تَنوير

BIOLOGY

Lec no :

File Title : Full Chapter 5

Done By : Haneen Frehat

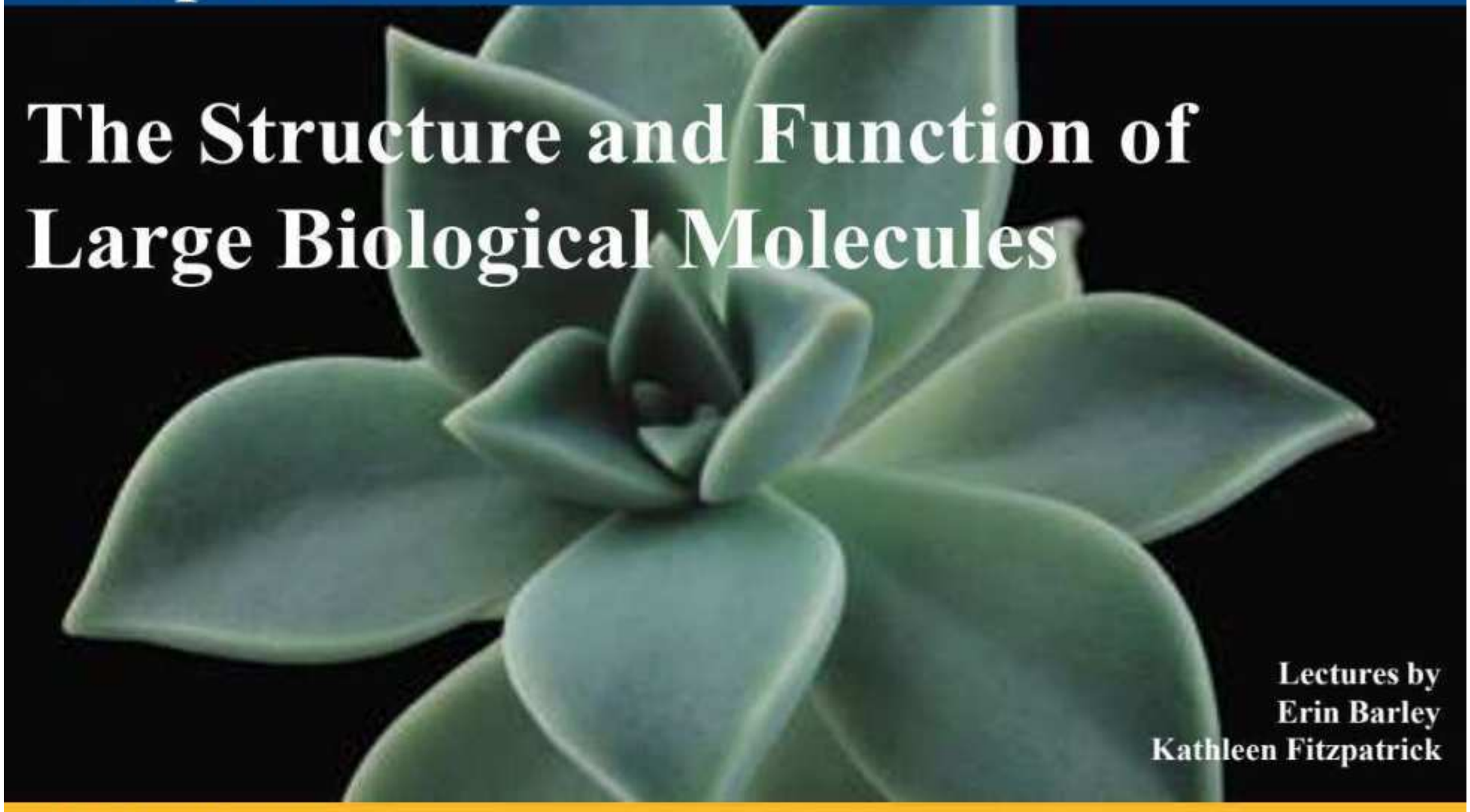
LECTURE PRESENTATIONS

For CAMPBELL BIOLOGY, NINTH EDITION

Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Robert B. Jackson

Chapter 5

The Structure and Function of Large Biological Molecules



Lectures by
Erin Barley
Kathleen Fitzpatrick

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Overview: The Molecules of Life

- All living things are made up of four classes of large biological molecules: carbohydrates, lipids, proteins, and nucleic acids
- **Macromolecules** are large molecules composed of thousands of covalently connected atoms
- Molecular structure and function are inseparable

Micromolecules : are small molecules

The body needs it less such as vitamins

The body needs it more Such as الكاربوهيدرات والدهون والبروتينات والاحماض النووية

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Figure 5.1

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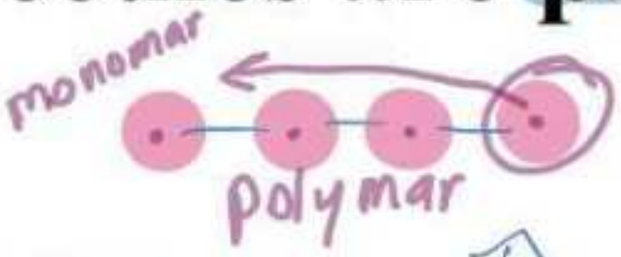
Concept 5.1: Macromolecules are polymers, built from monomers



- A **polymer** is a long molecule consisting of many similar building blocks
- These small building-block molecules are called **monomers**
- Three of the four classes of life's organic molecules are polymers
  - Carbohydrates
  - Proteins
  - Nucleic acids

هدف البناء تخزين الطاقة
وهدف الهدم انتاج كالطاقة

The true polymers :
الكاربوهيدرات ، البروتينات ، الاحماض النووية
Not true plymar :
الدهون

اثناء عملية الاكل يقوم الجسم بتخزين الطاقة اي عملية بناء
لكن عند عدم الاكل يقوم الجسم بعملية الهدم اي استخدام الطاقة
المخزنة فيه اي استخدامها للحركة وتحويل الغذاء لطاقة

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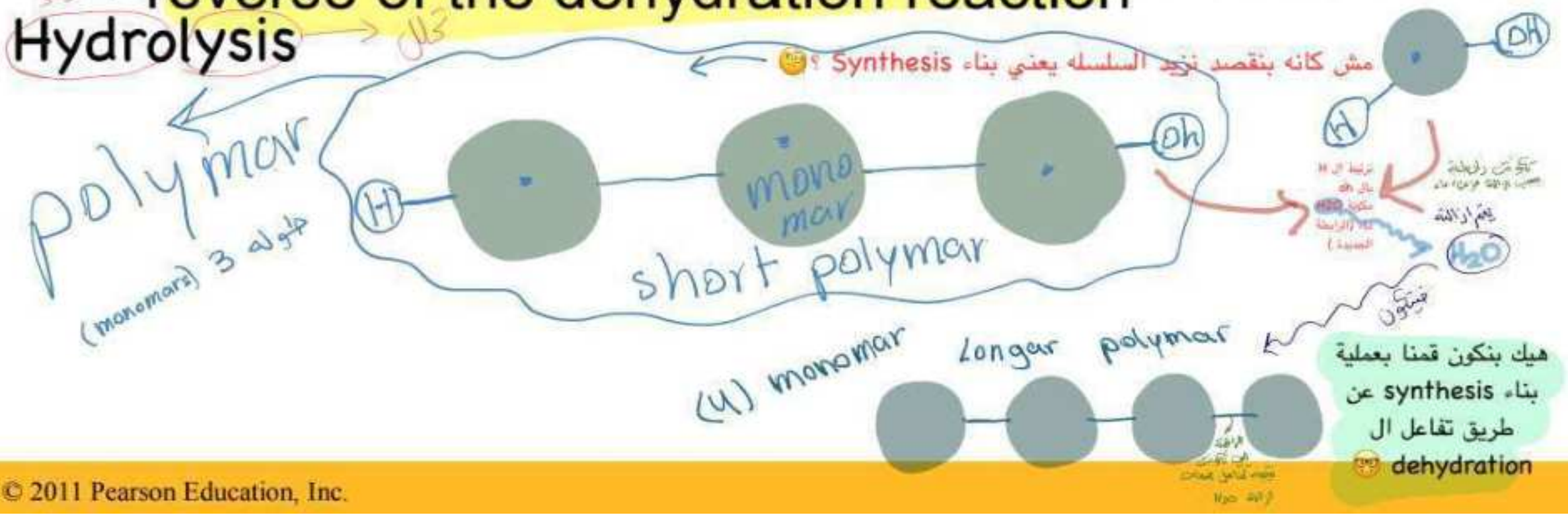
The Synthesis and Breakdown of Polymers

- A **dehydration reaction** occurs when two monomers bond together through the loss of a water molecule
- Polymers are disassembled to monomers by **hydrolysis**, a reaction that is essentially the reverse of the dehydration reaction

Hydrolysis



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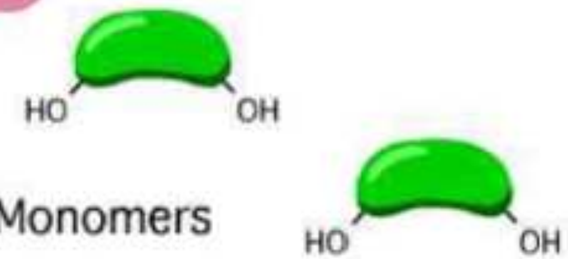
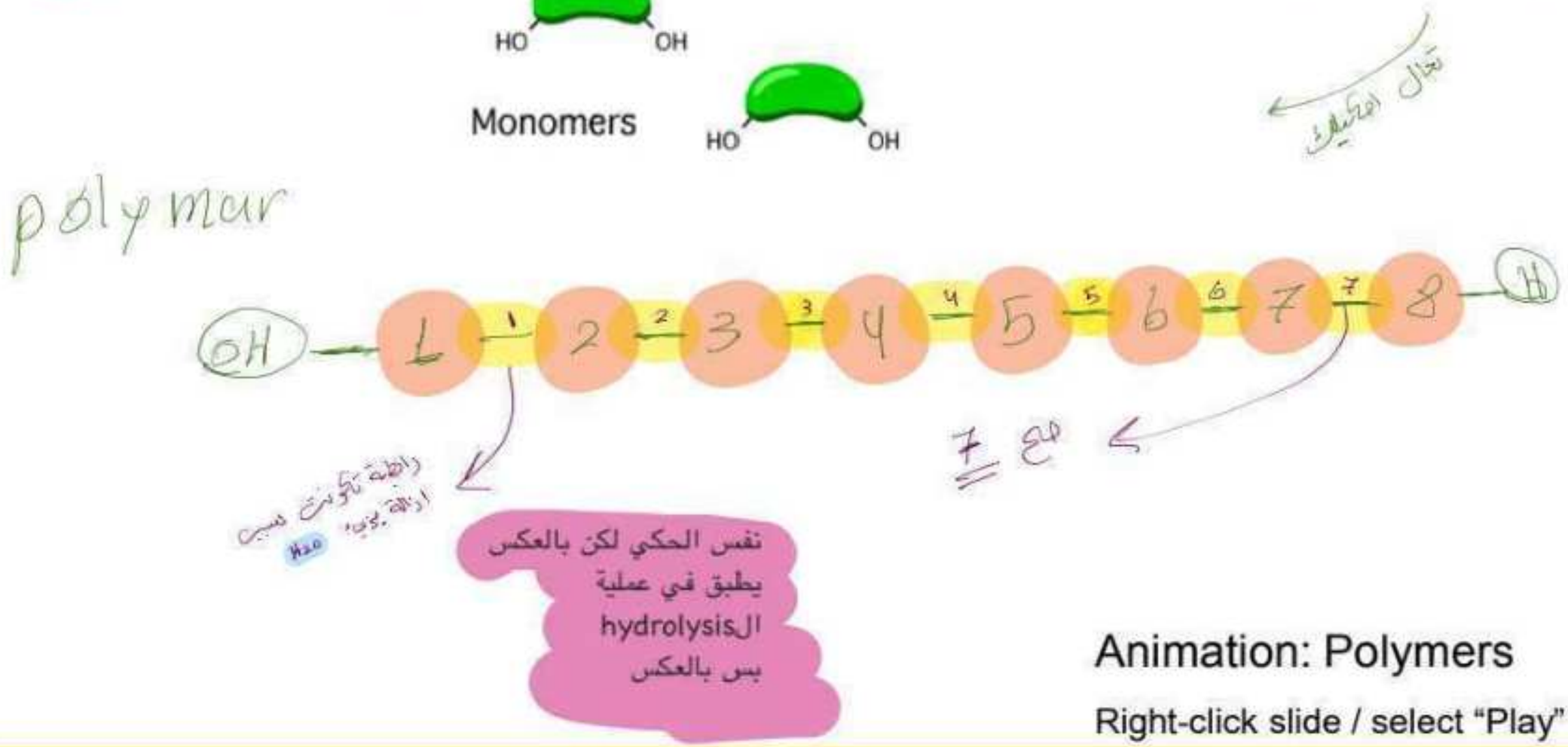
طيب بدي اعمل جزيء
polymar طولة 8
monomar كم جزيء ماء
لازم اشيل ؟ الجواب 7 😂
اوف ليه مش 8 😨

صحصح 🤦

استنتجنا من هالحكي
عدد الروابط او عدد جزيئات الماء المزالة
تساوي
عدد الmomomars ناقص 1





Animation: Polymers

Right-click slide / select "Play"

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Figure 5.2

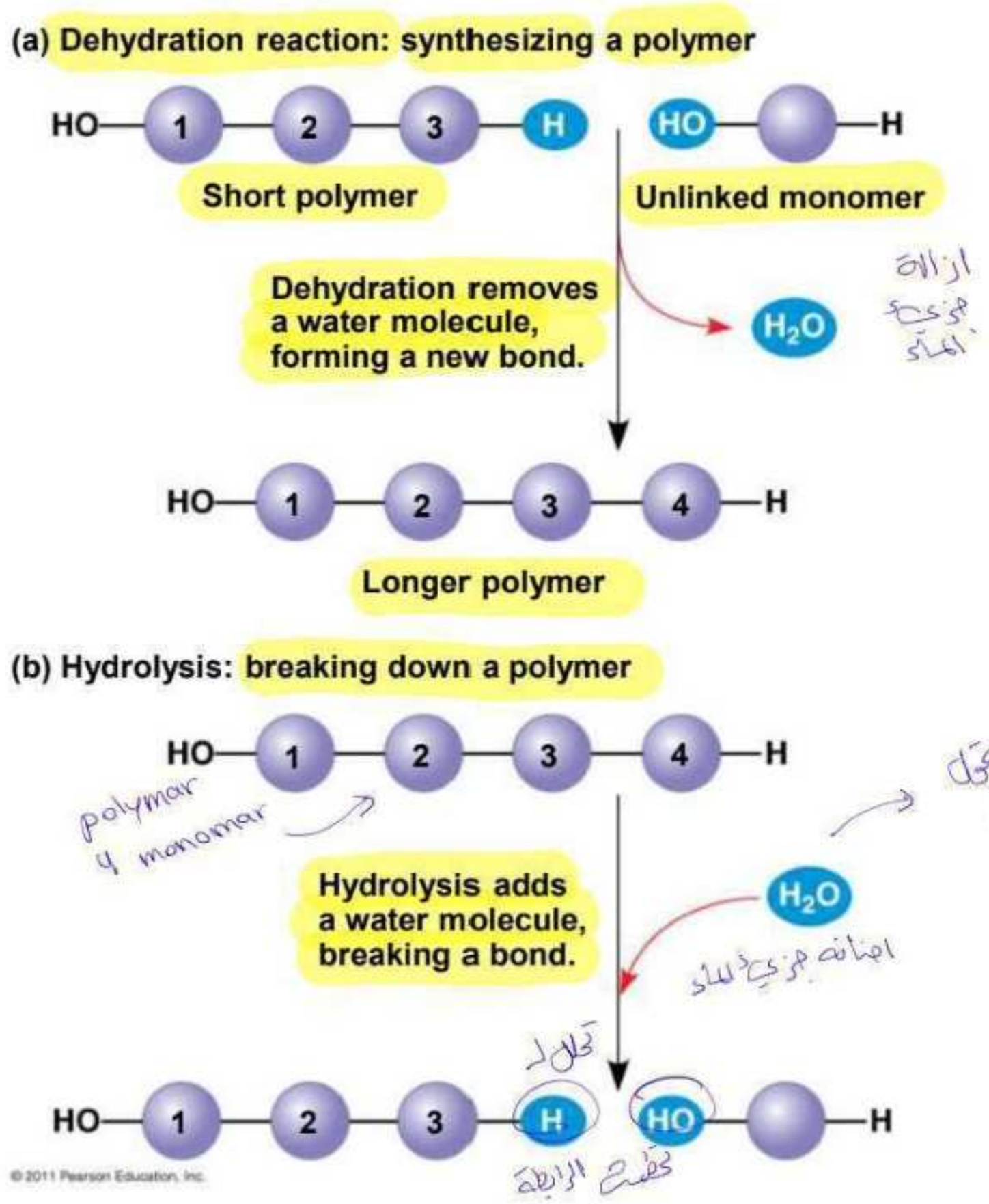
(a) Dehydration reaction: synthesizing a polymer
HO
1
2
3
H
Short polymer
HO
H
Unlinked monomer
Dehydration removes a water molecule, forming a new bond.
H2O
Longer polymer
HO
1
2
3
4
H
(b) Hydrolysis: breaking down a polymer
HO
1
2
3
4
H
Hydrolysis adds a water molecule, breaking a bond.
H2O
HO
1
2
3
H
HO
H
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Figure 5.2a

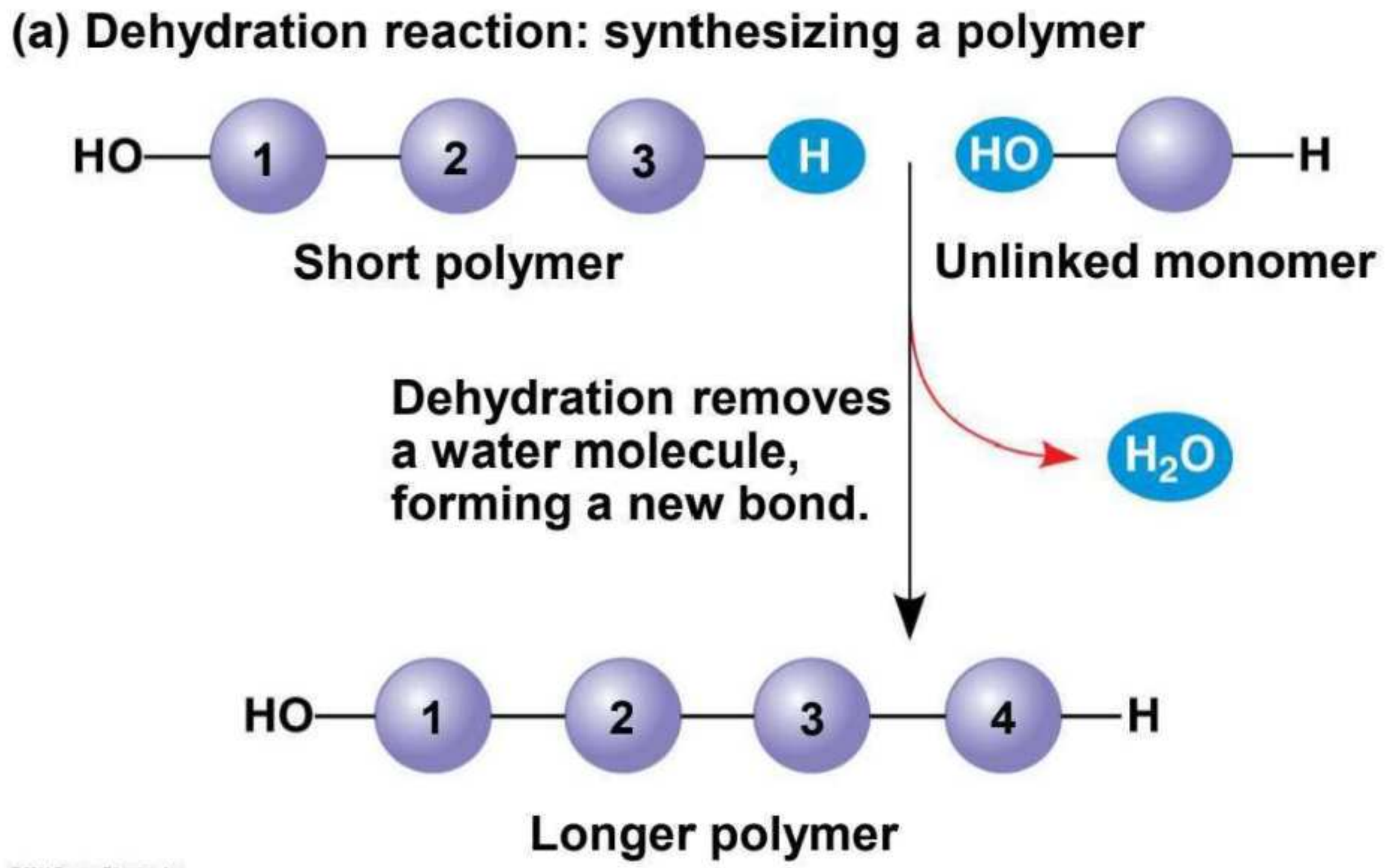

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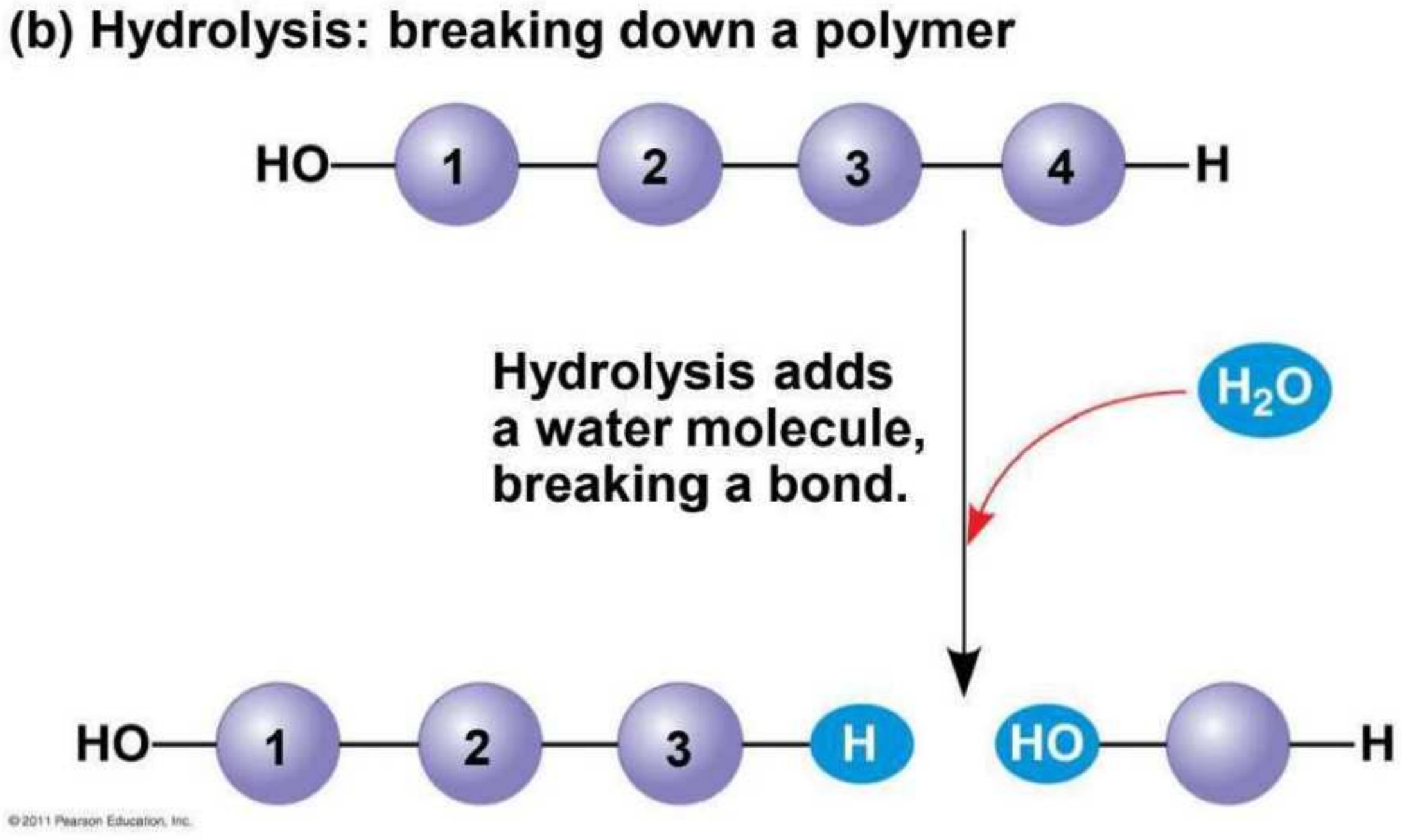
Figure 5.2b



