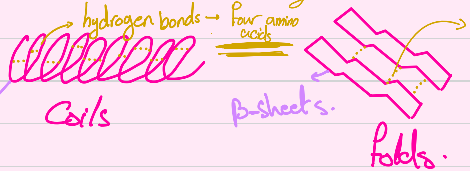
amino end ← T – G – Y – A – B – C – C – D → carboxyl end

→ encoded by genes

Example from the book
transthyretin → blood protein / thyroid's hormone
↳ transport Vitamin A
↳ It made up from 4 polypeptide
each one is formed from 127 amino acid

Secoundary → the local shapes





hydrogen bonds → between every four amino acids

α helix — Coils — β-sheets. — Folds.

There are hydrogen bonds between ($O^{-\delta}$ / $H^{+\delta}$) in the back bone of amino acids which work to fix and stabilis the Secondary structure of the protein.

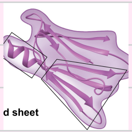
Secondary structure
- α helix — on globular كروي proteins
- β-sheets — on fibrous proteins like spider's web

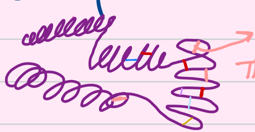
Note → H-bonds occurred between
- back bones together → in secondary
- Chains together → tertiary / Quaternary

hydrogen bonds in α helix between (1-4) (2-5) (5-7)

Tertiary :-

↳ 3d shape / the overall shape of proteins





a various types of bonds
- Covalent (disulfide Bridge) → very strong S–S
- non covalent
  - (Ionic Bonds) + −
  - (hydrogen bonds) δ^- δ^+
  - hydrophobic bonds
  - Van der waals.

IMP

روابط ضعيفة ولكن مع بعضها قوية

There are bonds between atoms in R-chains in the amino acids which work to fix the tertiary shape of the protein

تكون هذه التفاعلات في الأجزاء الكارهة للماء من البروتين
حيث هي تبتعد عن الماء تقترب جزيئاتها من بعضها فتشكل هذه الروابط الضعيفة

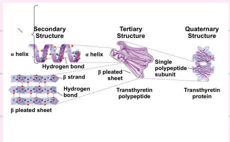
* the bonds between (R-chains) are found only in Tertiary and Quarternary structures.

Quaternary

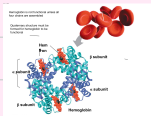
→ not all proteins have the quaternary because it formed from one sub unit.

(1) (2)

Quaternary > 1 subunit

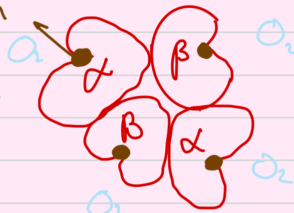


Example of proteins



Hemoglobins
→ Quaternary رباعي
→ It is a globular protein

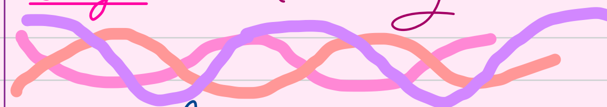
Iron
called heme
ترتبط بالأكسجين



O_2 → 4 subunits
- 2β strand
- 2α helix

Collagen → Quaternary

Structural protein



↳ fibrous protein / tubular structure.

↳ 3 identical polypeptide coils like a rope

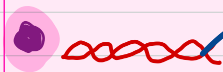
↳ accounts to 40% proteins in humans body.

Protein of hair (α keratin) → has many α helices so do the silk hair

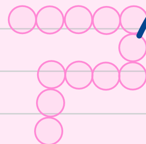
Note: fibrous proteins: has many β sheets

→ There are a hydrophobic core in all proteins.

What determines the structure?



genetic information → translated to →



primary protein. → converted to → by hydrogen bonds between the back bone.

Secoundary structure of a protein →

Tertiary structure → very complecated

→ a various types of bonds (covelant + not covelant) bonds between R-chains of proteins.

Conditions :-

→ pH, [salt], temp, The solvant

↳ all this conditions and others play a role / affecting factor in manufacturing proteins structures

One single change in the primary structure may affect the structure and the function

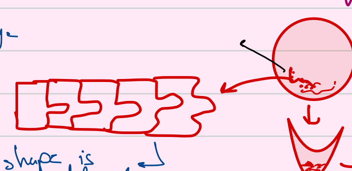
الخلل الجيني ← عمل على تغيير شكل الهيموغلوبين
← وصاروا الهيموغلوبين يرتبطوا ببعض
← مما شكل ثقل أسفل كرة الدم
← حتى جعلها تتقوس بشكل منجل

Example of disease :-

Inhavated ← **Sickle Cell Anemia** → inhavated disease

the normal process. ← gene → primary → Secoundary → tertiary → quandary → normal hemoglobine → Carry oxygen normally
(normal, normal, normal, normal, normal)

un normal process ← change in gene (6th Glu → 6th Valine) → change in 1° → change in 2° → change in 3° → change in 4°



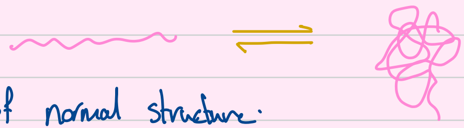
the shape is deformed. — sickle shape → the capacity to carry O_2 is reduced.