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The Diversity of Polymers

ليش بتتنوع ال polymars
بسبب تنوع الmonomars المكونة لها

- Each cell has thousands of different macromolecules
- Macromolecules vary among cells of an organism, vary more within a species, and vary even more between species
- An immense variety of polymers can be built from a small set of monomers

بدنا نعرف كمان كلما زادت
درجة القرابة كلما زاد
تشابة ال polymars
كيف ؟ بما انها ال polymars احد مكونات
الكائن الحي
طبيعي عند التوائم تكون اكثر تشابة
من الاخوة الغير توائم او من ابناء العم
بسبب التنوع بين الكائنات يوجد تنوع بال polymars

كل ما زادت القرابة زاد لتشابة في ال polymars 😱
بنستفيد من التشابه متى ؟
بعمليات فحوصات التطابق في زراعة عضو او نسيج او خلية

كل مازاد القرب زاد التطابق بال polymars

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Concept 5.2: Carbohydrates serve as fuel and building material

- **Carbohydrates** include sugars and the polymers of sugars
- The simplest carbohydrates are monosaccharides, or single sugars
- Carbohydrate macromolecules are polysaccharides, polymers composed of many sugar building blocks

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Sugars

السكريات الاحادية → not polymar

- **Monosaccharides** have molecular formulas that are usually multiples of CH_2O (غالبًا من مضاعفات)
- Glucose ($C_6H_{12}O_6$) is the most common monosaccharide (أكثر انواع السكريات الاحادية شيوعًا)
- Monosaccharides are classified by
  - The location of the carbonyl group (as aldose or ketose) (حسب موقع مجموعة الكربونيل) C=O
  - The number of carbons in the carbon skeleton

5. السكر يرتبط بمجموعة وظيفية functional group
4. متصاوغات isomers
3. سبب اخر للتنوع هو ممكن يكون السكر الاحادي على شكل حلقة او عمودي rings ←

كيف بنصنف السكريات الاحادية او بشو بتختلف عن بعضها او اسباب تنوعها 🥰؟

موقع مجموعة الكربونيل او
عدد ذرات الكربون

تحالوا عالجدول

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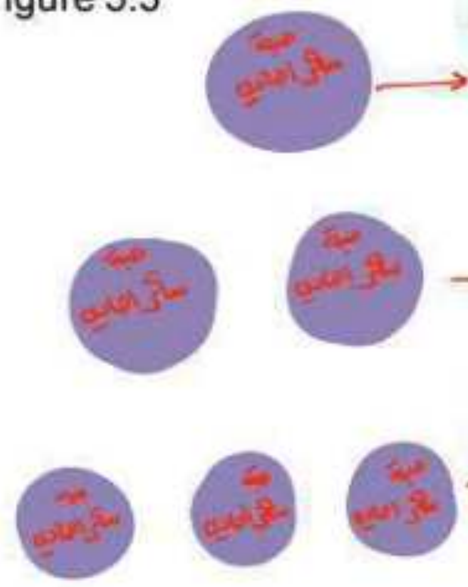
Figure 5.3



اذا صار عندي تنوع بالسكر الاحادي رح يصير تنوع بباقي السكريات 😎

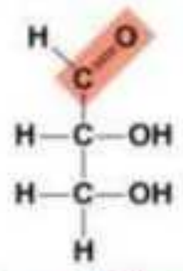
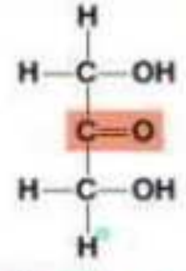
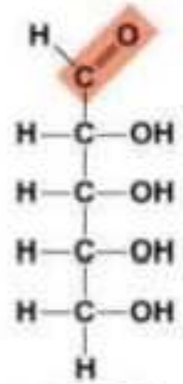
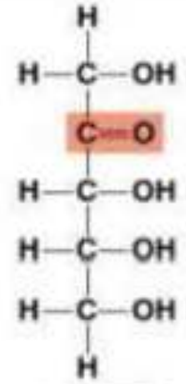
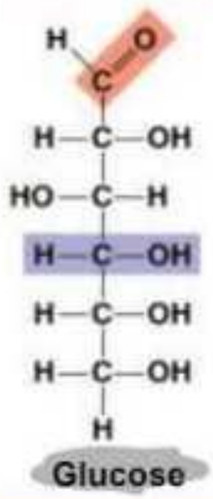
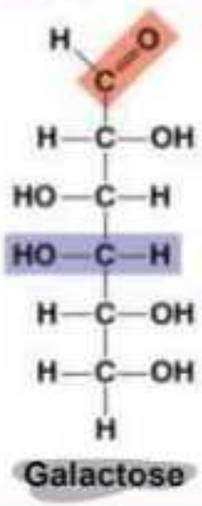
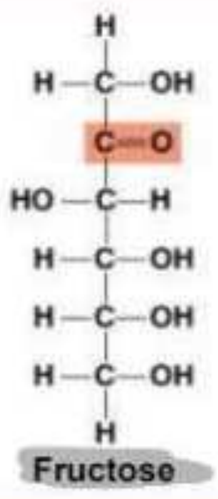
Aldoses (Aldehyde Sugars)	Ketoses (Ketone Sugars)
Trioses: 3-carbon sugars ($C_3H_6O_3$)	
 Glyceraldehyde	 Dihydroxyacetone
Pentoses: 5-carbon sugars ($C_5H_{10}O_5$)	
 Ribose	 Ribulose
Hexoses: 6-carbon sugars ($C_6H_{12}O_6$)	
 Glucose  Galactose	 Fructose

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Figure 5.3a

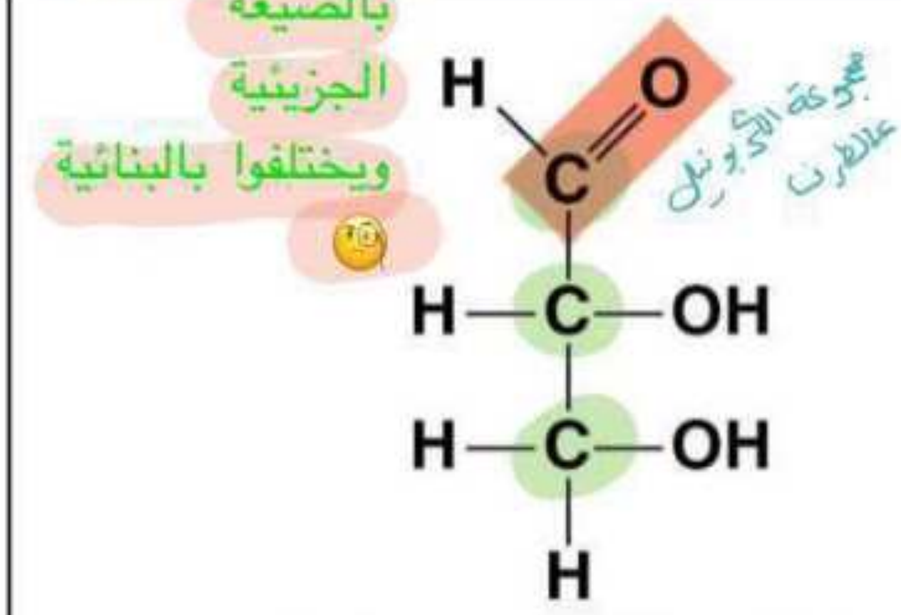
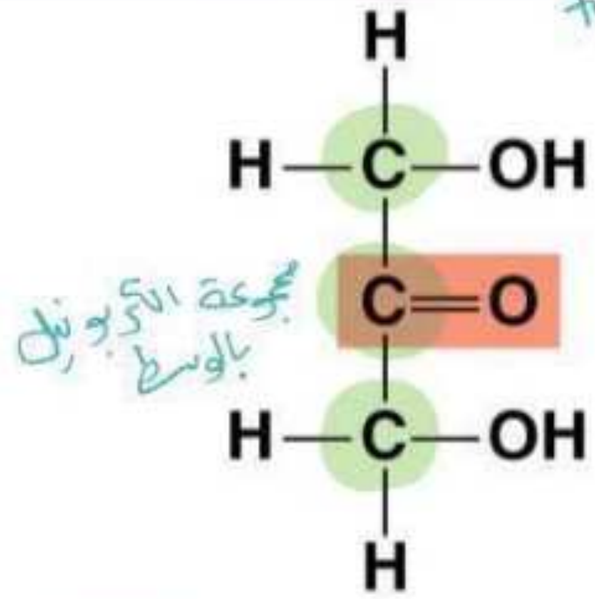
Aldose (Aldehyde Sugar)	Ketose (Ketone Sugar)
Trioses: 3-carbon sugars ($C_3H_6O_3$)	
	
Glyceraldehyde	Dihydroxyacetone

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Figure 5.3b

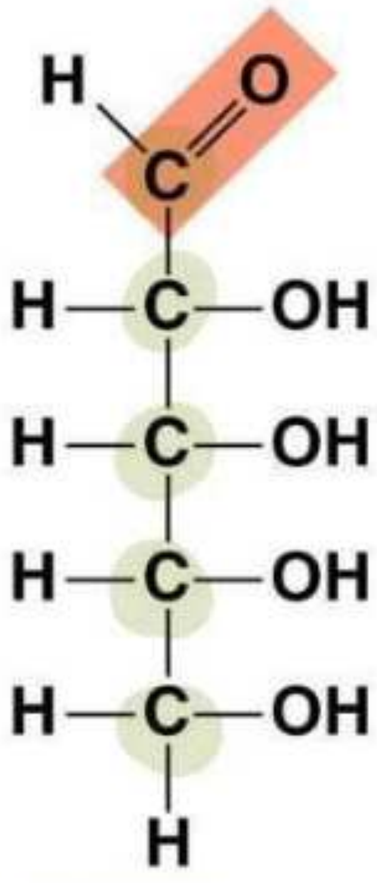
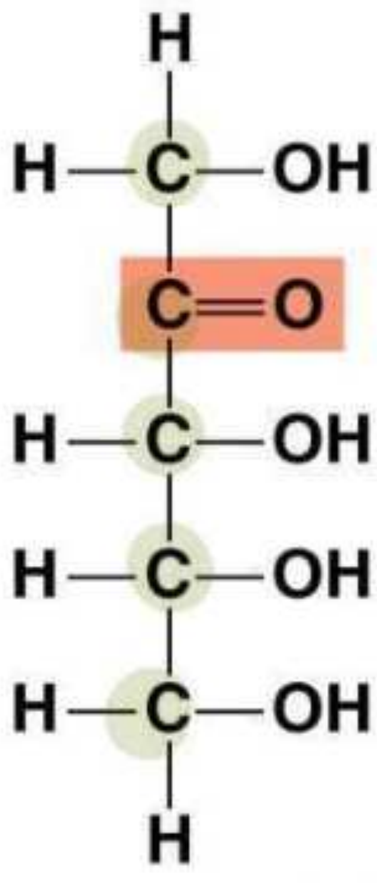
Aldose (Aldehyde Sugar)	Ketose (Ketone Sugar)
Pentoses: 5-carbon sugars ($C_5H_{10}O_5$)	
 Ribose	 Ribulose

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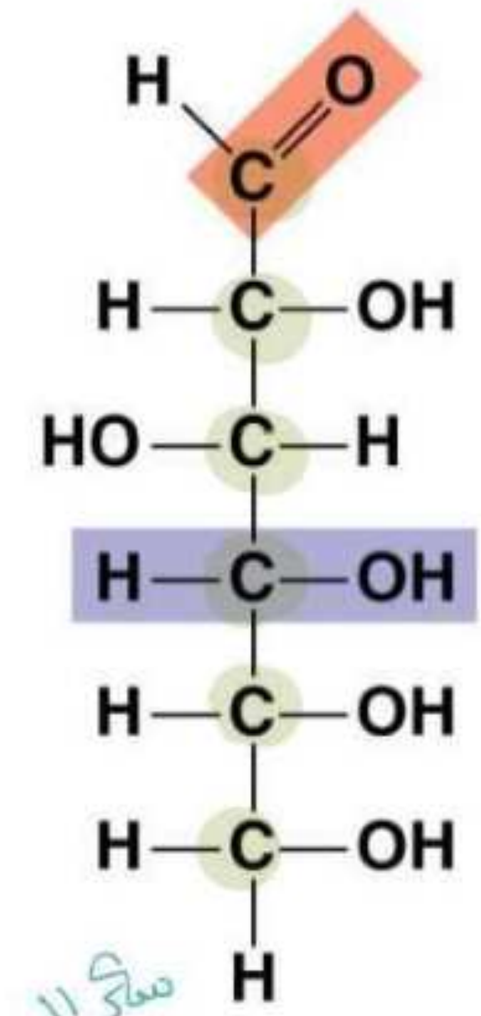
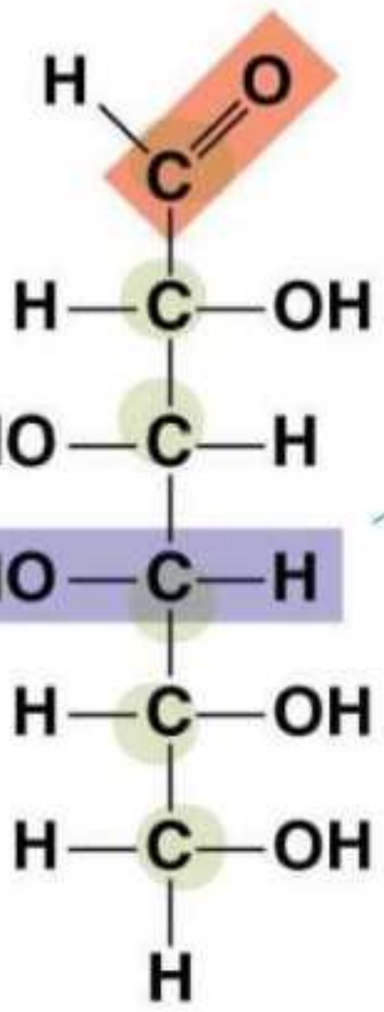
Figure 5.3c

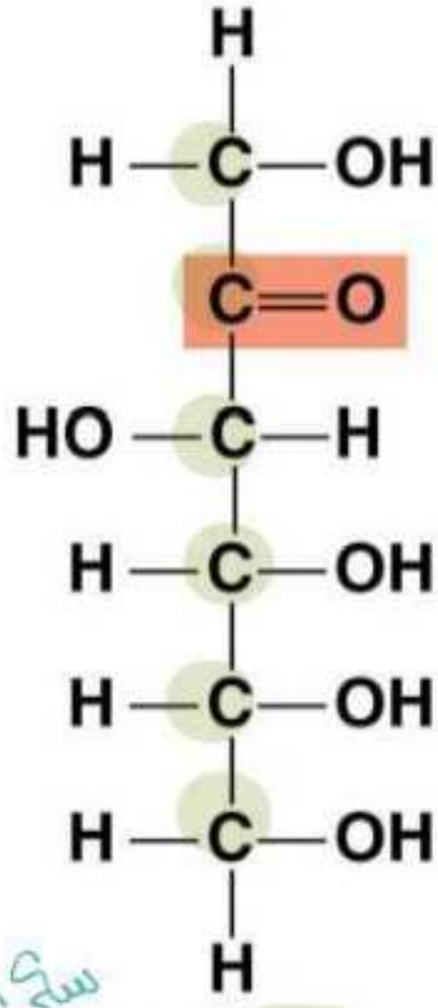
Aldose (Aldehyde Sugar)	Ketose (Ketone Sugar)
Hexoses: 6-carbon sugars ($C_6H_{12}O_6$)	



Glucose



Galactose



Fructose

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هون بحكيلنا على الرغم انه السكريات غالبا
ترسم على شكل هياكل عمودية الا انها

في المحاليل المائية تكون على شكل حلقات
وبسس 🙂

- Though often drawn as linear skeletons, in aqueous solutions many sugars form rings
- Monosaccharides serve as a major fuel for cells and as raw material for building molecules

لبناء الجزيئات

* بدنا نكون انه السكر اساس الطاقة
جسمنا ← بدنا طاقه بناكل سكر
ياسكر

monosaccharide

اي مركبين يتشابهوا في الصيغة الجزيئية ويختلفوا بالصيغة البنائية نسميهم ايزومر (متصاوغات)

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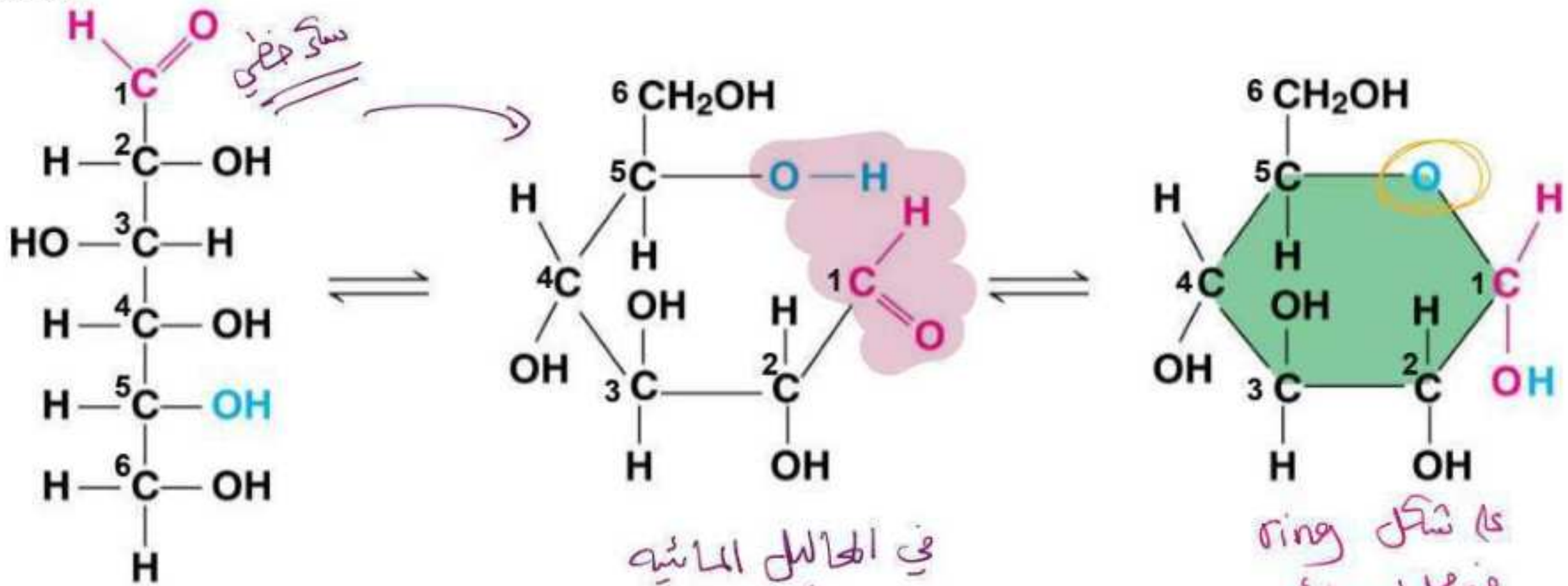
Figure 5.4



(a) Linear and ring forms

(b) Abbreviated ring structure

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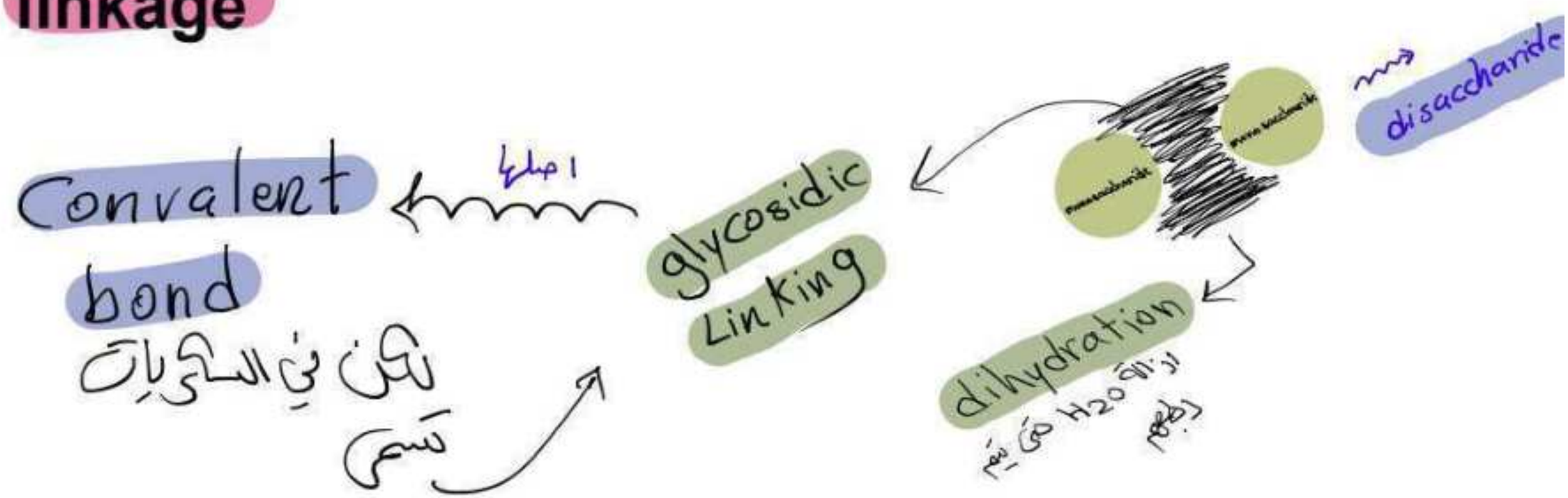
$C_{12}H_{22}O_{11}$

not polymer

- A **disaccharide** is formed when a dehydration reaction joins two monosaccharides
- This covalent bond is called a **glycosidic linkage**

ربطنا 2 سكر احادي نتج
عندي سكر ثنائي 😉
عشان هيك الاساس يلي
بيتحكم بنوع السكر الثنائي هو
السكر الاحادي المكون له 😀



صححح الرابطة نشات بين 2 monosaccharide 😢

الرابطة التي تكون منها ال disaccaride هي covalent bond لكن لانها بالسكر glycosidic linking 😇

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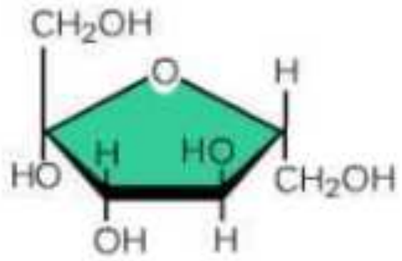
Glucose



Fructose

Disaccharide

ثنائي

سكر الحليب

سكر الفاكهة

سكر الجلوكوز

glucose + galactose ⟶ Lactose

1-4 α

Animation: Disaccharide
Right-click slide / select "Play"

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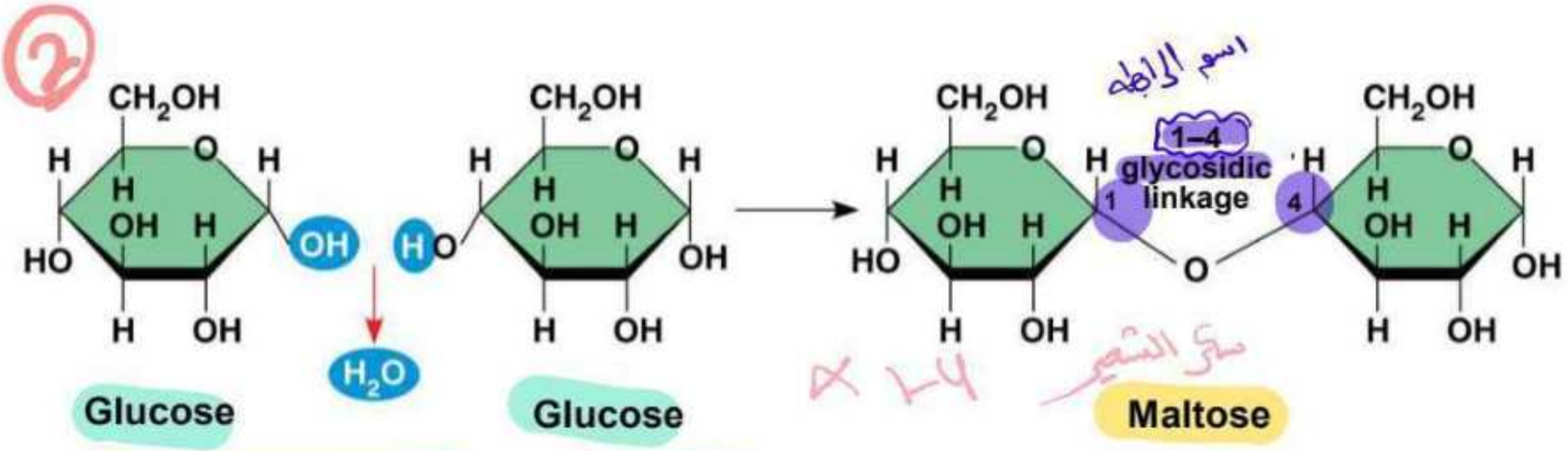
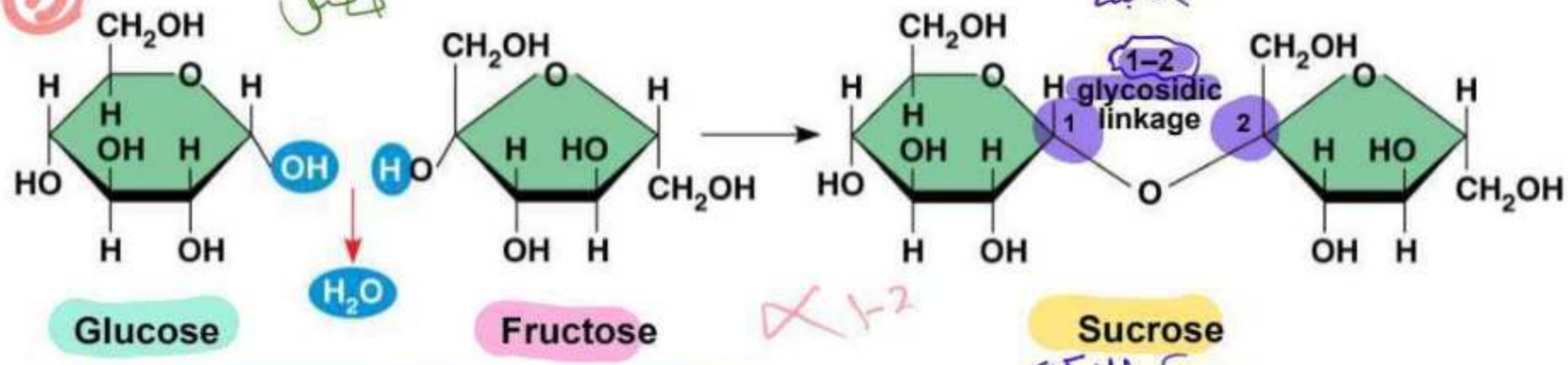
Figure 5.5



(a) Dehydration reaction in the synthesis of maltose



(b) Dehydration reaction in the synthesis of sucrose

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Polysaccharides

polymer
several monosaccharide

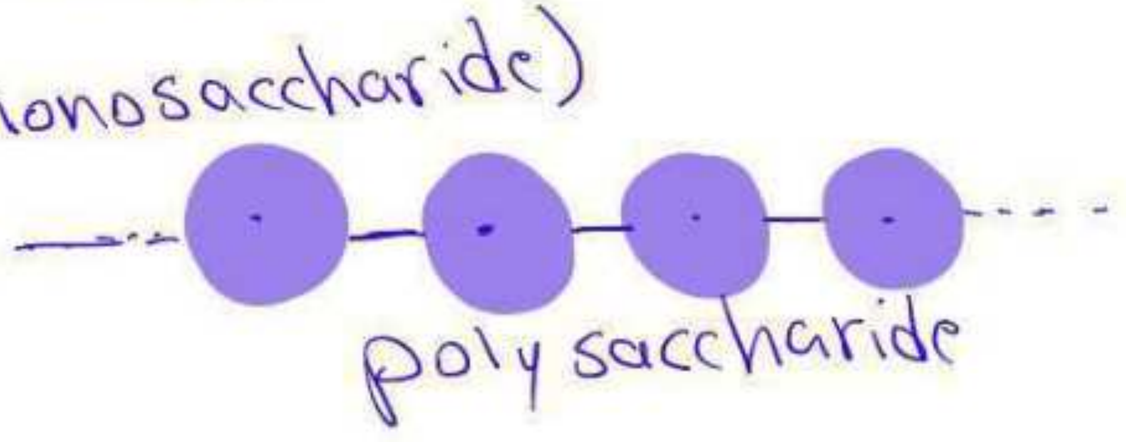
اي شيء بنائي لازم يكون صلب
حتى يعطي دعامه (support)

- **Polysaccharides**, the polymers of sugars, have storage and structural roles
- The structure and function of a polysaccharide are determined by its sugar monomers and the positions of glycosidic linkages

energy storage
تخزين
بنائي
من خلال
1
3

تصنيف ال polysaccharide حسب الوظيفة ل:
1. Structural
2. Storage

في فرع 2 بيقصد :
تركيب (شكل) ال polysaccharide
ووظيفته بتعتمد عشغلتين :
ال monosaccharaid المكونه له +
موقع او مكان ال glycosidic linkages



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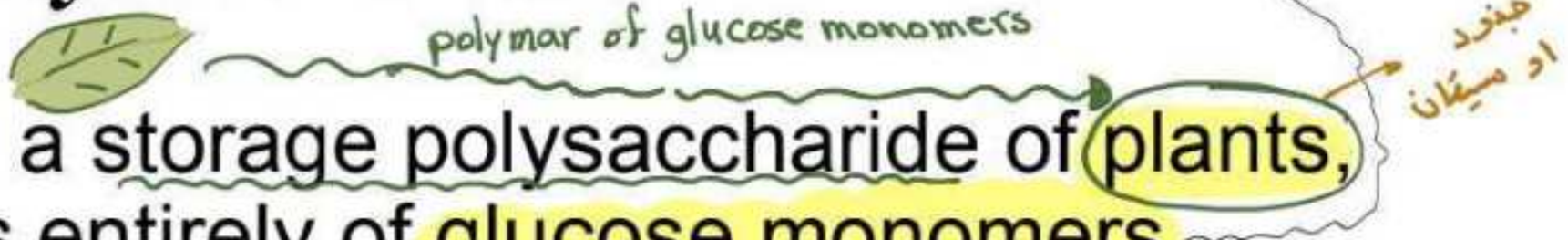
Storage Polysaccharides



- **Starch**, a storage polysaccharide of plants, consists entirely of glucose monomers
- Plants store surplus starch as granules within chloroplasts and other plastids
- The simplest form of starch is amylose

النباتات تحتوي على بلاستيدات خضراء تقوم بعملية البناء الضوئي وتصنع غذائها بنفسها

غذاء النبات هو السكر الذي تصنعه بنفسها على شكل storage (starch)

طيب الفائض عن حاجته من السكر الكافي لغذائه وين بروح ؟

ببساطه بيحتفظ فيه وبخزنه على شكل starch granules (حبيبات النشأ) في البلاستيدات الخضراء والبلاستيدات عديمة اللون وبيستخدمه حين الحاجه اله مثلوضعه في مكان مظلم مدة زمنيه

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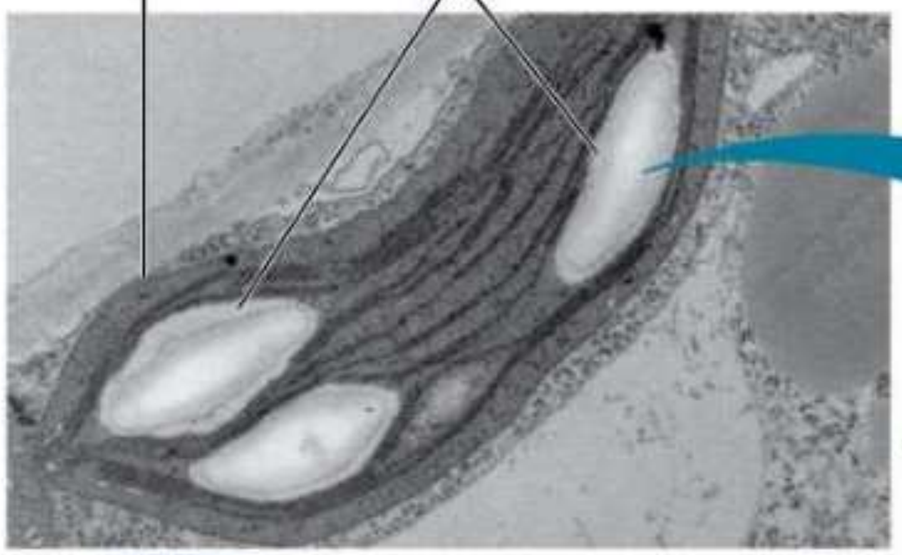
Figure 5.6 بلاستيدات خضراء

Types of starch :

Chloroplast

Starch granules

هبيبات النشا



1 µm

(a) Starch:
a plant polysaccharide

لاحظنا انه شكله spiral حلزوني

Amylopectin ①

helical
un braced

عبارة عن حبيبات بلوكوز

helical

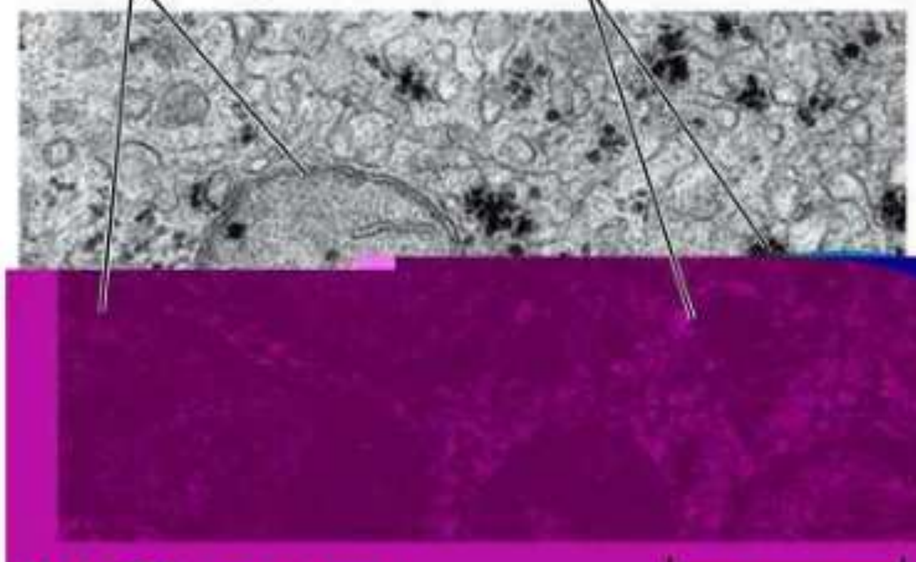
branch لاحظنا انه متفرع و more complicated اكثر تعقيد

Amylose ②

النوع الابسط

Mitochondria

Glycogen granules



0.5 µm

(b) Glycogen:
an animal polysaccharide

similar Amylopectin but more branched

Glycogen

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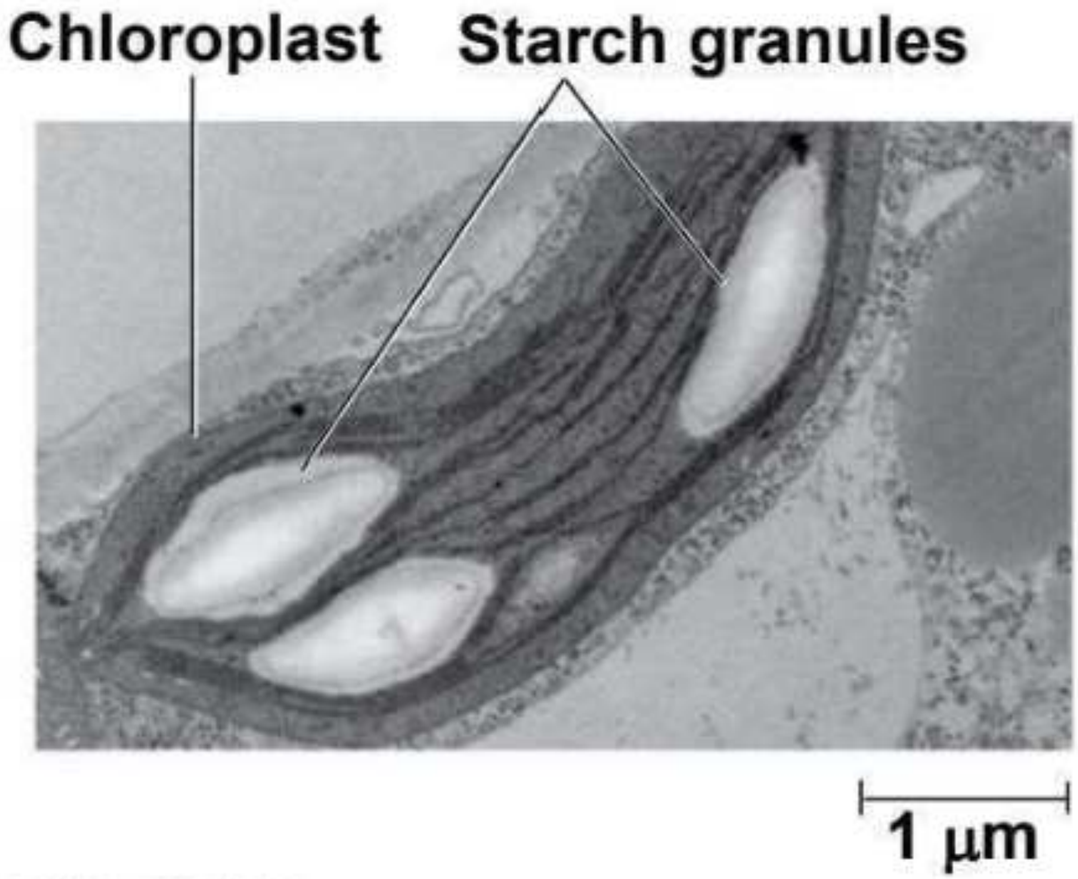
Figure 5.6a



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الجلوكوز ← البوليمر

Type 2

- **Glycogen** is a storage polysaccharide in animals

الإنسان ← الحيوان

- Humans and other vertebrates store glycogen mainly in liver and muscle cells

الفقريات

الكبد ① ← أماكن تخزين الـ glycogen في الجسم

خلايا العضلات ②

نوتاتي الصغيرة حتى ما نحفظ : 🐣

لما الحيوان او الحيوان يخزنوا بجسمهم كميات كبيرة من السكر شو بصير فيها؟

الجسم رح ياخذ حاجته من هذا السكر طيب والفائض !

رح احكيلك هون انه جسمنا بخزنه مدة 24 ساعة بس على الكبد والخلايا العضلية بيستنا

من حضراتنا نتحرك ونحوله لطاقة حركية 🧕

طيب لو ماحرقناه وضلينا نايمين ؟ 🥶

رح يروح هاد السكر للدم وبيتحول لدهون 😖

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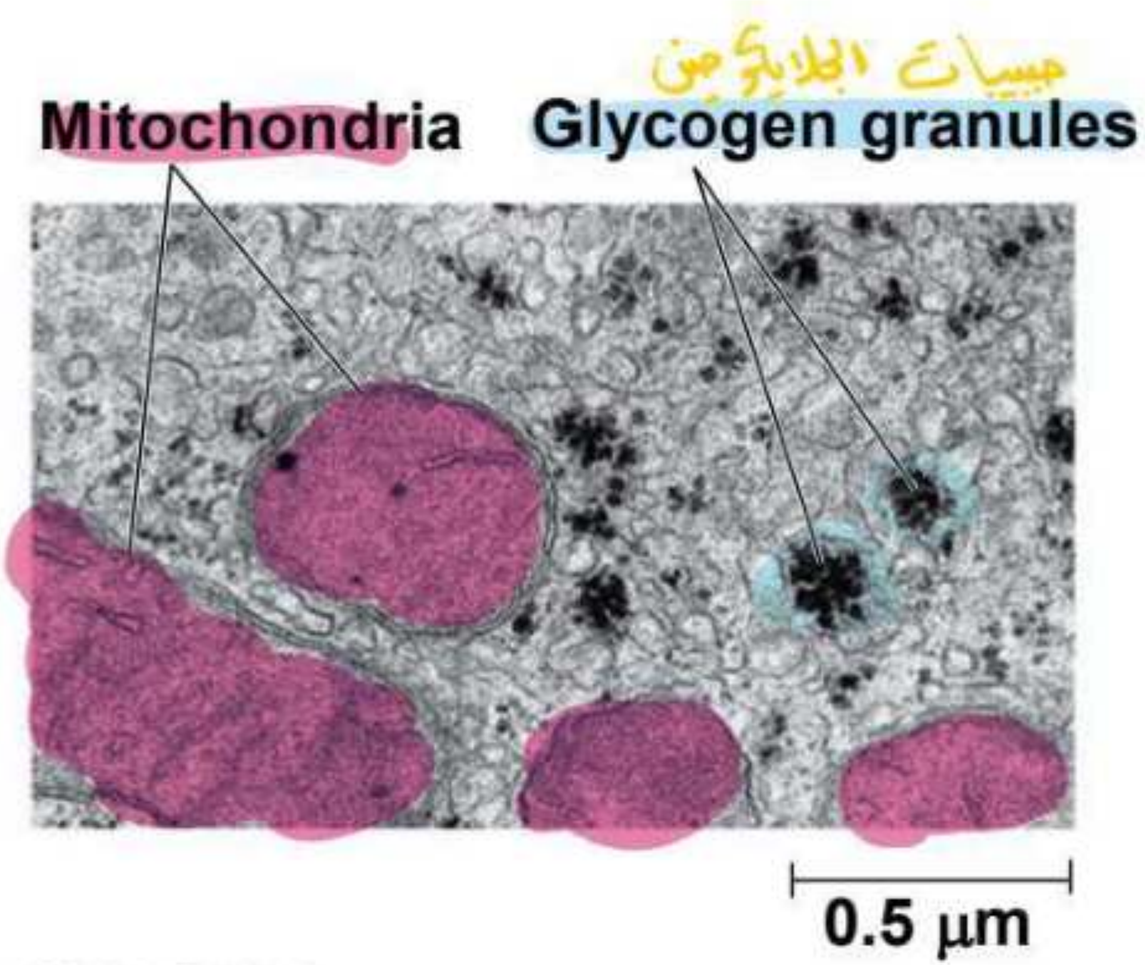
Figure 5.6b



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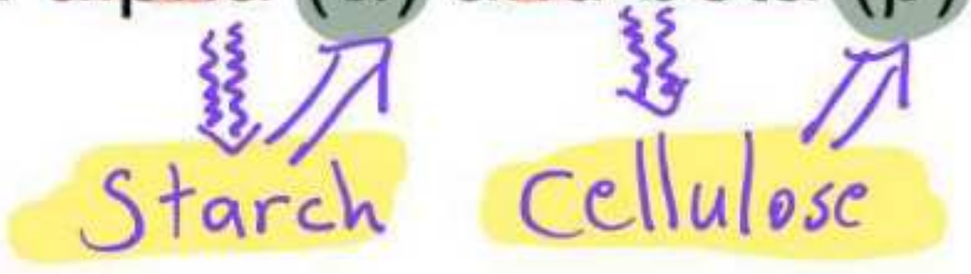
Structural Polysaccharides

- The polysaccharide **cellulose** is a major component of the tough wall of plant cells
- Like starch, cellulose is a polymer of glucose, but the glycosidic linkages differ
- The difference is based on two ring forms for glucose: alpha (α) and beta (β)



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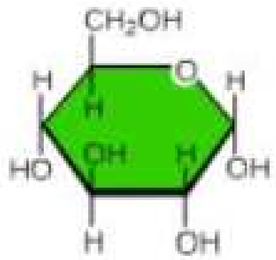

Animation: Polysaccharides

Right-click slide / select “Play”

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Figure 5.7

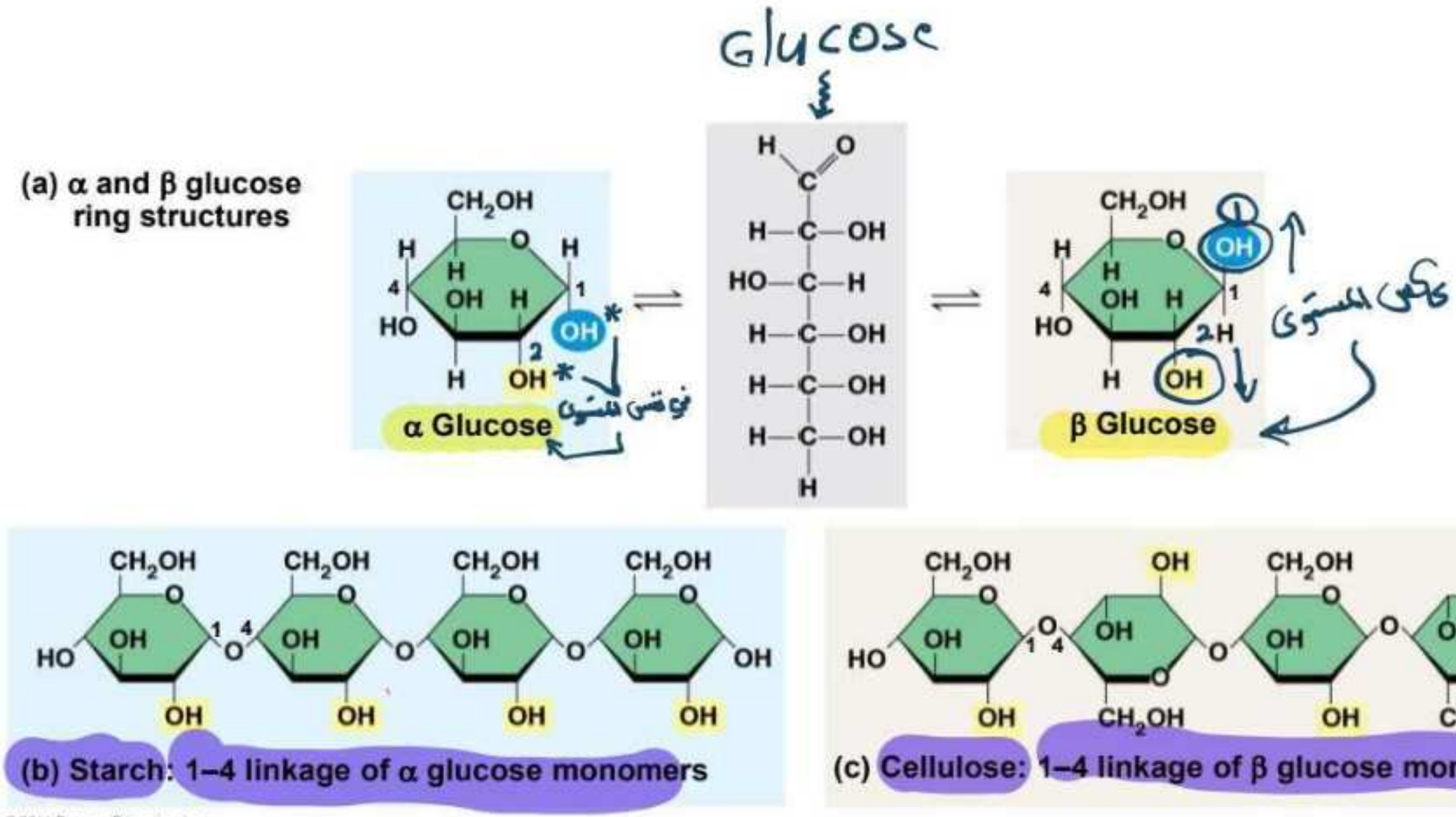

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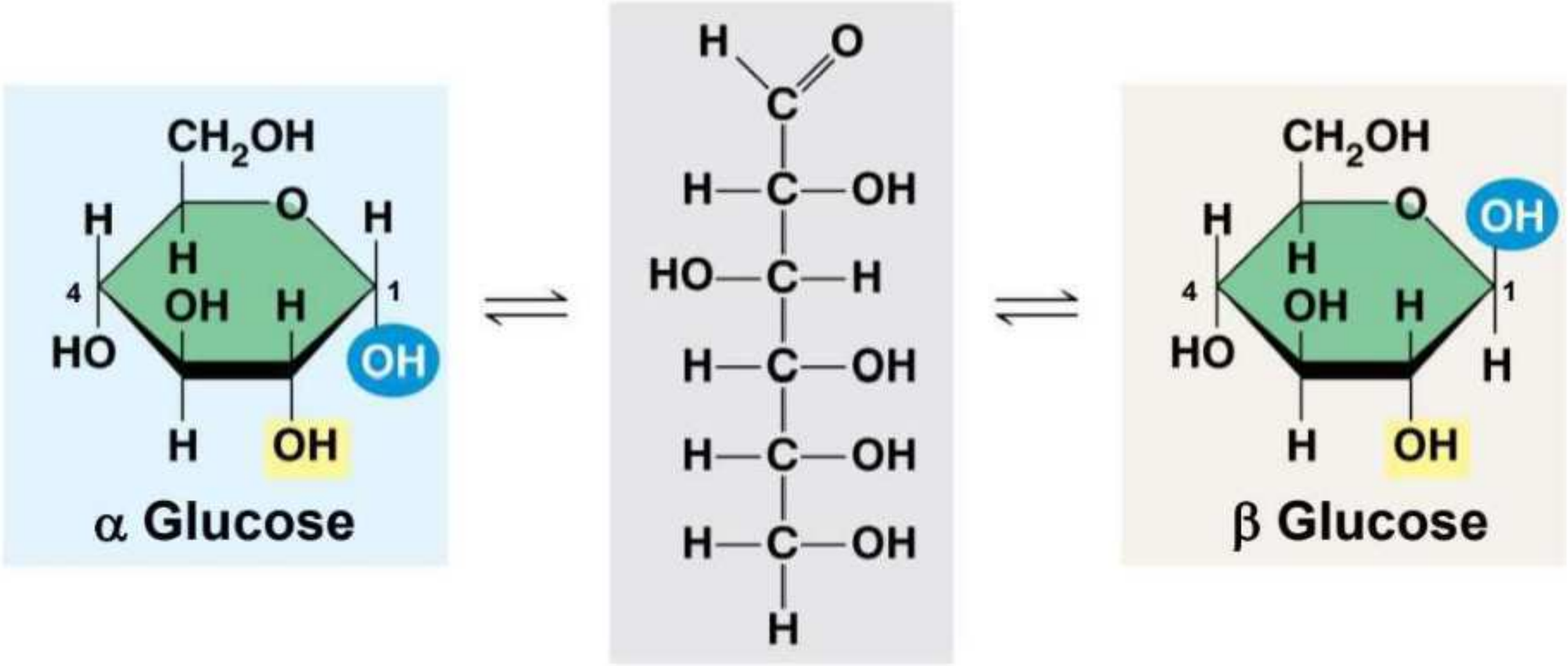
Figure 5.7a