- **Alzheimers** ← ترسب بروتين في الدماغ ← النسيان
- **Parkinson** ← ترسب بروتين في منطقة تنظيم الحركة ← رجفا
- **Mad cow**

} mis folded protein

denaturation ⇌ renaturation

إفلات شكل البروتين الطبيعي

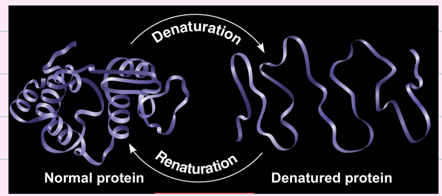


إعادة شكل البروتين الطبيعي

any change in conditions can cause a denaturation to the protein. Some not all proteins are able to renaturate when the conditions returns normal again.

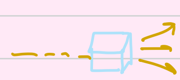
loss of normal structure.
(function)

- ↳ it may happen if the protein is placed in polar solvent
- ↳ biologically inactive



⊗ how we study the 3d shape :-

→ X-ray Crystallography



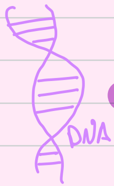
تجميد البروتين ← إسقاط إشعاع x-ray

→ Nuclear magnetic Resonance spectroscopy الرنين المغناطيسي

→ Crystallization

– Bioinformatics. → prediction protein structure from amino acid sequences.

Nucleic Acids



- The genes → consist of DNA which belongs to Nucleic Acids.
- DNA has the codes which determine the consequence of amino acids in the primary structure of proteins.

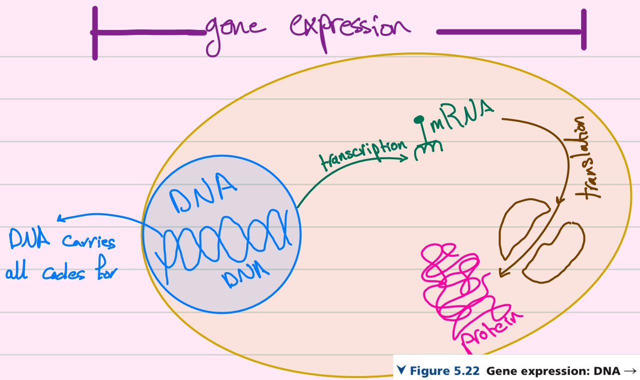
codes → Proteins → morphological qualities
↳ functional proteins.

1 gene = 1 protein

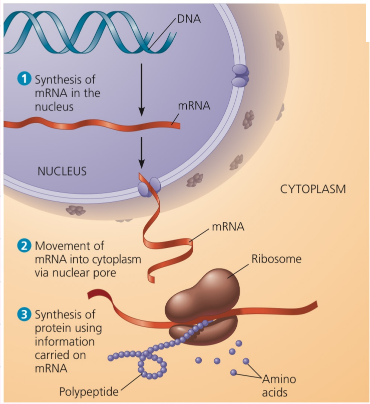
If the primary structure of polypeptides determines a protein's shape, what determines primary structure? The amino acid sequence of a polypeptide is programmed by a discrete unit of inheritance known as a **gene**. Genes consist of DNA, which belongs to the class of compounds called nucleic acids. **Nucleic acids** are polymers made of monomers called nucleotides.

We have two types of Nucleic acids → Deoxyribonucleic acids (DNA)
↳ Ribonucleic acids. (RNA)

Note: DNA provides directions for its own replication
also it direct RNA synthasis.



↳ know it in general:

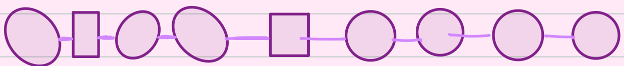


▼ **Figure 5.22 Gene expression: DNA → RNA → protein.** In a eukaryotic cell, DNA in the nucleus programs protein production in the cytoplasm by dictating synthesis of messenger RNA (mRNA).

to proteins? A given gene along a DNA molecule can direct synthesis of a type of RNA called *messenger RNA* (*mRNA*). The mRNA molecule interacts with the cell's protein-synthesizing machinery to direct production of a polypeptide, which folds into all or part of a protein. We can summarize the flow of genetic information as DNA → RNA → protein (see Figure 5.22). The sites of protein synthesis are cellular structures called ribosomes. In a eukaryotic cell, ribosomes are in the cytoplasm—the region between the nucleus and the plasma membrane, the cell's outer boundary—but DNA resides in the nucleus. Messenger RNA conveys genetic instructions for building proteins from the nucleus to the cytoplasm. Prokaryotic cells lack nuclei but still use mRNA to convey a message from the DNA to ribosomes and other cellular equipment that translate the coded information into amino acid sequences. Later in the

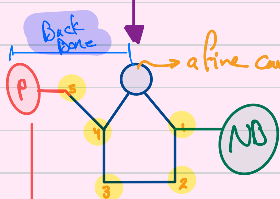
Genes are inherited from the parents and each 1 chromosome contain one long DNA molecule, usually carrying hundreds of genes.