(a) α and β glucose ring structures

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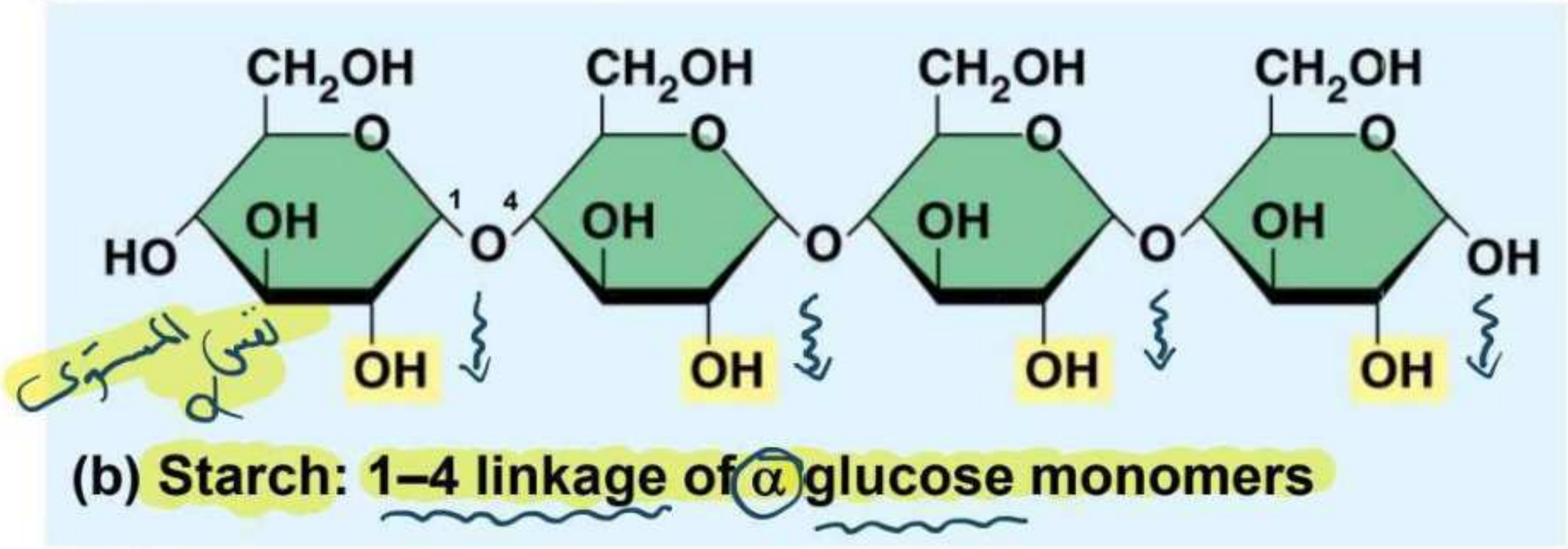
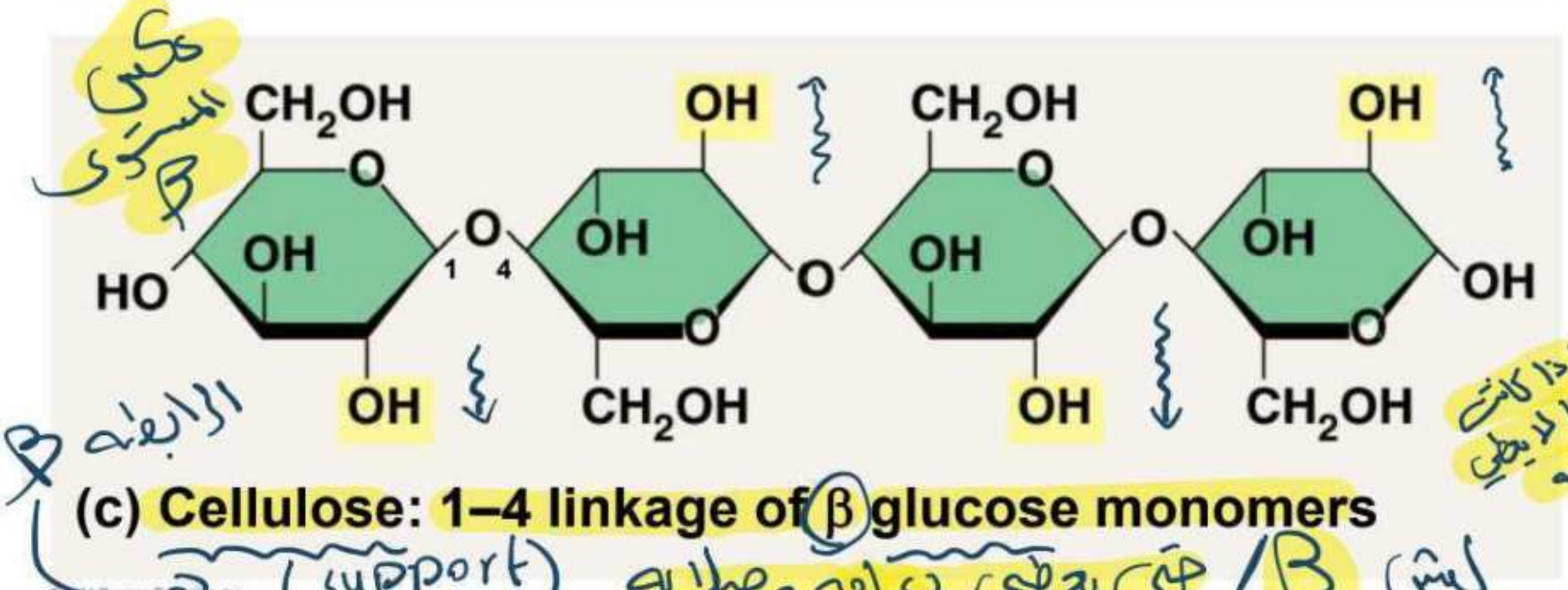
Figure 5.7b


CH2OH
O
OH
HO
1
4
O
OH
(b) Starch: 1–4 linkage of α glucose monomers


CH2OH
O
OH
HO
1
4
O
OH
CH2OH
(c) Cellulose: 1–4 linkage of β glucose monomers

- Polymers with α glucose are helical
- Polymers with β glucose are straight
- In straight structures, H atoms on one strand can bond with OH groups on other strands
- Parallel cellulose molecules held together this way are grouped into microfibrils, which form strong building materials for plants

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Figure 5.8

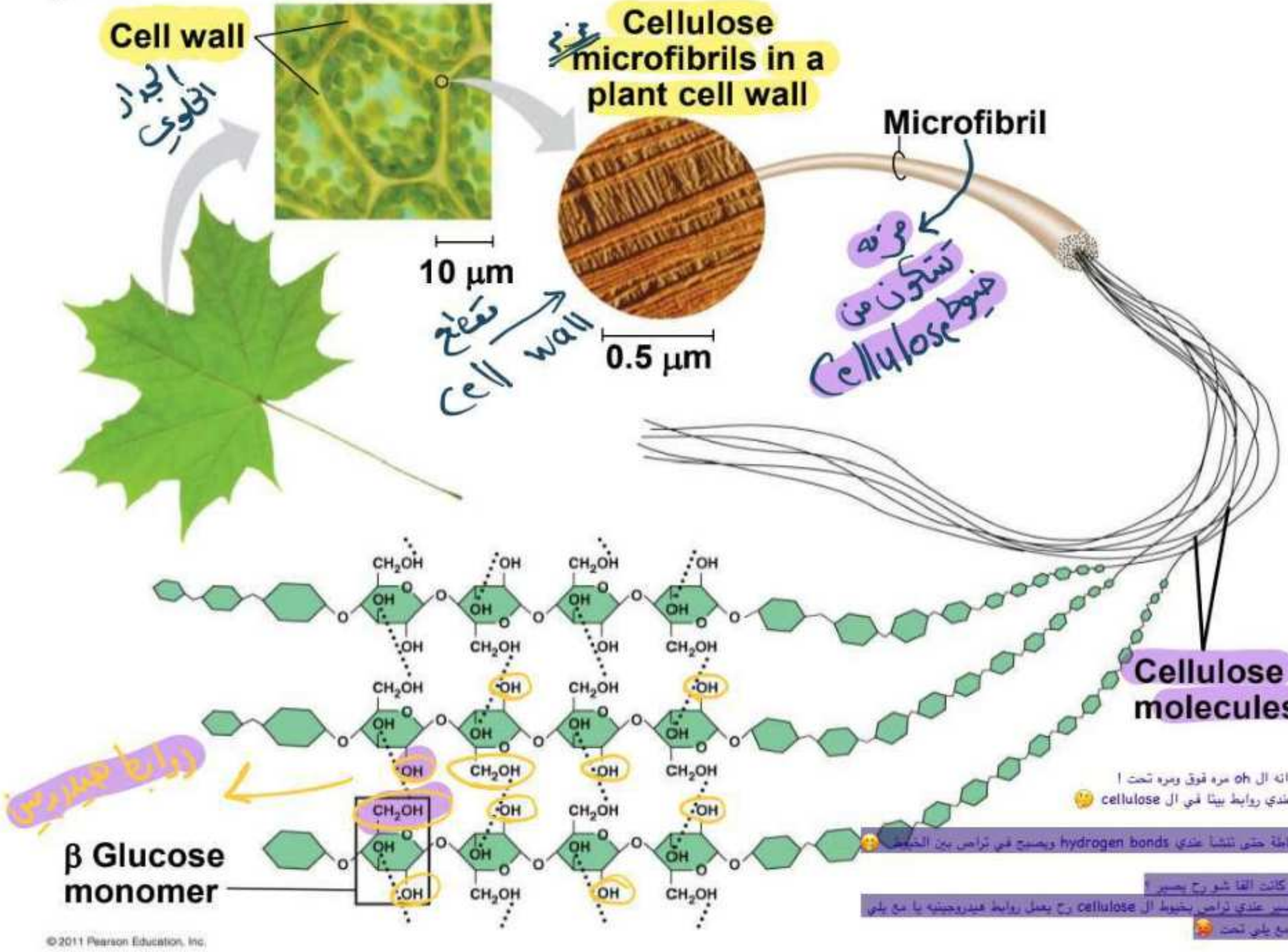

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Figure 5.8a

لو جيت اكلت starch مثل البطاطا هل
جسمنا رح يهضمها ؟
اكيد بسبب وجود انزيم اسمه Amylase
بيبدا افرازه باللعاب يقوم بهضم النشأ😈

طيب لو جيت اكلت Celleolose الالياف النباتية ؟
رح تبقى بالمعدة فترة طويلة لانه مافي عنا انزيم
يهضمها ولهذا السبب رح نحس بالشبع لفترة طويلة 😲
طيب شو بصير فيها بعدين ؟بينزل عالامعاء
تبقى على شكل قطع بتخدش جدار الامعاء حتى يحفز
على افراز العصارة الهاضمة 🤭

بما انه حكينا عن الاالانسان طيب شو وضع الحيوانات اكلات الاعشاب؟
الحيوانات يا صديقي عندها بكتيريا بينها وبين الحيوان عملية تكافل
تقوم بافراز الانزيم الذي يقوم بهضم الالياف 🐎

Figure 5.8b

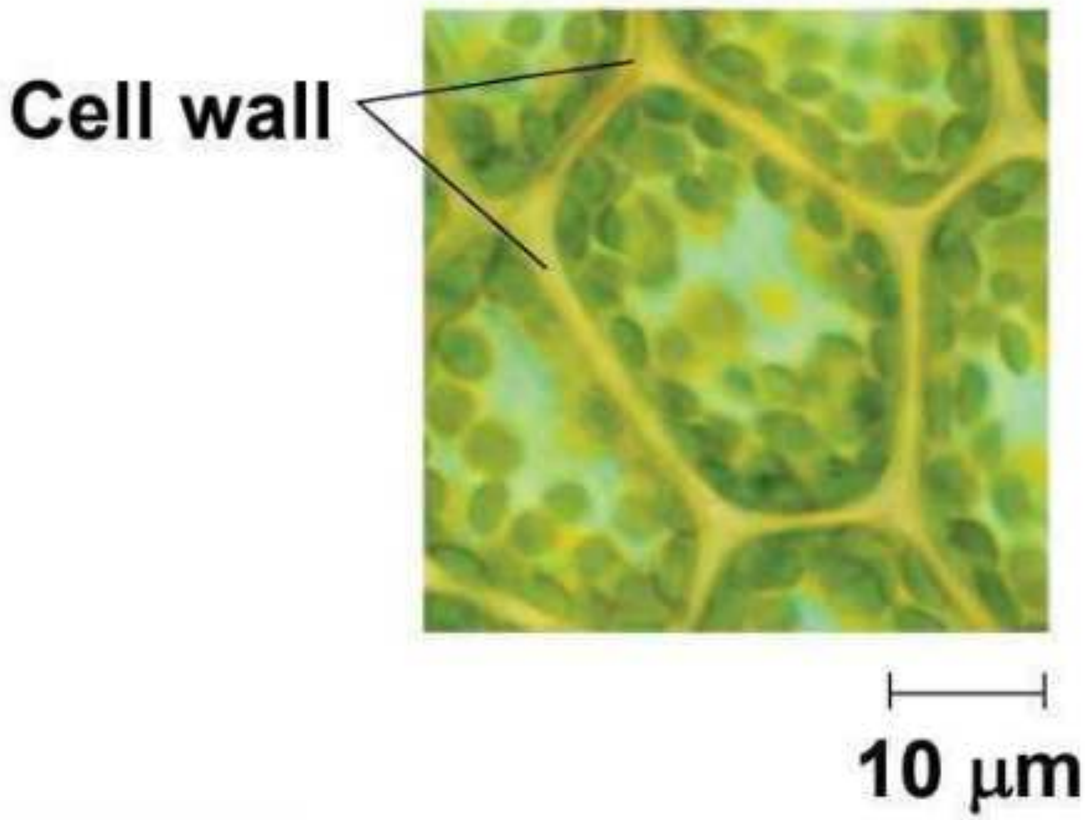

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Figure 5.8c

Cellulose microfibrils in a plant cell wall

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- Enzymes that digest starch by hydrolyzing α linkages can't hydrolyze β linkages in cellulose
- Cellulose in human food passes through the digestive tract as insoluble fiber
- Some microbes use enzymes to digest cellulose
- Many herbivores, from cows to termites, have symbiotic relationships with these microbes

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- **Chitin**, another structural polysaccharide, is found in the exoskeleton of arthropods
- Chitin also provides structural support for the cell walls of many fungi

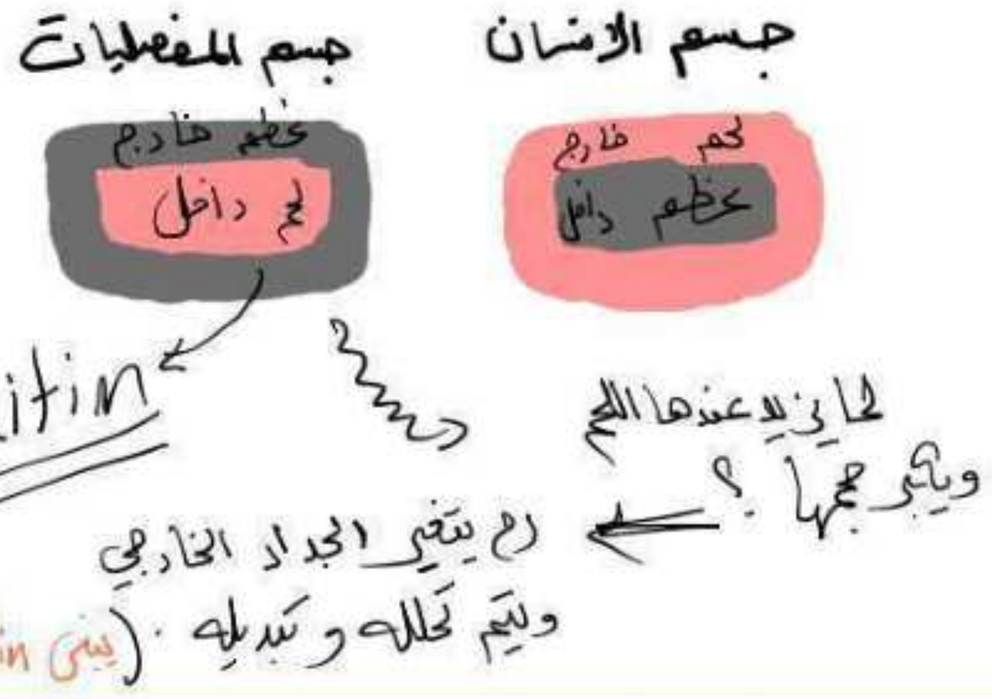

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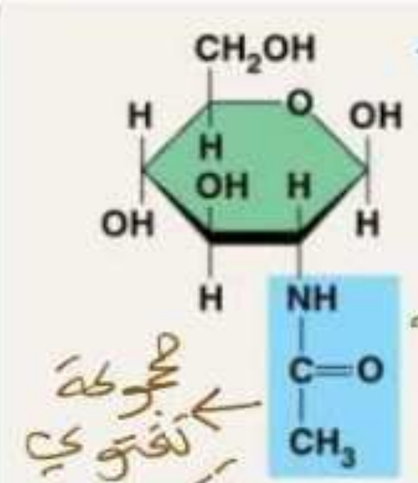
Figure 5.9



◀ The structure of the chitin monomer

◀ Chitin forms the exoskeleton of arthropods.

Chitin
polymer عبارة عن
The monomer of Chitin

▲ Chitin is used to make a strong and flexible surgical thread that decomposes after the wound or incision heals.

نستخدم مادة ال chitin في صناعة خيوط الجروح لانها تحتوي مواد طبيعية قابلة للتحلل

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Figure 5.9a

▲ **Chitin forms the exoskeleton of arthropods.**

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Figure 5.9b

▲ **Chitin is used to make a strong and flexible surgical thread that decomposes after the wound or incision heals.**

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Concept 5.3: Lipids are a diverse group of hydrophobic molecules

- **Lipids** are the one class of large biological molecules that do not form polymers
- The unifying feature of lipids is having little or no affinity for water
- Lipids are hydrophobic because they consist mostly of hydrocarbons, which form nonpolar covalent bonds
- The most biologically important lipids are fats, phospholipids, and steroids

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Fats

3 → fatty acids
1 → glycerol

- **Fats** are constructed from two types of smaller molecules: glycerol (جلسرين) and fatty acids (احماض دهنيه) ← The molecules in fat
- Glycerol is a three-carbon alcohol with a hydroxyl group attached to each carbon → عبارة عن 3 كربونات
- A **fatty acid** consists of a carboxyl group attached to a long carbon skeleton

هيكل كربوني
← ملبان فيه C / H
C → سي كربون
H → هيدروجين

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Figure 5.10

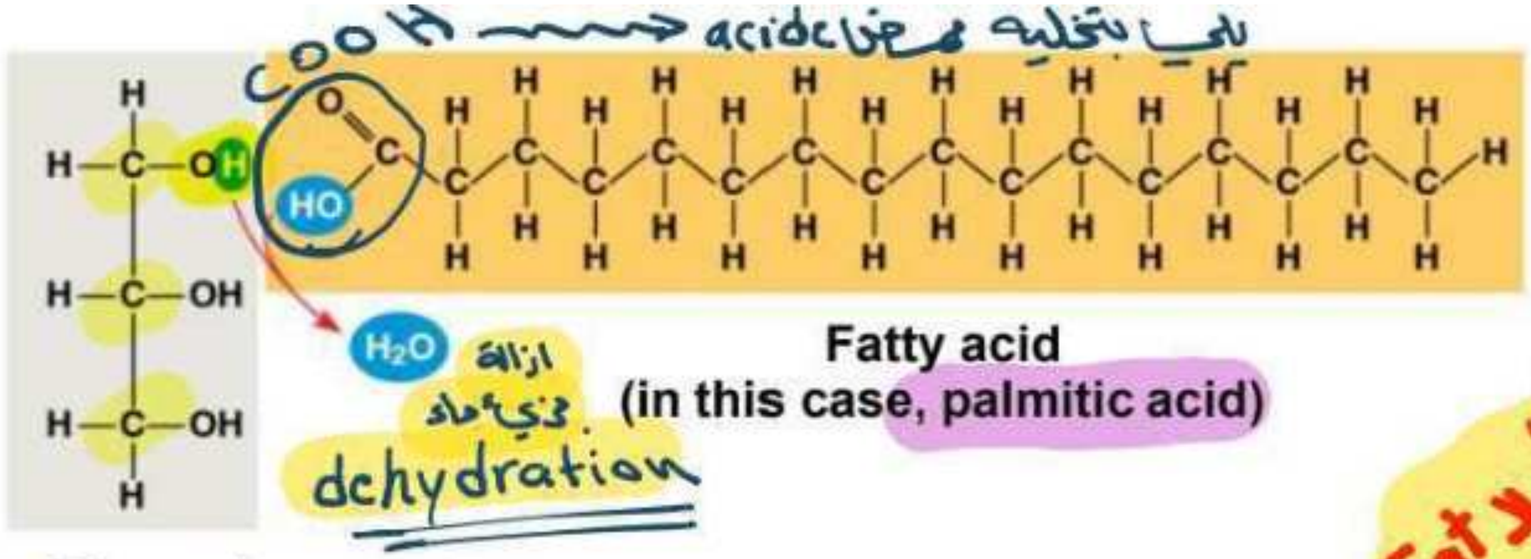
H2O
Fatty acid
(in this case, palmitic acid)
dehydration
Glycerol
(a) One of three dehydration reactions in the synthesis of a fat
Ester linkage
Covalent
3 Fatty acids
(b) Fat molecule (triacylglycerol)
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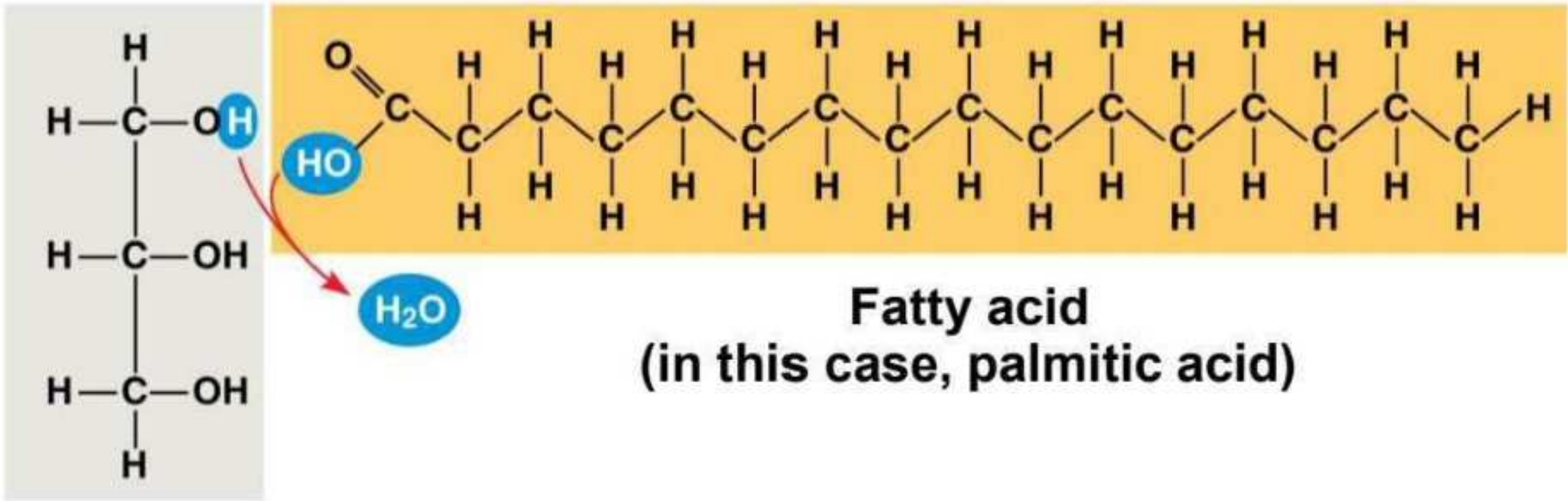
Figure 5.10a



(a) One of three dehydration reactions in the synthesis of a fat

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سبب انفصال الدهون عن الماء

الماء عن تنفصل

- Fats separate from water because water molecules form hydrogen bonds with each other and exclude the fats

يستبعد

- In a fat, three fatty acids are joined to glycerol by an ester linkage, creating a **triacylglycerol**, or triglyceride or fat

جزيئات الماء بترتبط مع بعضها بروابط هيدروجينية وبتنفصل عن الدهون

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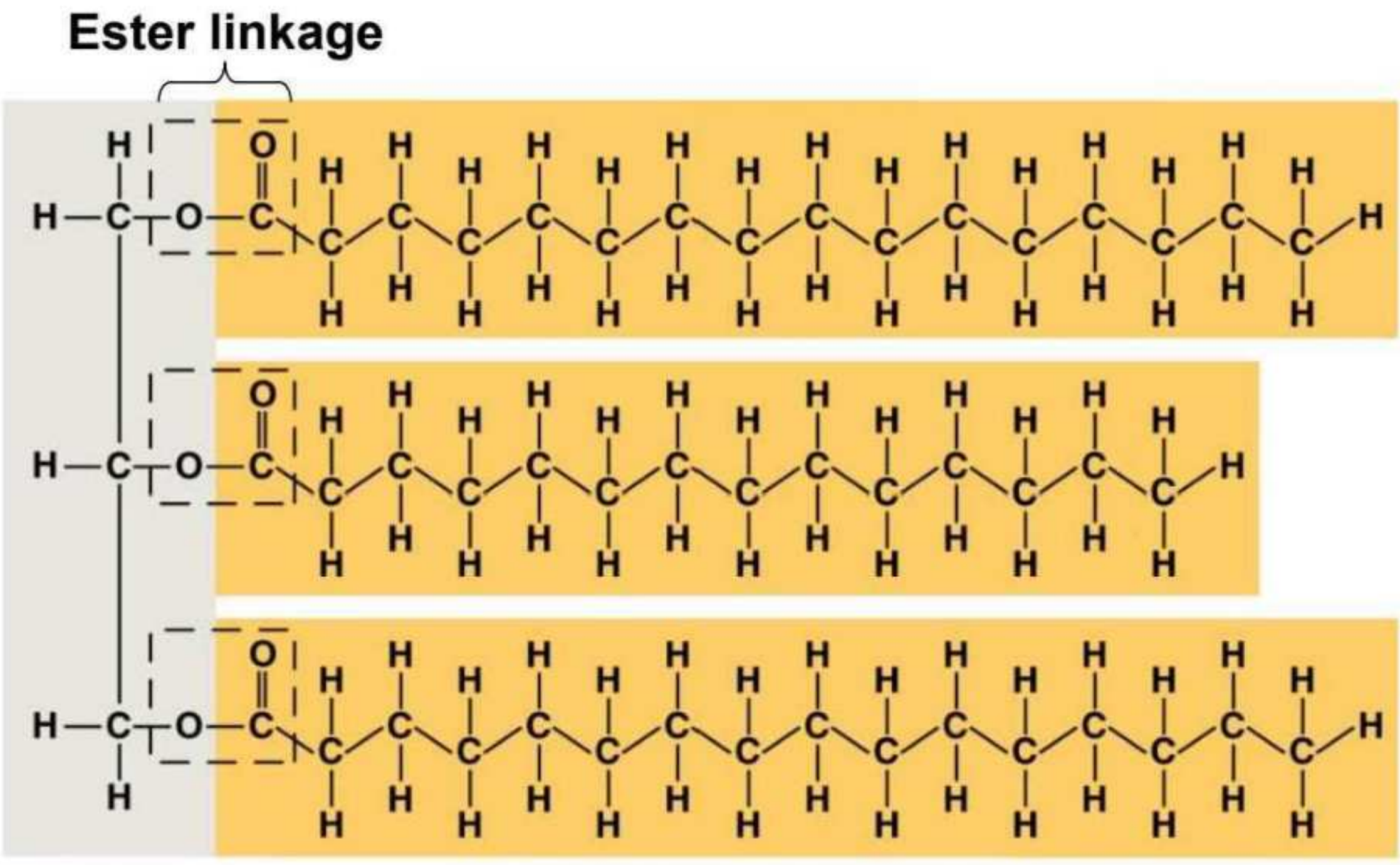
Figure 5.10b



(b) Fat molecule (triacylglycerol)

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اختلافات الدهون

1 الطول

- Fatty acids vary in length (number of carbons) and in the number and locations of double bonds

2 موقع وعدد الروابط المزدوجه

- **Saturated fatty acids** have the maximum number of hydrogen atoms possible and no double bonds

دهن مشبع

انواع الحمض الدهني

- **Unsaturated fatty acids** have one or more double bonds

دهن غير مشبع

ذرة الكربون هي ذرة رباعية التكافؤ في وضع الاشباع بترتبط ب ٤ ذرات هيدوجين 😌
طيب لما يكون عندي نقص بالهيدروجين رح تعمل ذرة الكربون رابطة ثنائية 😄
بالحالة الاولى بينتج عندي دهون مشبعة وبالحالة الثانية غير مشبعة

عمل رابطة ثنائيه ليس ؟ لانه ماعنده اشباع بال H

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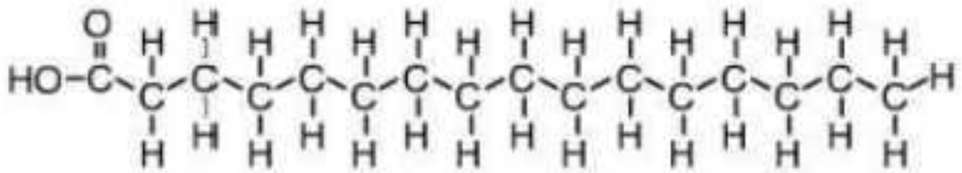
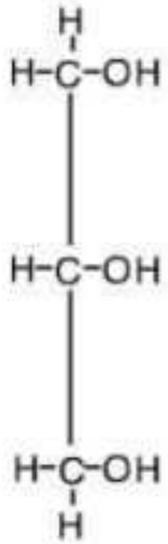
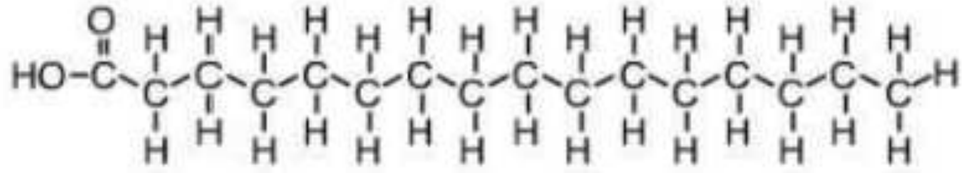


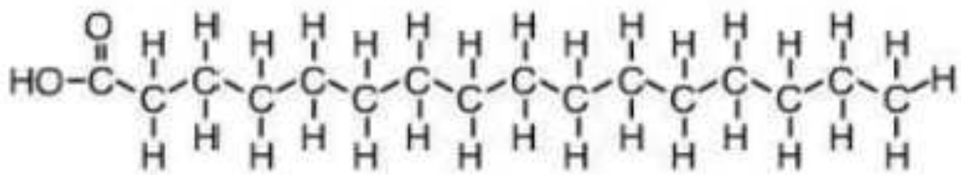
Fatty acid



Glycerol



Fatty acid



Fatty acid

Animation: Fats

Right-click slide / select "Play"

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Figure 5.11

(a) Saturated fat

Structural formula of a saturated fat molecule

Space-filling model of stearic acid, a saturated fatty acid

(b) Unsaturated fat

Structural formula of an unsaturated fat molecule

Space-filling model of oleic acid, an unsaturated fatty acid

Cis double bond causes bending.

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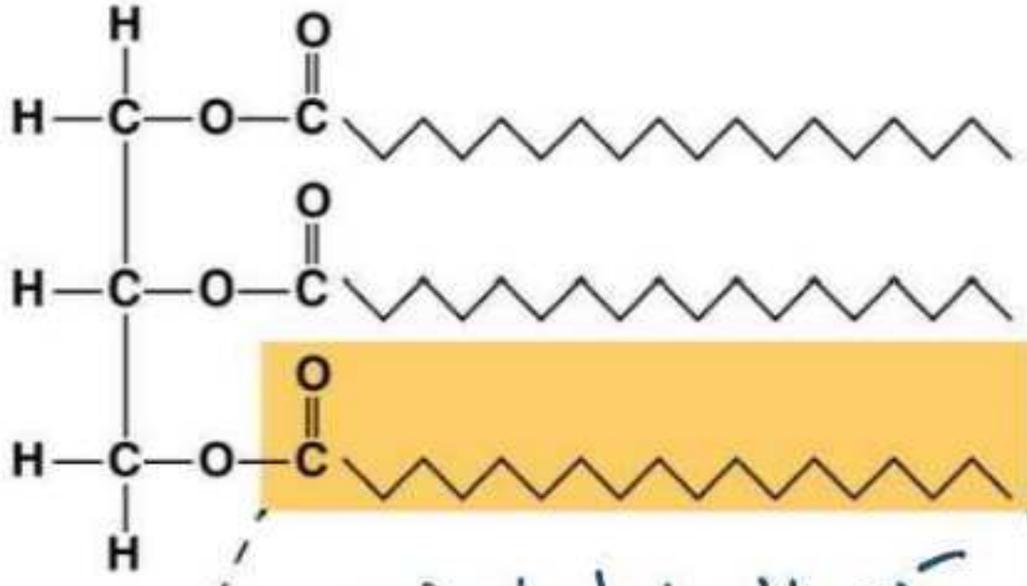
Figure 5.11a

(a) Saturated fat

Structural formula of a saturated fat molecule



Space-filling model of stearic acid, a saturated fatty acid

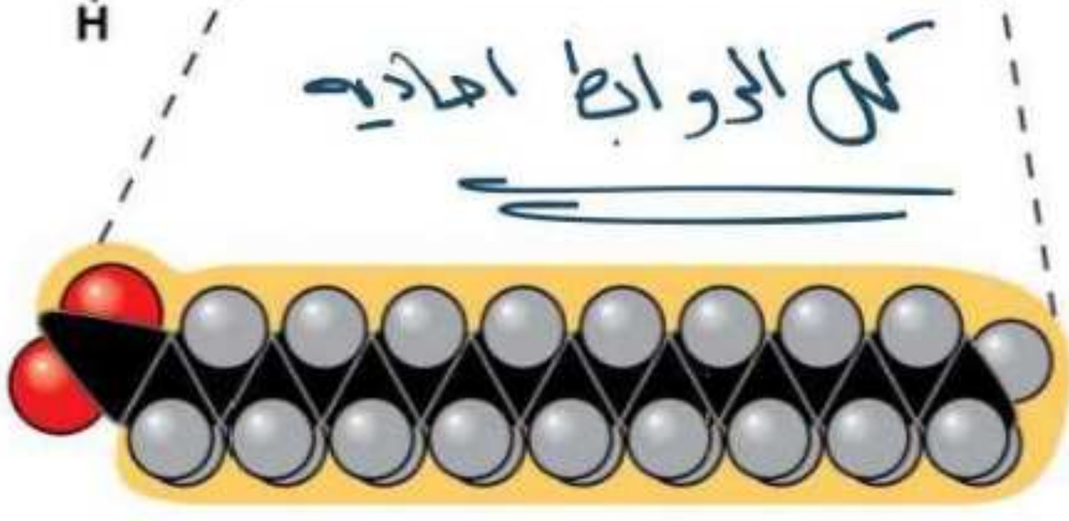


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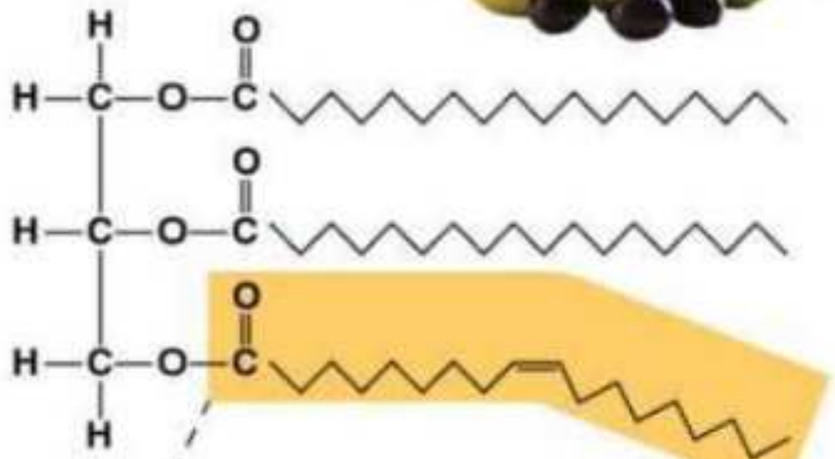
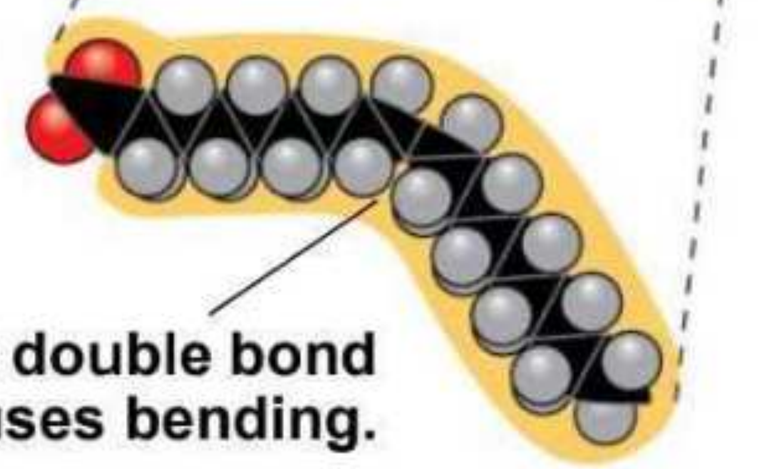
Figure 5.11b

(b) Unsaturated fat

Structural formula of an unsaturated fat molecule



Space-filling model of oleic acid, an unsaturated fatty acid



***Cis* double bond causes bending.**

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Figure 5.11c

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Figure 5.11d

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- Fats made from saturated fatty acids are called saturated fats, and are solid at room temperature
- Most animal fats are saturated
- Fats made from unsaturated fatty acids are called unsaturated fats or oils, and are liquid at room temperature
- Plant fats and fish fats are usually unsaturated

الدهون المشبعة غير صحية !
لانها عندما تدخل الجسم تاخذ درجة حرارة الجسم وتعود صلبة وبهذه الحاله تترسب على جدار الشرايين والاوعية الدموية فيصغر قطرها مسبب تجلطات وامراض القلب والاوعية

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- A diet rich in saturated fats may contribute to cardiovascular disease through plaque deposits
- Hydrogenation is the process of converting unsaturated fats to saturated fats by adding hydrogen
- Hydrogenating vegetable oils also creates unsaturated fats with *trans* double bonds
- These ***trans* fats** may contribute more than saturated fats to cardiovascular disease

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- Certain unsaturated fatty acids are not synthesized in the human body
- These must be suppiied in the diet
- These essential fatty acids include the omega-3 fatty acids, required for normal growth, and thought to provide protection against cardiovascular disease

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- The major function of fats is energy storage
- Humans and other mammals (الثدييات) store their fat in adipose cells (في خلايا الانسجه الدهنيه)
- Adipose tissue also cushions vital organs (محايه الاعضاء الحيويه) and insulates the body (تعزل)

(الانسجه الدهنيه)

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Phospholipids

- In a **phospholipid**, two fatty acids and a phosphate group are attached to glycerol
- The two fatty acid tails are hydrophobic, but the phosphate group and its attachments form a hydrophilic head

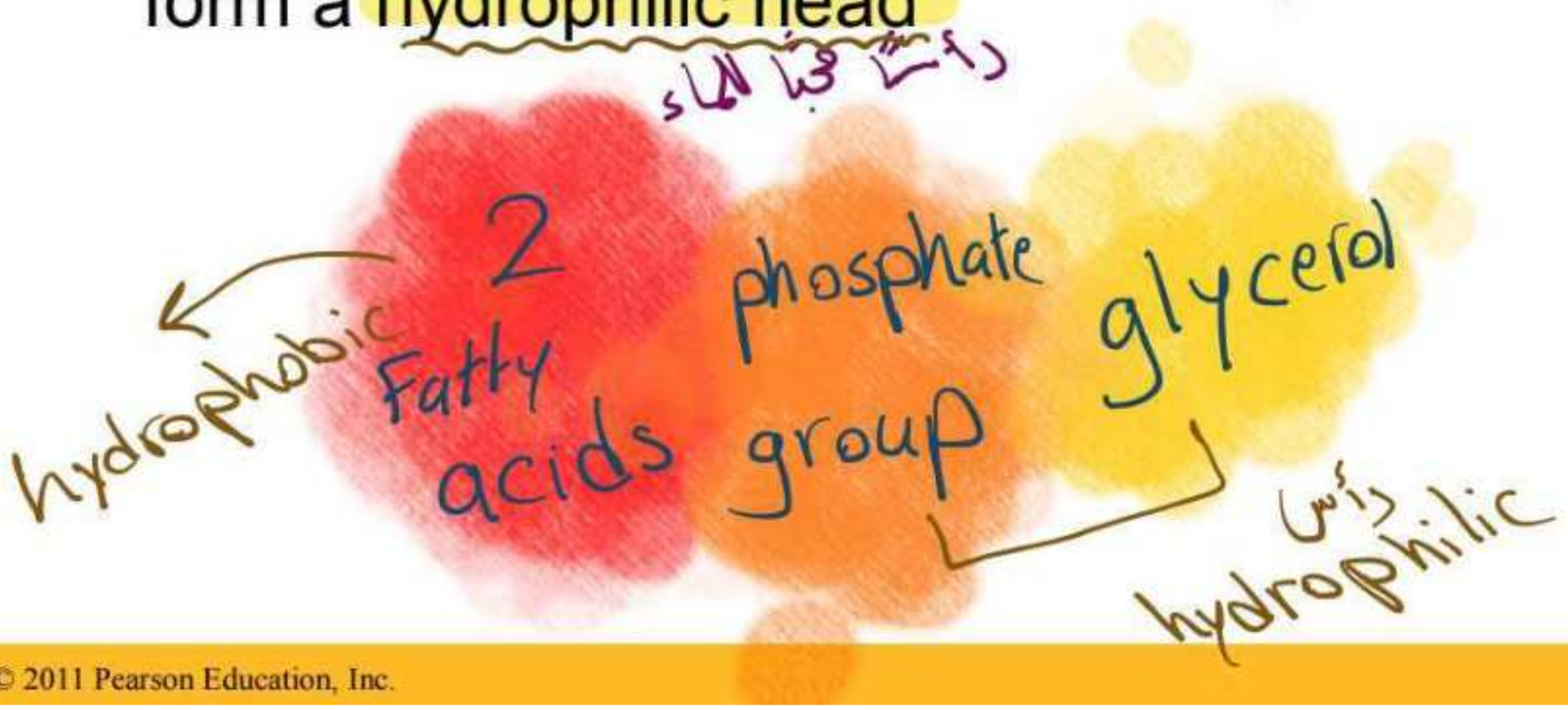

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Figure 5.12

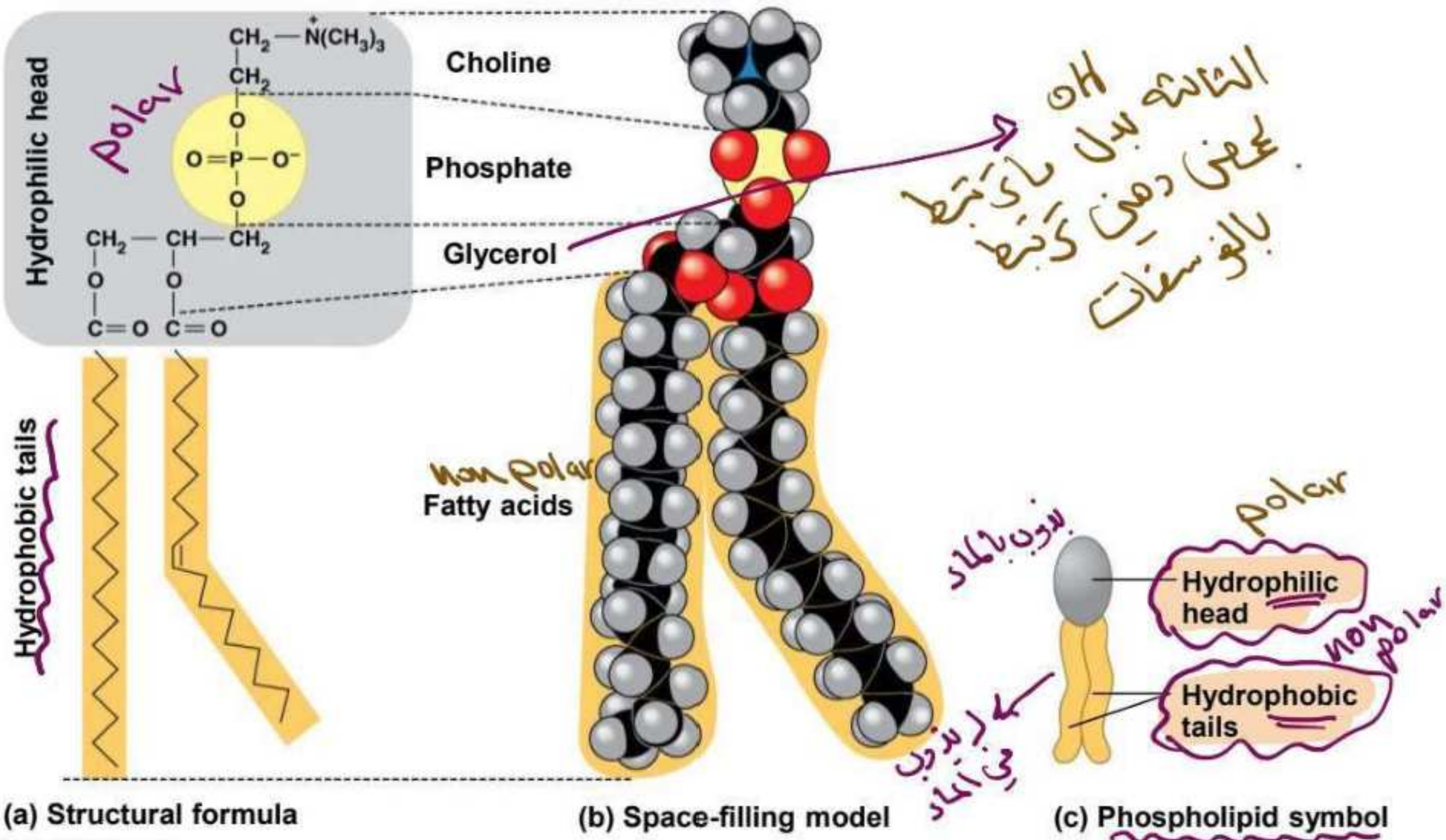

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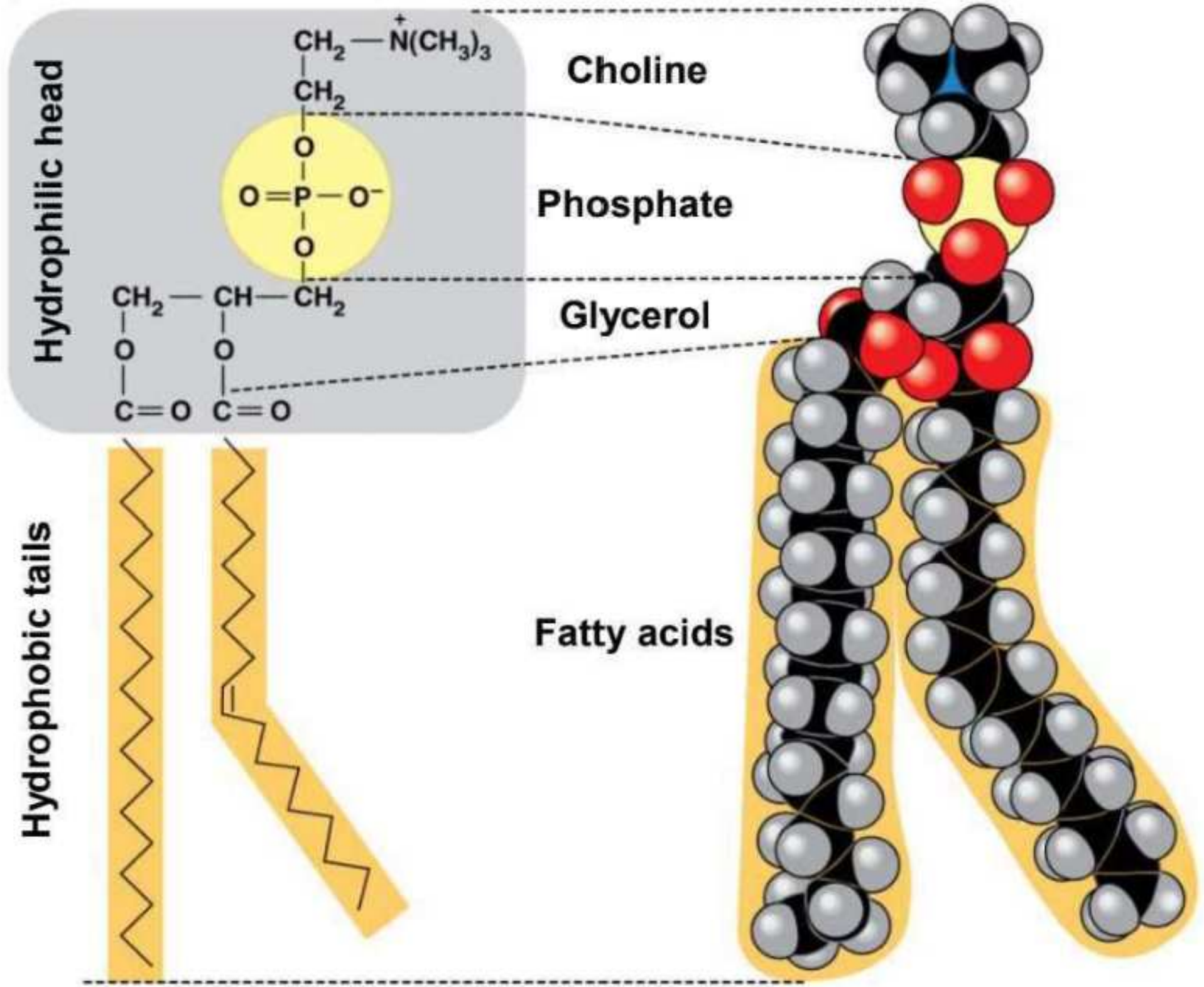
Figure 5.12a