Nucleic Acid → called "polynucleotides" "polymer"



↳ the monomer

nucleotide



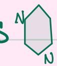
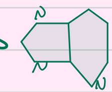
→ a five carbon Sugar

Phosphate group + « Pentose » + Nitrogenous Base

Nucleoside ~ without phosphate.

Nucleotide.

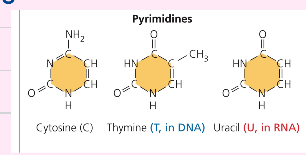
⁂ NB

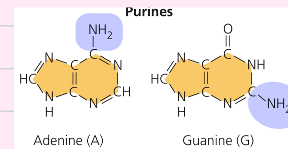
↳ Pyrimidines  → Purines 

→ from the Bodes they differ in the chemical groups attached to the ring

خماسي + سداسي

C	U	T	A	G
cytosine	uracil	Thymine	Adenine	Guanine

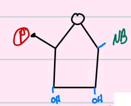


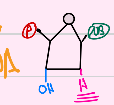


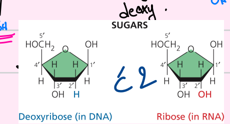
حجم أصغر ← حلقة أكبر

حجم أكبر ← حلقة أصغر .

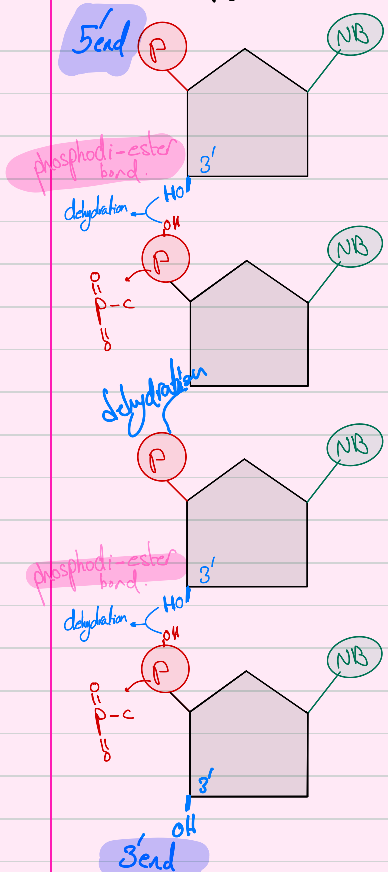
Pentose

RNA 

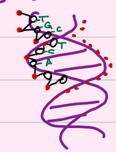
DNA → deoxy . 



The poly nucleotide



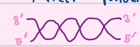
1 DNA



Deoxy ribose
↳ lacks an oxygen atom
On the second carbon in the ring.

⇒ Double helix
↳ DNA replication.

⇒ "Anti - Parallel"

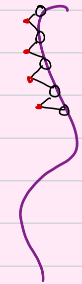


3' → 5'
5' ← 3' أنهم متعاكسين

hydrogen bonds
A ----- T → found only in DNA
G ----- C

2 RNA

↳ mostly single



mRNA → حامل الكودات
tRNA → تنقل amino acids في عملية الترجمة
rRNA → يصنع البروتين

hydrogen bond
C --- G
A --- U
↳ It only found in RNA

The Components of Nucleic Acids

Nucleic acids are macromolecules that exist as polymers called **polynucleotides (Figure 5.23a)**. As indicated by the name, each polynucleotide consists of monomers called **nucleotides**. A nucleotide, in general, is composed of three parts: a five-carbon sugar (a pentose), a nitrogen-containing (nitrogenous) base, and one to three phosphate groups **(Figure 5.23b)**. The beginning monomer used to build a polynucleotide has three phosphate groups, but two are lost during the polymerization process. The portion of a nucleotide without any phosphate groups is called a *nucleoside*.

To understand the structure of a single nucleotide, let's first consider the nitrogenous bases **(Figure 5.23c)**. Each nitrogenous base has one or two rings that include nitrogen atoms. (They are called nitrogenous *bases* because the nitrogen atoms tend to take up H^+ from solution, thus acting as bases.) There are two families of nitrogenous bases: pyrimidines and purines. A **pyrimidine** has one six-membered ring of carbon and nitrogen atoms. The members of the pyrimidine family are cytosine (C), thymine (T), and uracil (U). **Purines** are larger, with a six-membered ring fused to a five-membered ring. The purines are adenine (A) and guanine (G). The specific pyrimidines and purines differ in the chemical groups attached to the rings. Adenine, guanine, and cytosine are found in both DNA and RNA; thymine is found only in DNA and uracil only in RNA.

Now let's add the sugar to which the nitrogenous base is attached. In DNA the sugar is **deoxyribose**; in RNA it is **ribose** (see Figure 5.23c). The only difference between these two sugars is that deoxyribose lacks an oxygen atom on the second carbon in the ring, hence the name *deoxy*ribose.

So far, we have built a nucleoside (base plus sugar). To complete the construction of a nucleotide, we attach one to three phosphate groups to the 5′ carbon of the sugar (the carbon numbers in the sugar include ′, the prime symbol; see Figure 5.23b). With one phosphate, this is a nucleoside monophosphate, more often called a nucleotide.