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- When phospholipids are added to water, they self-assemble into a bilayer, with the hydrophobic tails pointing toward the interior
- The structure of phospholipids results in a bilayer arrangement found in cell membranes
- Phospholipids are the major component of all cell membranes

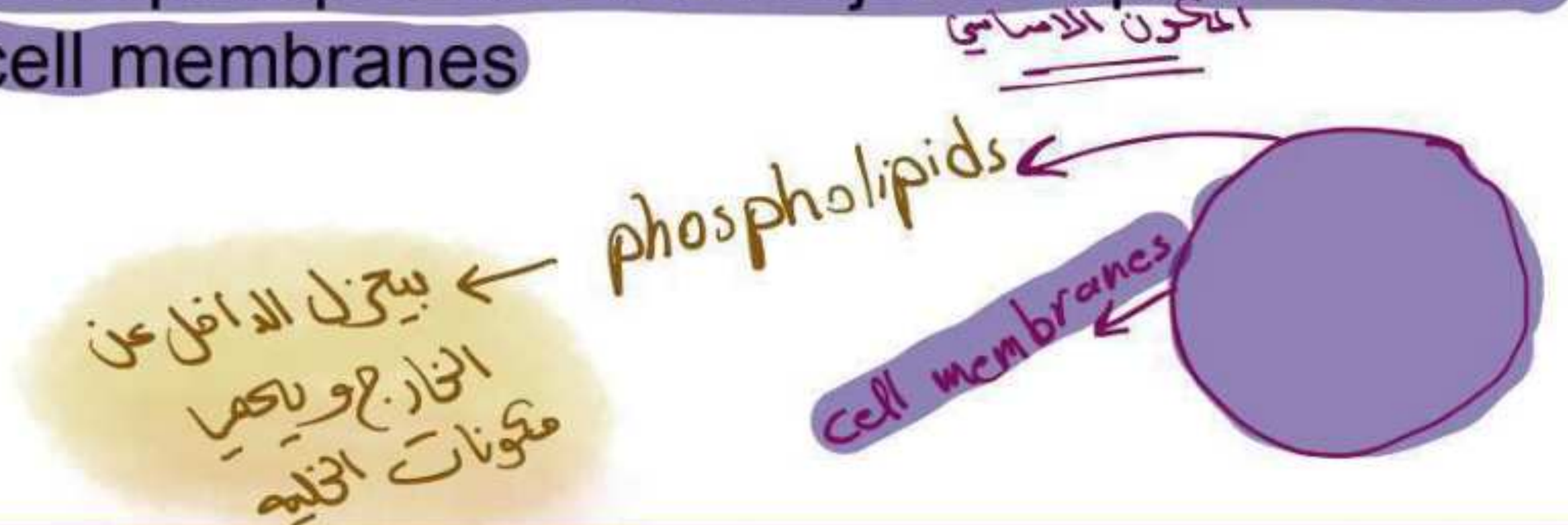

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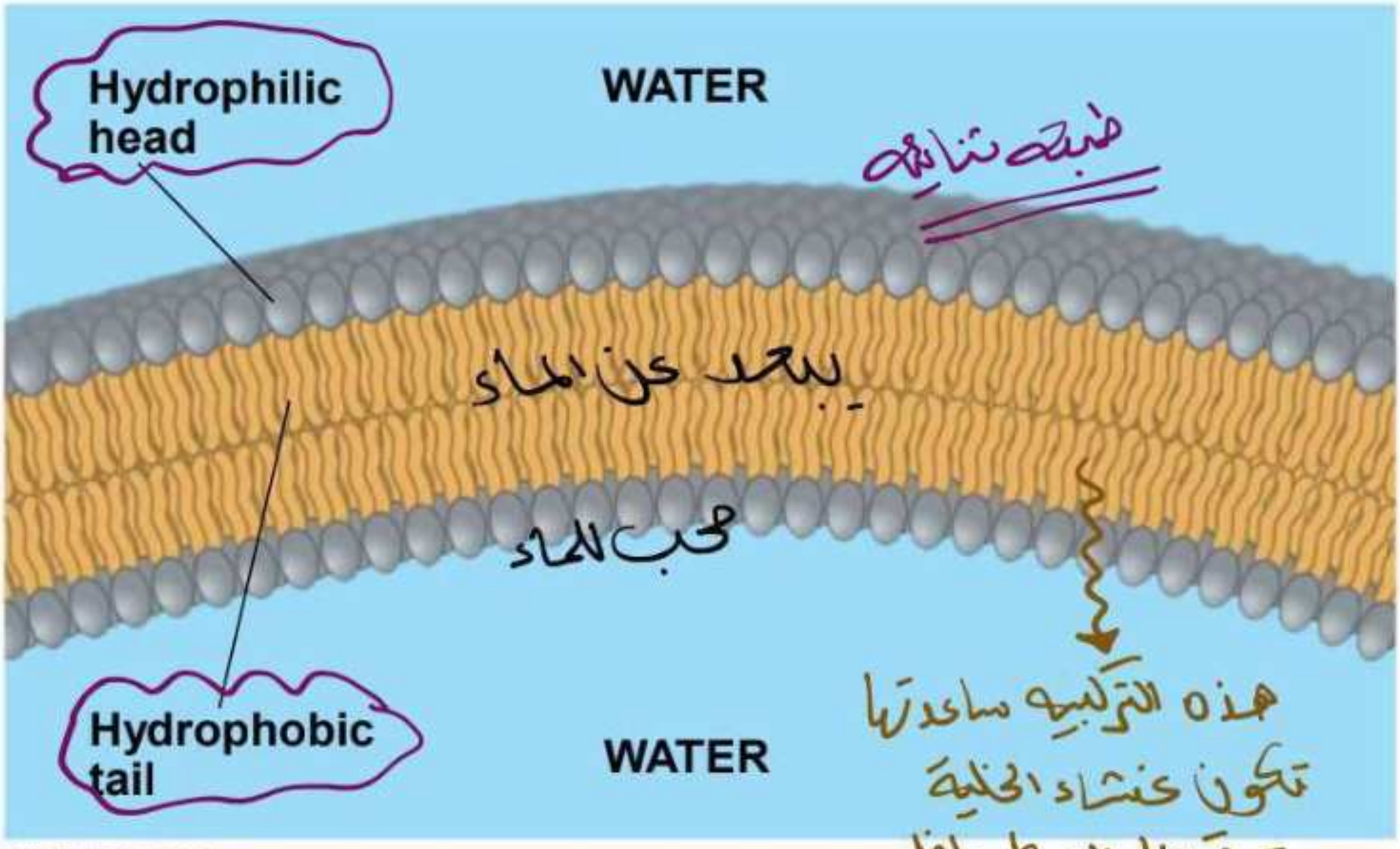
Figure 5.13



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Steroids الدهون الحلقية

- **Steroids** are lipids characterized by a carbon skeleton consisting of four fused rings
- **Cholesterol**, an important steroid, is a component in animal cell membranes
- Although cholesterol is essential in animals, high levels in the blood may contribute to cardiovascular disease

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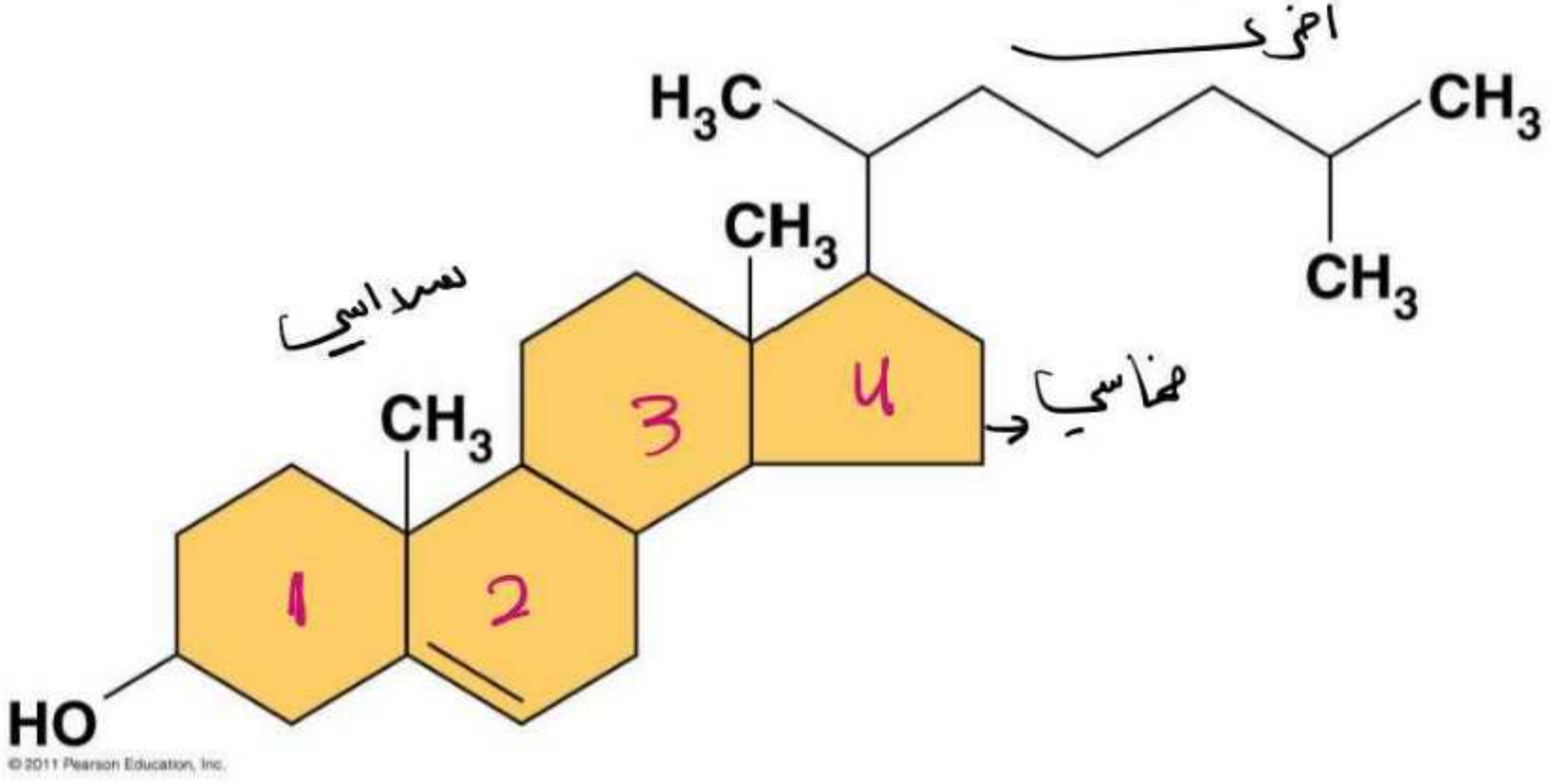
Figure 5.14

* اذا ضيف عليه شيء
لـ بيطلع مركبات



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Concept 5.4: Proteins include a diversity of structures, resulting in a wide range of functions

- Proteins account for more than 50% of the dry mass of most cells
- Protein functions include structural support, storage, transport, cellular communications, movement, and defense against foreign substances

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Figure 5.15-a

Enzymatic proteins

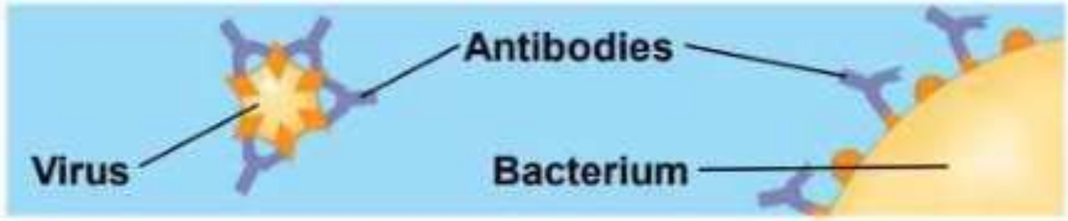
Function: Selective acceleration of chemical reactions

Example: Digestive enzymes catalyze the hydrolysis of bonds in food molecules.

Defensive proteins

Function: Protection against disease

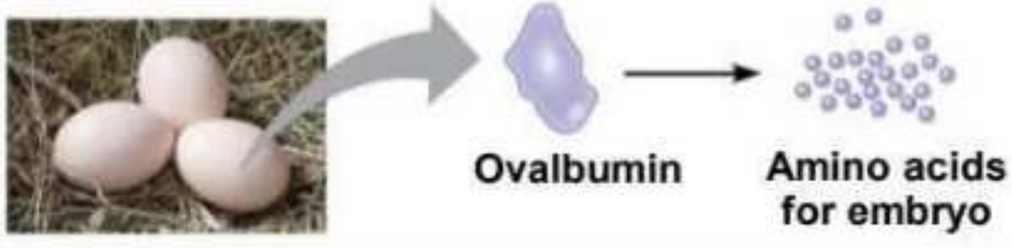
Example: Antibodies inactivate and help destroy viruses and bacteria.



Storage proteins

Function: Storage of amino acids

Examples: Casein, the protein of milk, is the major source of amino acids for baby mammals. Plants have storage proteins in their seeds. Ovalbumin is the protein of egg white, used as an amino acid source for the developing embryo.



Transport proteins

Function: Transport of substances

Examples: Hemoglobin, the iron-containing protein of vertebrate blood, transports oxygen from the lungs to other parts of the body. Other proteins transport molecules across cell membranes.

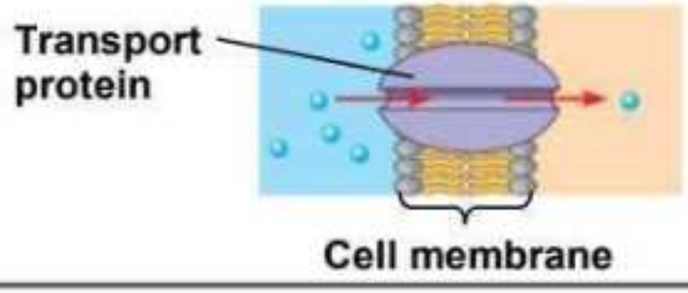


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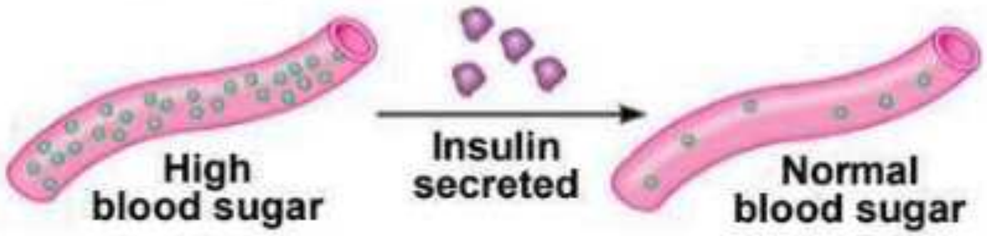
Figure 5.15-b

Hormonal proteins

Function: Coordination of an organism's activities

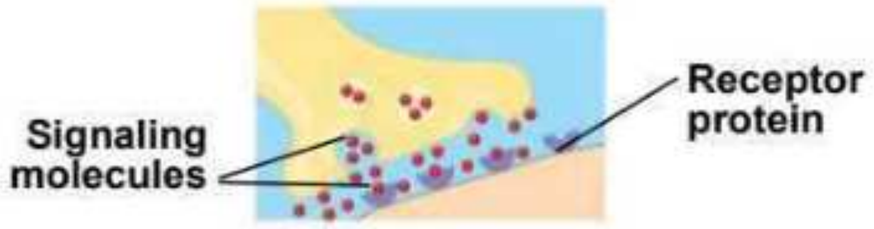
Example: Insulin, a hormone secreted by the pancreas, causes other tissues to take up glucose, thus regulating blood sugar concentration



Receptor proteins

Function: Response of cell to chemical stimuli

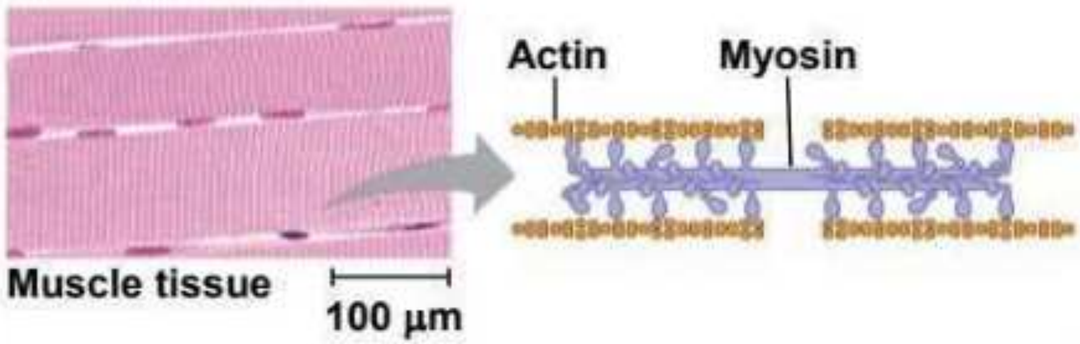
Example: Receptors built into the membrane of a nerve cell detect signaling molecules released by other nerve cells.



Contractile and motor proteins

Function: Movement

Examples: Motor proteins are responsible for the undulations of cilia and flagella. Actin and myosin proteins are responsible for the contraction of muscles.



Structural proteins

Function: Support

Examples: Keratin is the protein of hair, horns, feathers, and other skin appendages. Insects and spiders use silk fibers to make their cocoons and webs, respectively. Collagen and elastin proteins provide a fibrous framework in animal connective tissues.

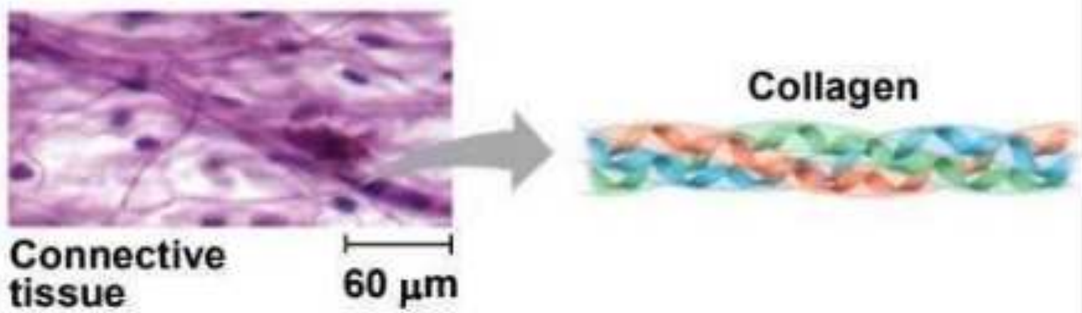


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Figure 5.15a

عامل محفز
Catalyst

* وظائف البروتين : 8

The main to speed up Proteins reaction

without changing

Enzymatic proteins

افتراضي ← كل انزيم بيعتاد لمتفاعل معين يكون

التفاعلات الكيميائية

Function: Selective acceleration of chemical reactions

التسريع

Example: Digestive enzymes catalyze the hydrolysis of bonds in food molecules.

الغذاء الماكل — كيخن

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Figure 5.15b

Storage proteins

Function: Storage of amino acids

Examples: Casein, the protein of milk, is the major source of amino acids for baby mammals. Plants have storage proteins in their seeds. Ovalbumin is the protein of egg white, used as an amino acid source for the developing embryo.

Ovalbumin

Amino acids for embryo

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Figure 5.15c

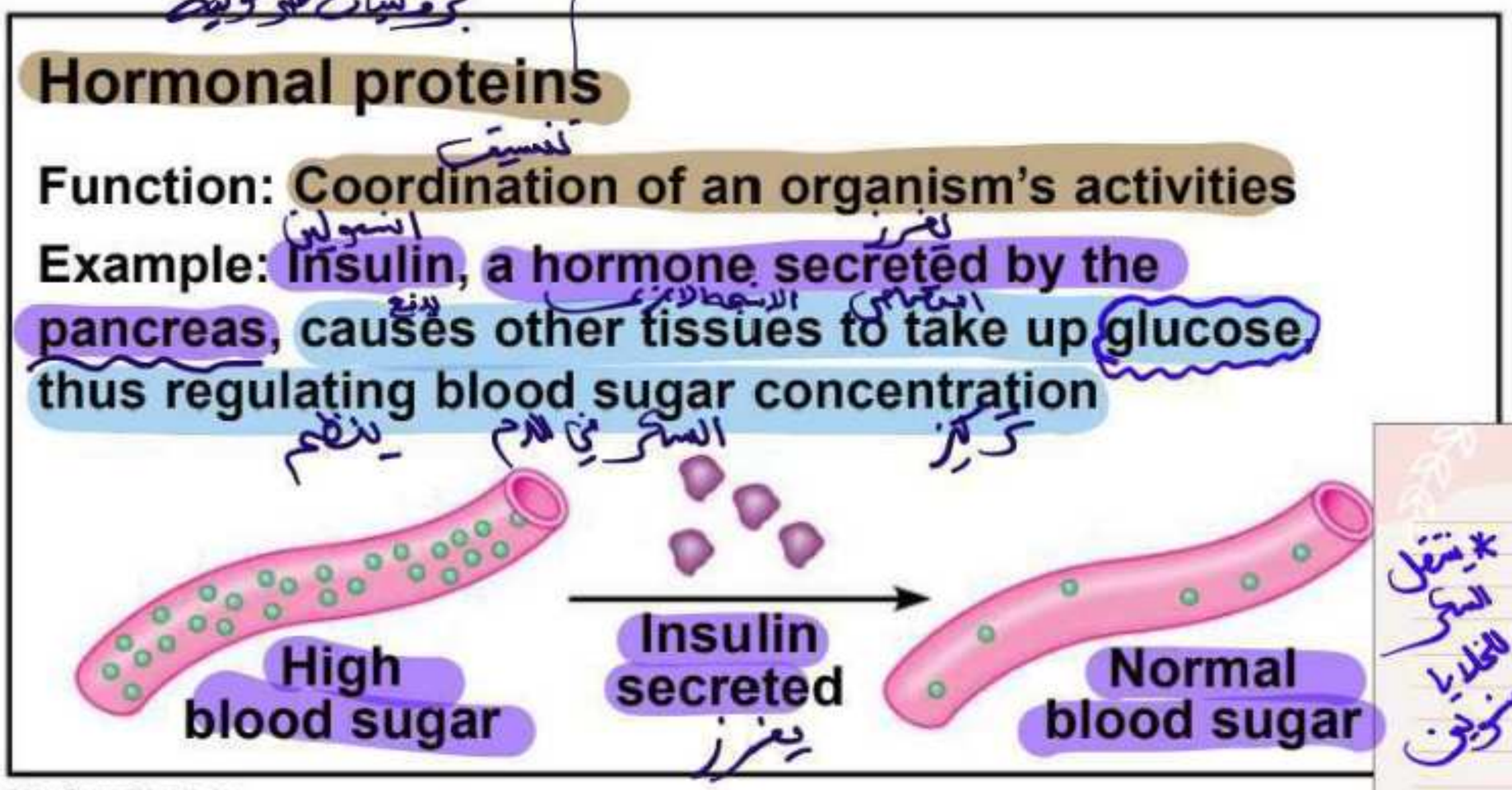

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Figure 5.15d

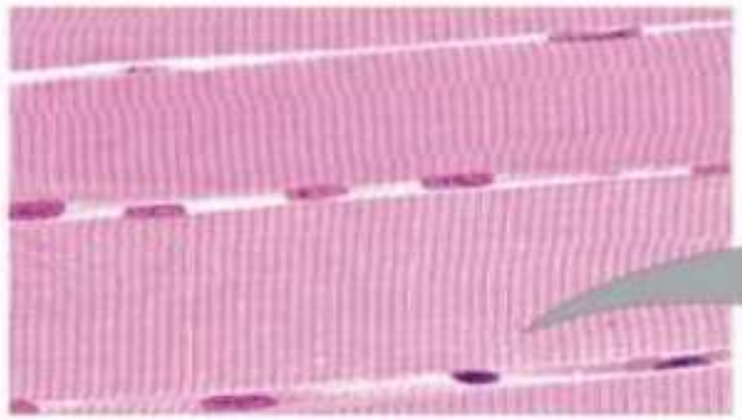
Contractile and motor proteins

Function: Movement

Examples: Motor proteins are responsible for the undulations of cilia and flagella. Actin and myosin proteins are responsible for the contraction of muscles.

Actin
Myosin
Contractile

Cilia and flagella
Motor



Muscle tissue

100 μm

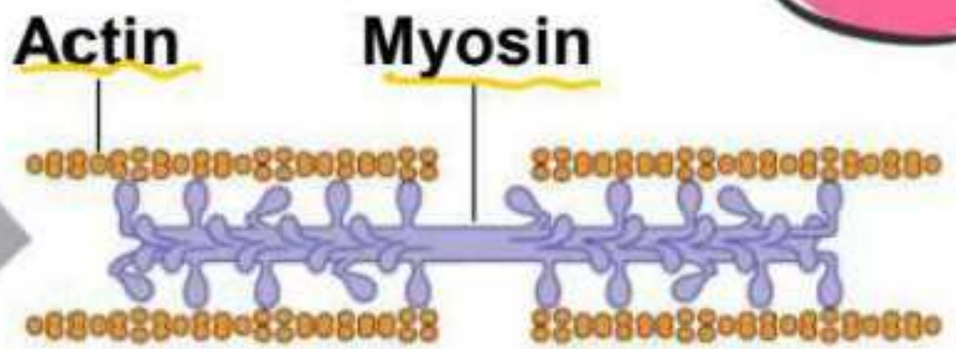


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Figure 5.15e

Defensive proteins

Function: Protection against disease

Example: Antibodies inactivate and help destroy viruses and bacteria.

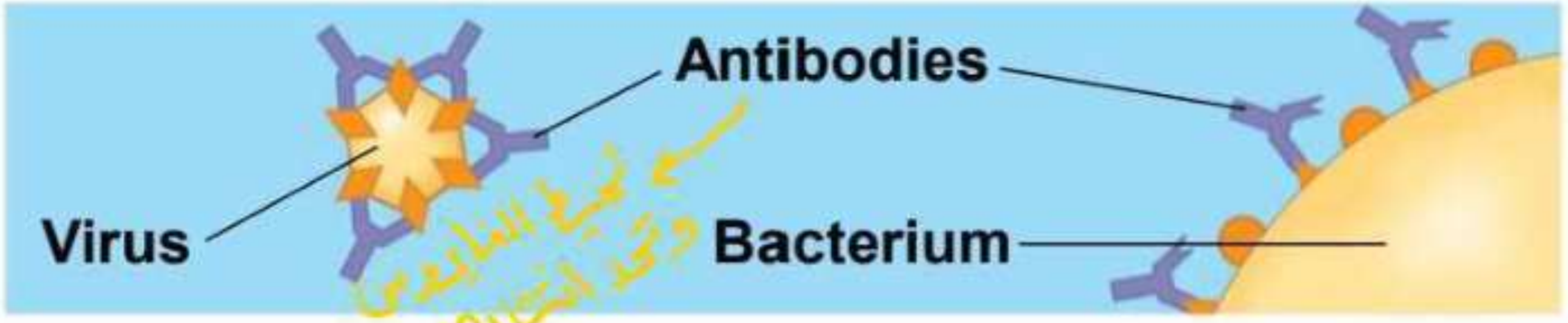

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Figure 5.15f

Transport proteins

Function: Transport of substances

Examples: Hemoglobin, the iron-containing protein of vertebrate blood, transports oxygen from the lungs to other parts of the body. Other proteins transport molecules across cell membranes.

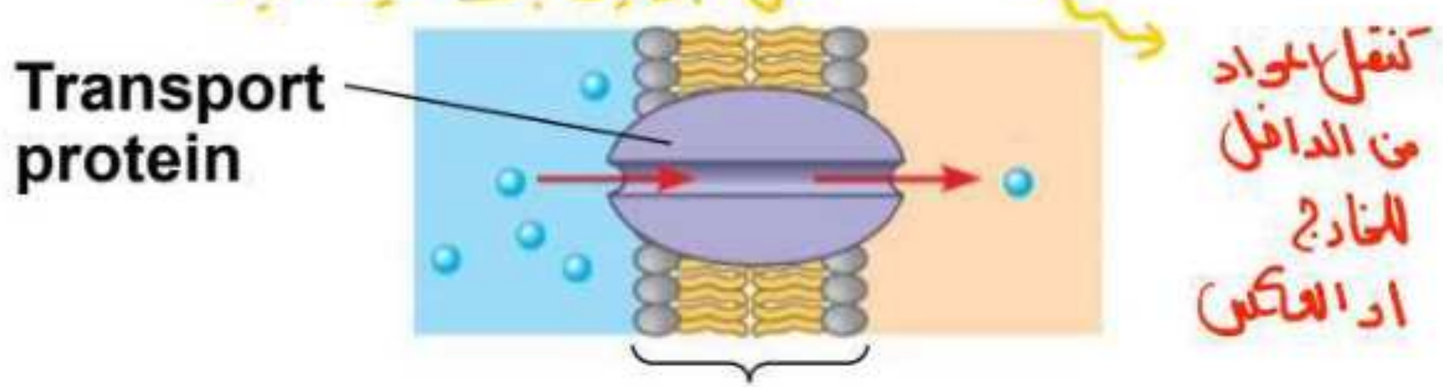

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Figure 5.15g

في خلايا على سطحها مستقبلات (بروتينات)

بروتينات مستقبله

Receptor proteins

الاشارات
محفزات كيميائيه

استجابة

Function: Response of cell to chemical stimuli

مستقبلات مدمجة

Example: Receptors built into the membrane of a nerve cell detect signaling molecules released by other nerve cells.

خلايا عصبيه — الاشارات — محفزات — الصادرة

بتنتقل الاشارات العصبيه بين النواقل العصبية

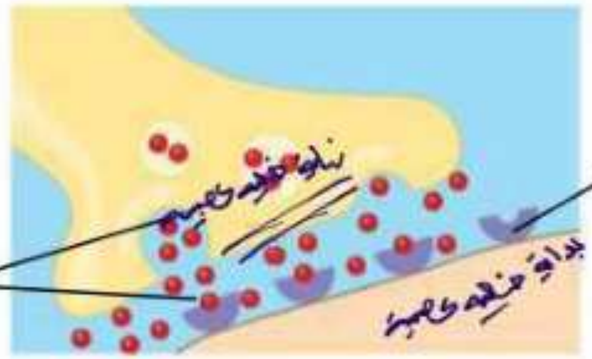

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Figure 5.15h

تدخل في البنيه

Structural proteins

في المنطقة اليابسة (الخارجيه)

Function: Support

تكون الحيوانات

Examples: Keratin is the protein of hair, horns, feathers, and other skin appendages. Insects and spiders use silk fibers to make their cocoons and webs, respectively. Collagen and elastin proteins provide a fibrous framework in animal connective tissues.

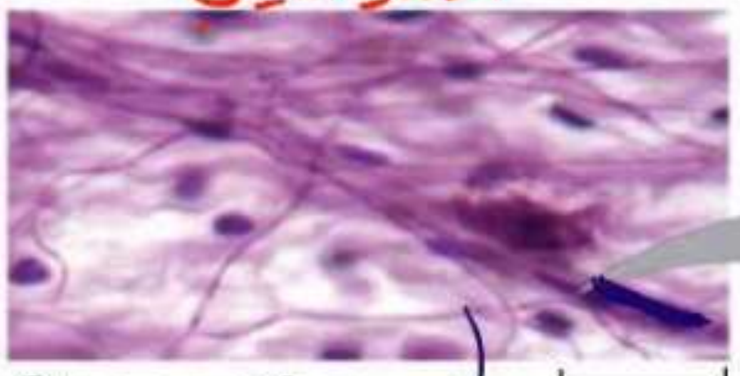
مثل الطيور

شبكات

حرير العنكبوت

الاطار الليفي

في الانسجه الضامة الحيوانية



Connective tissue

Elastin

60 μm

Collagen

انسجه ضامه

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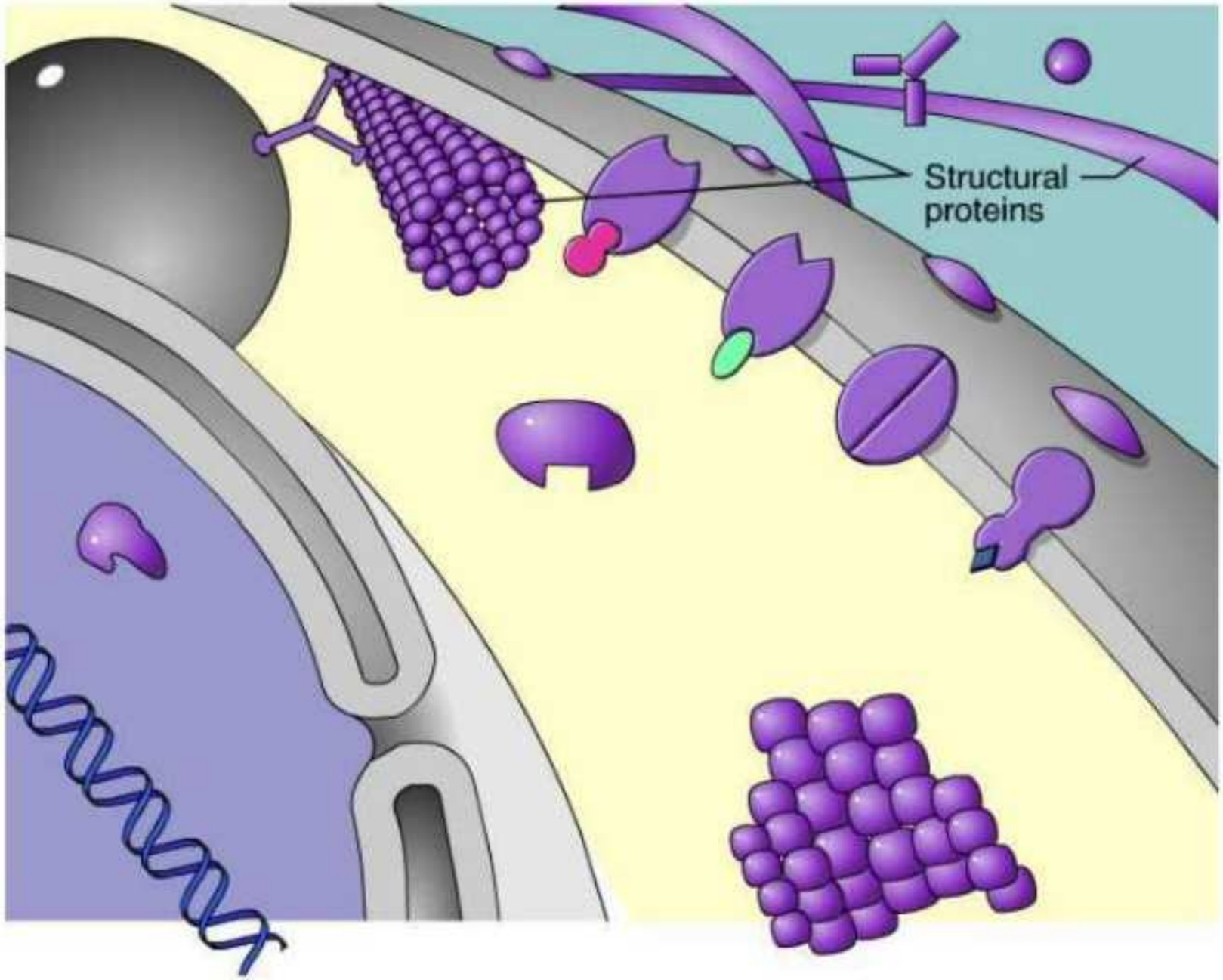

Animation: Structural Proteins

Right-click slide / select "Play"

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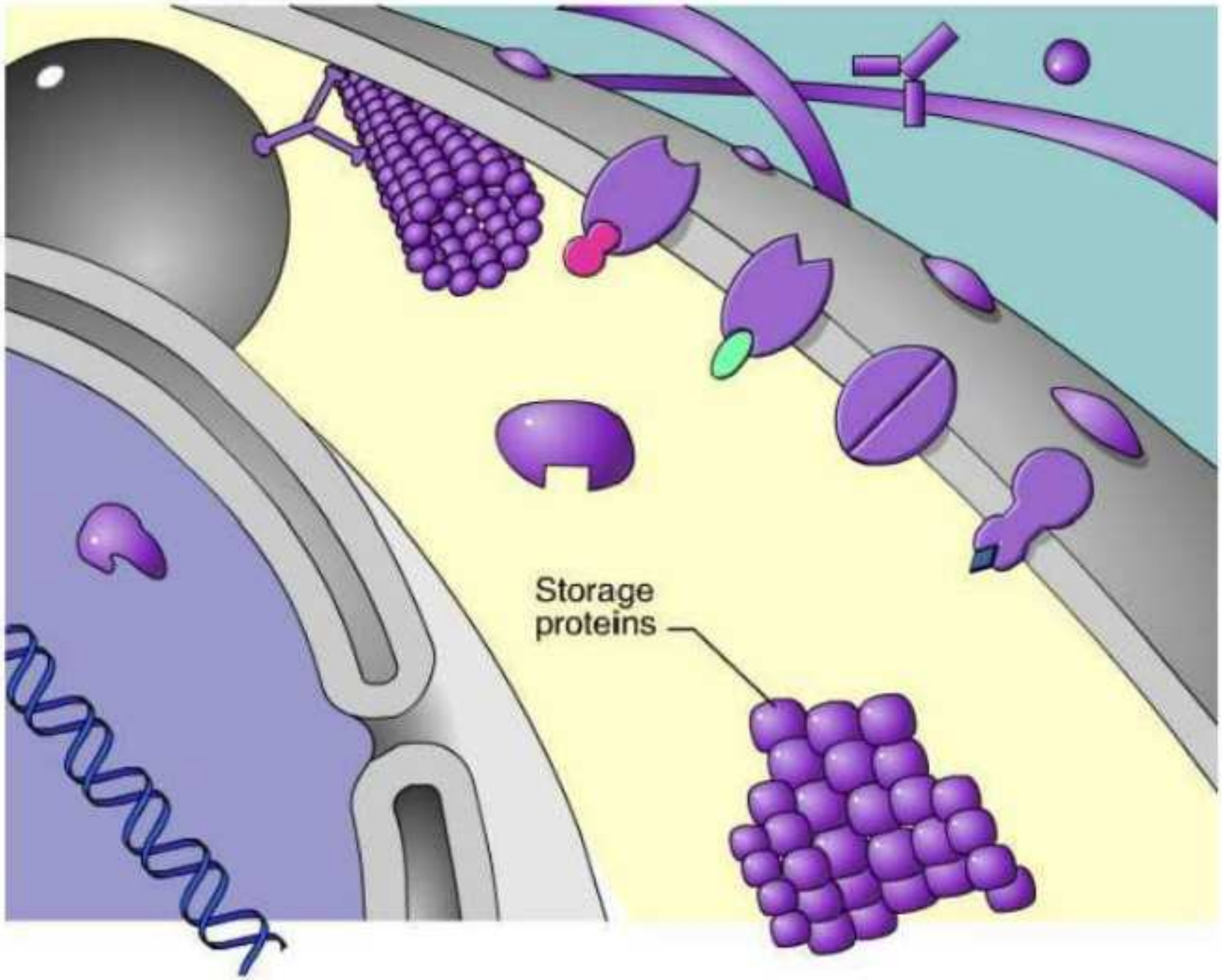

Animation: Storage Proteins

Right-click slide / select “Play”

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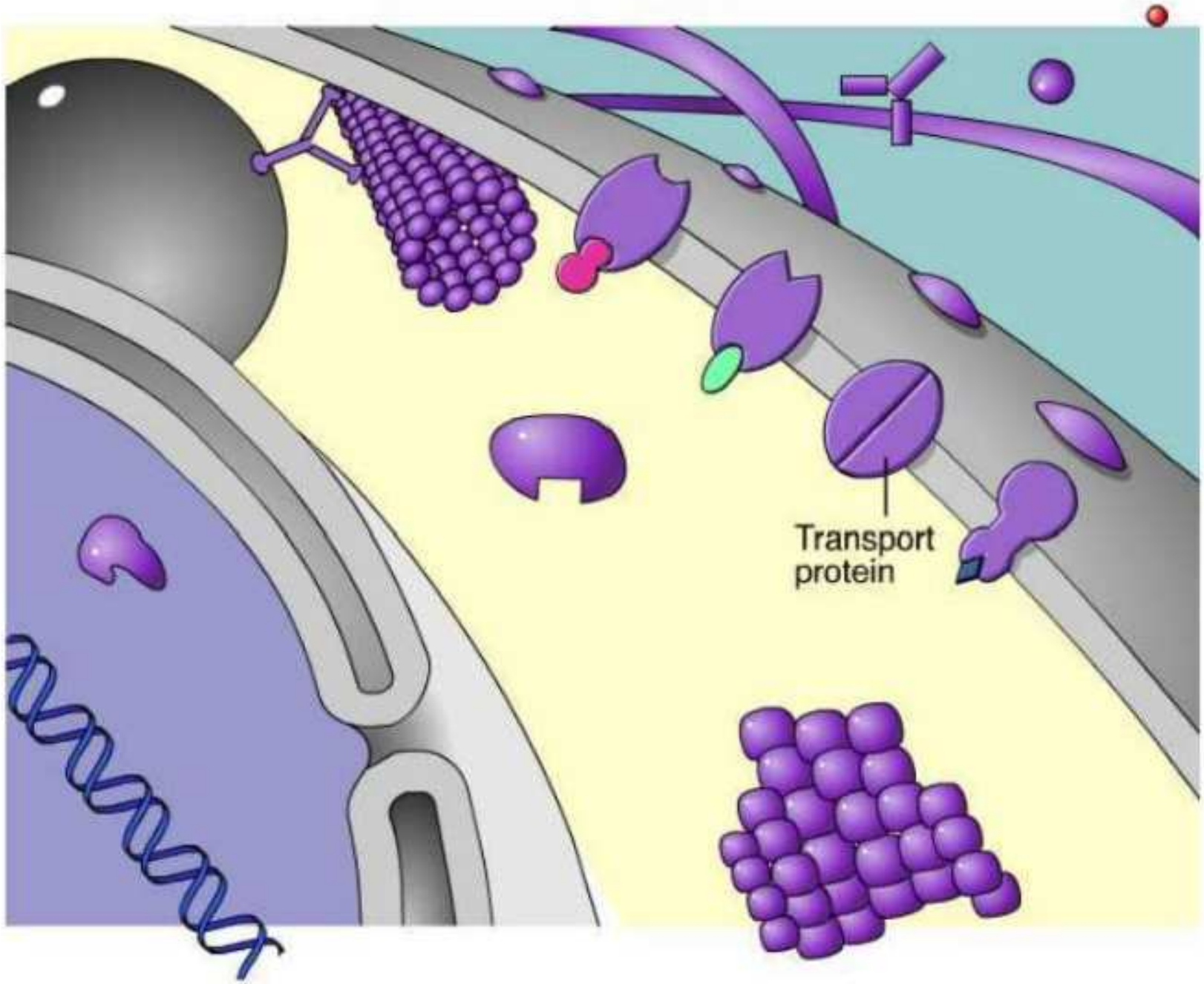

Animation: Transport Proteins

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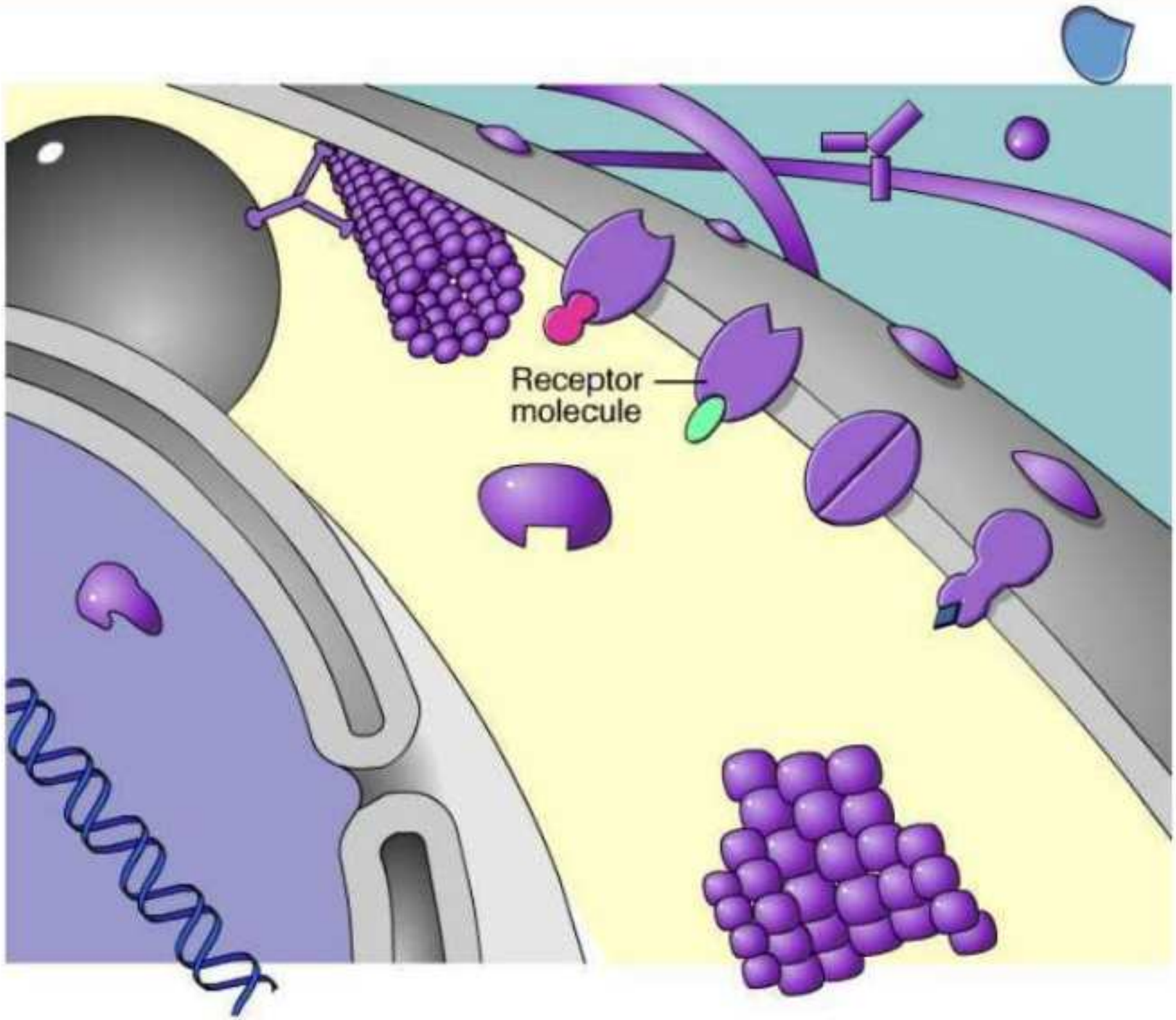

Animation: Receptor Proteins

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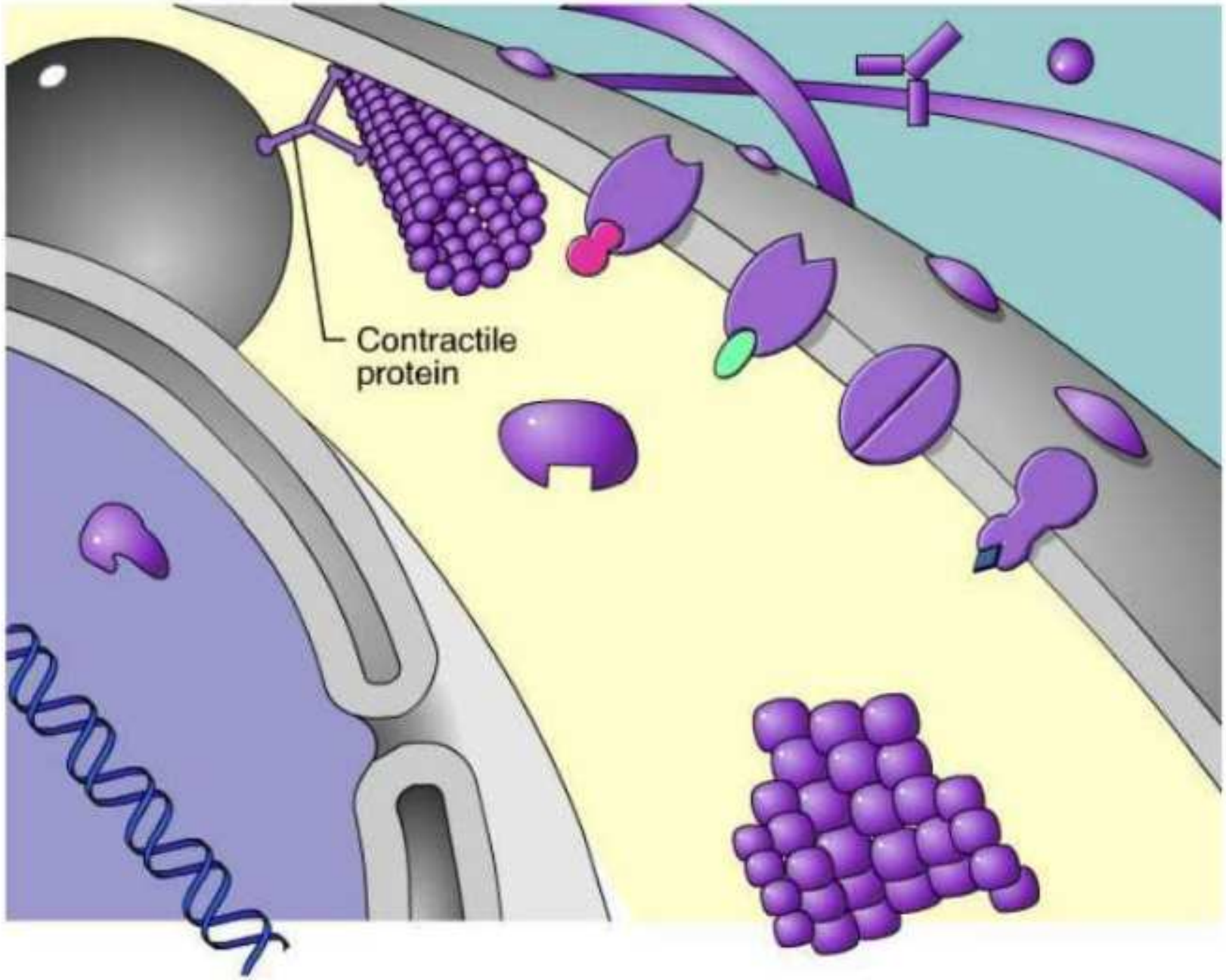

Animation: Contractile Proteins

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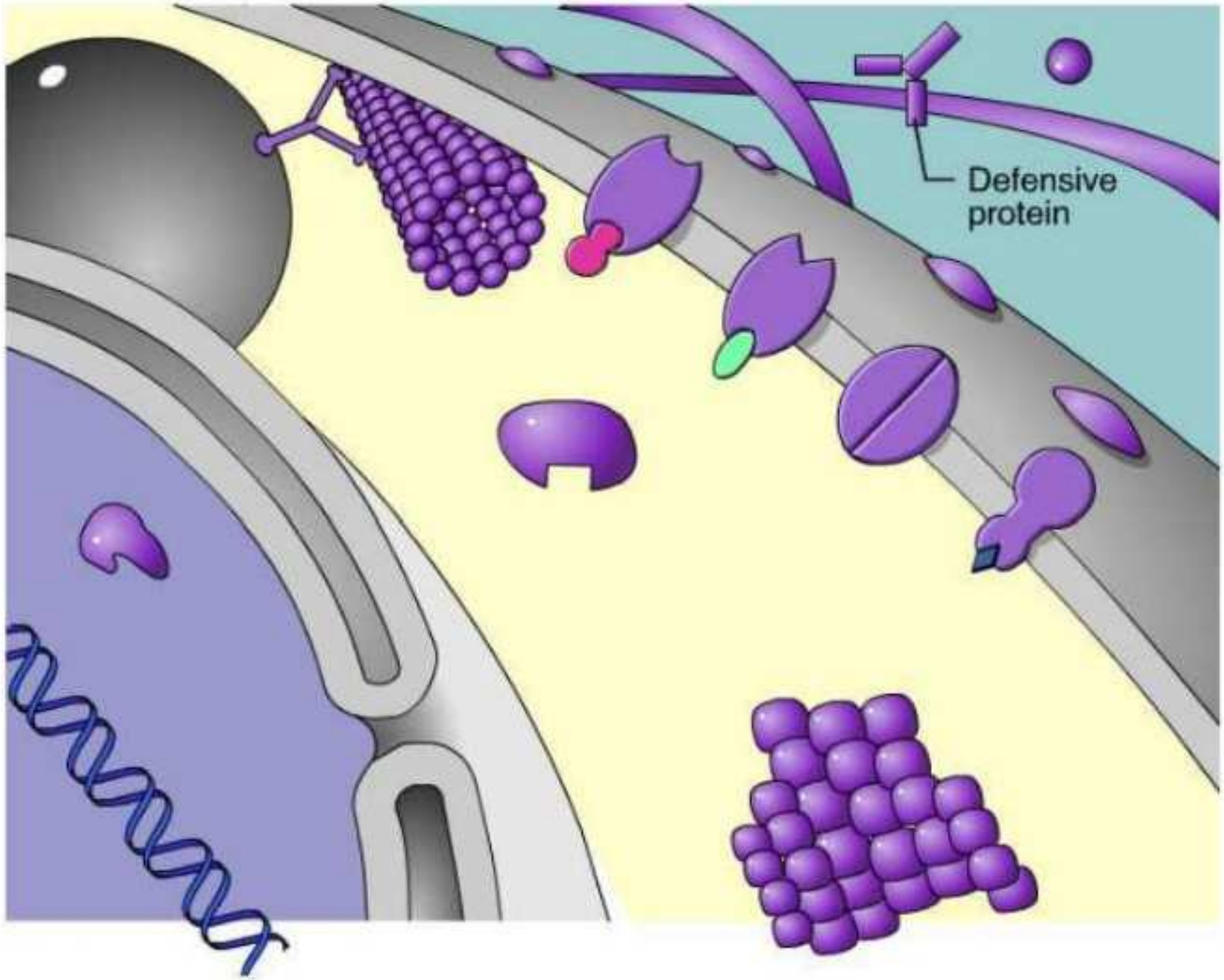

Animation: Defensive Proteins

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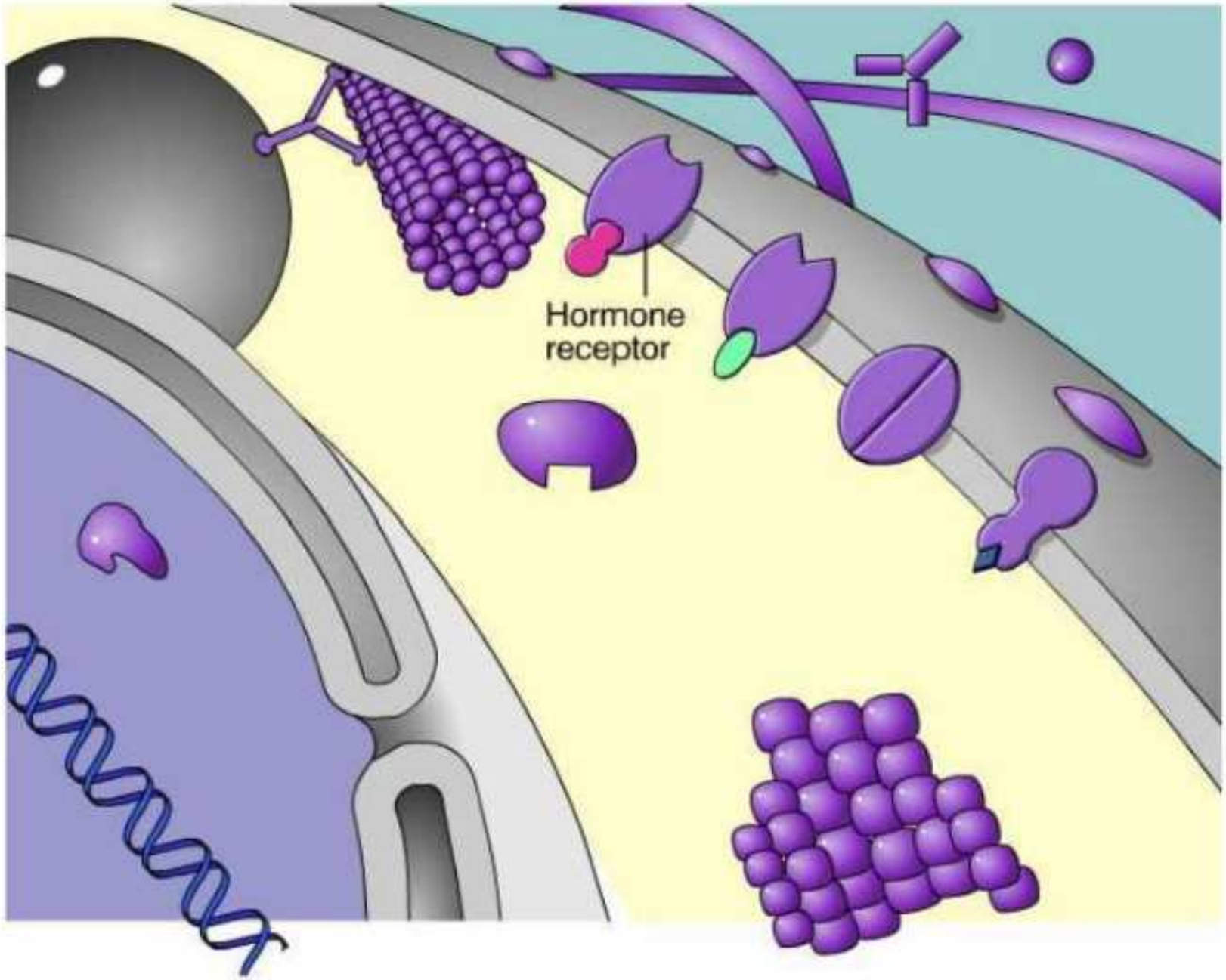

Animation: Hormonal Proteins

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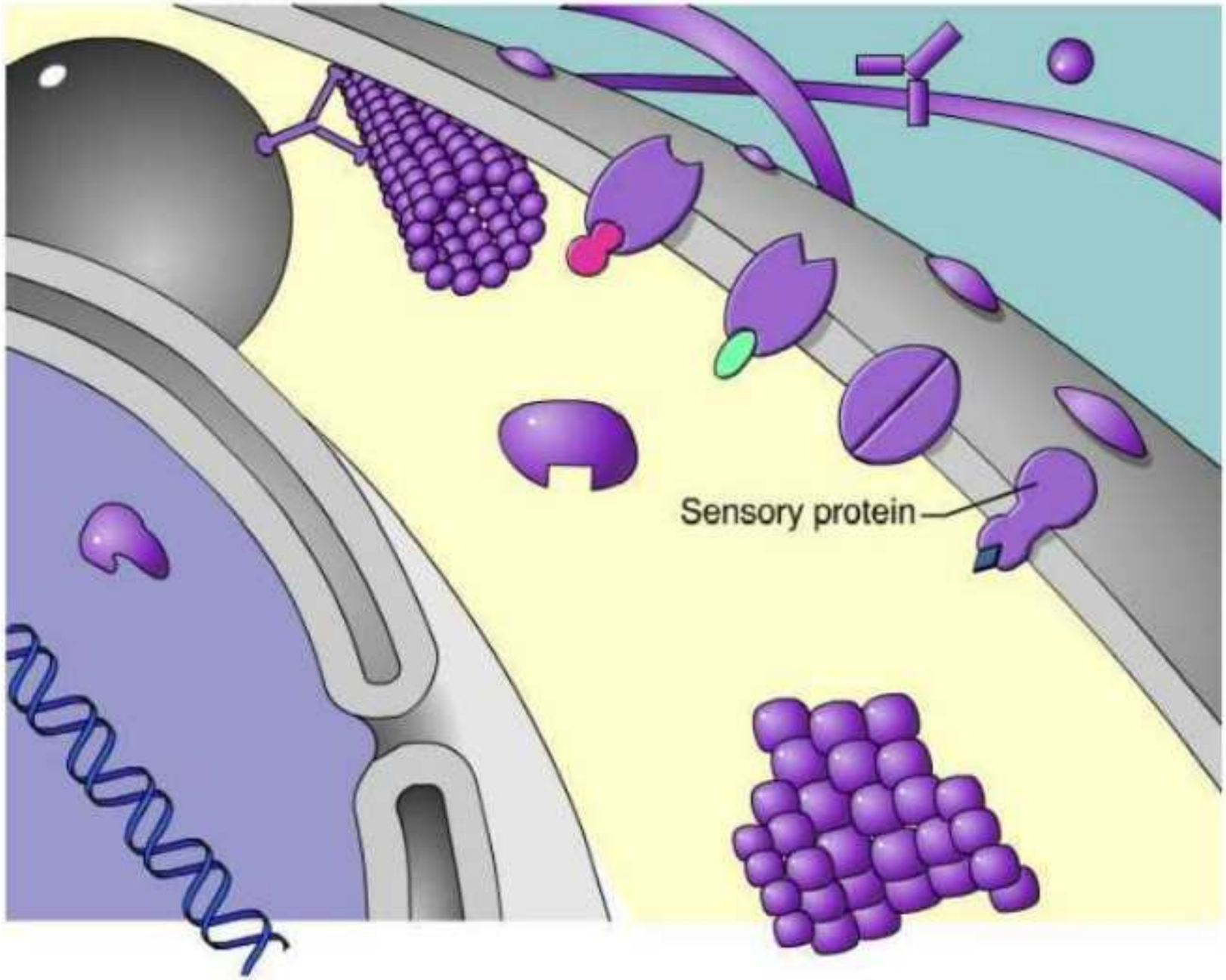

Animation: Sensory Proteins
Right-click slide / select "Play"

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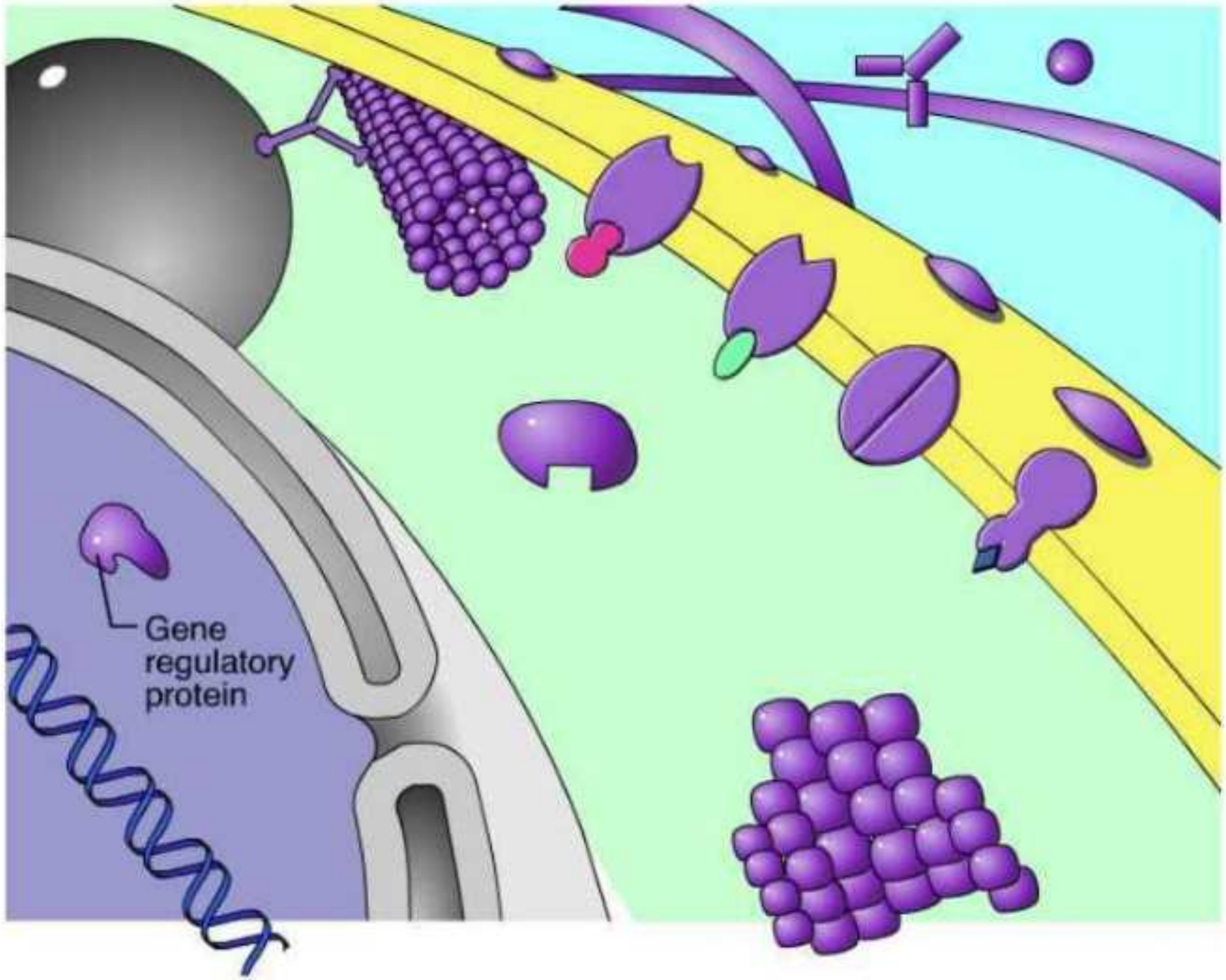

Animation: Gene Regulatory Proteins

Right-click slide / select "Play"

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- **Enzymes** are a type of protein that acts as a **catalyst** to speed up chemical reactions
- Enzymes can perform their functions repeatedly, functioning as workhorses that carry out the processes of life

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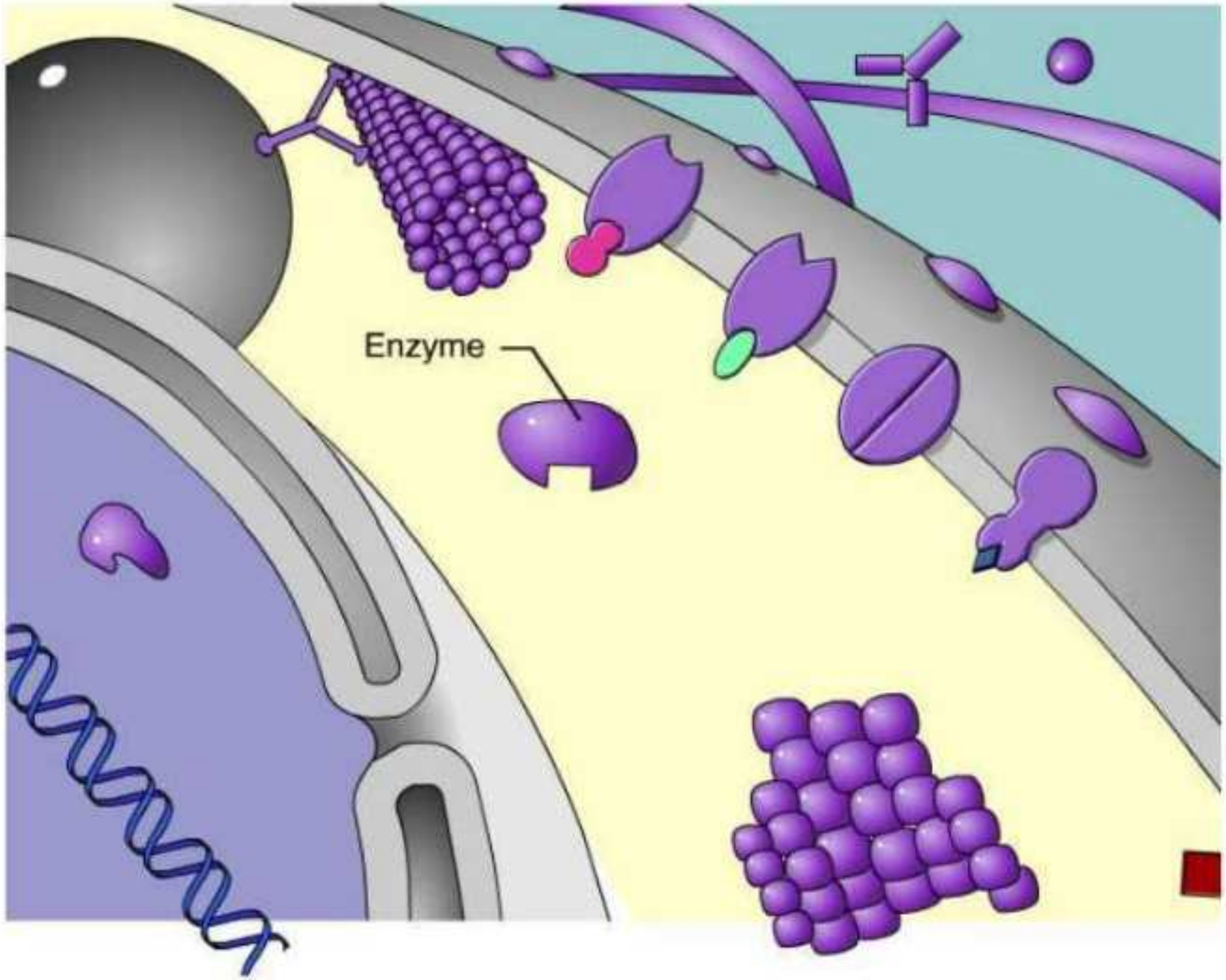

Animation: Enzymes
Right-click slide / select "Play"

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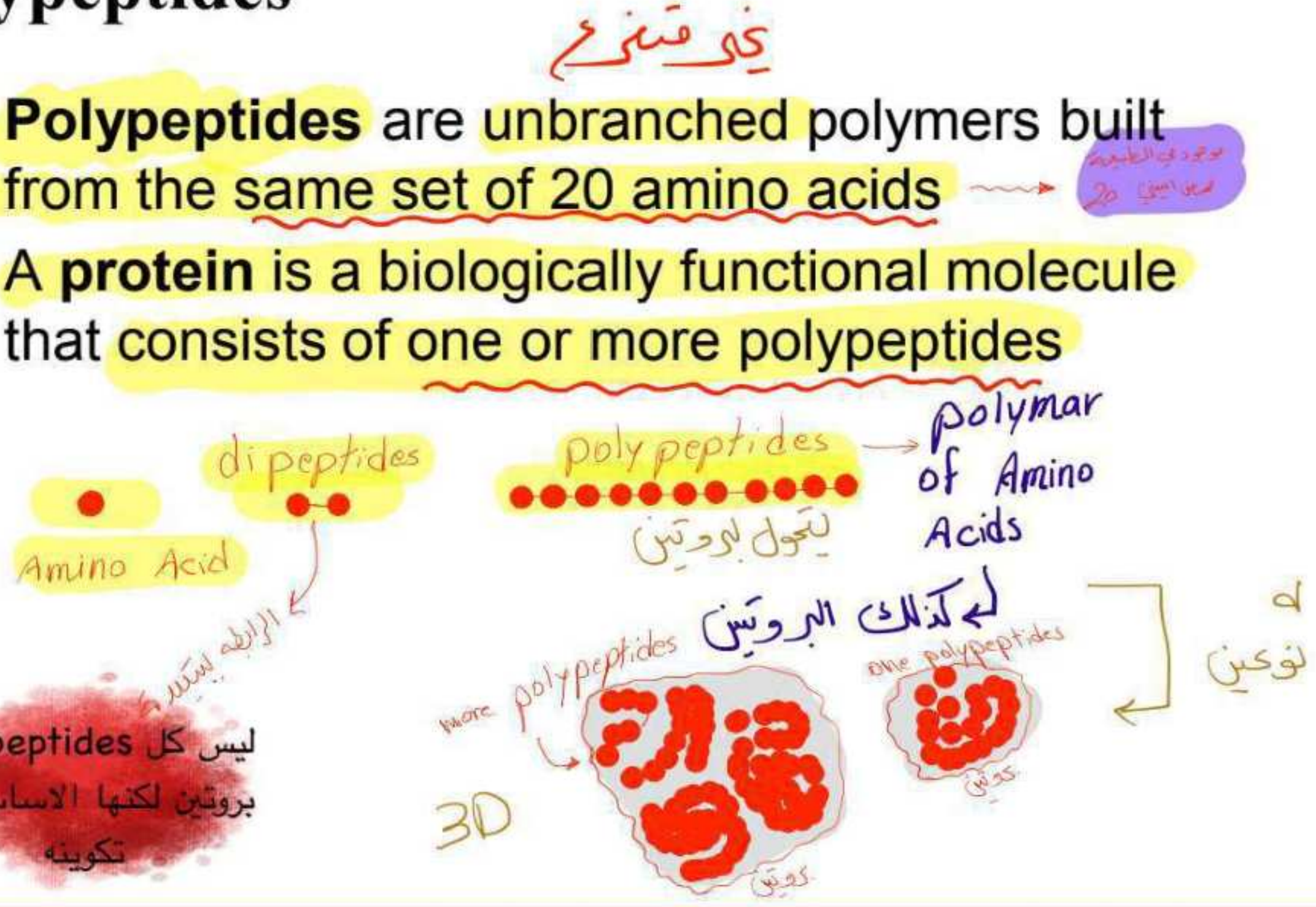
Polypeptides

- **Polypeptides** are unbranched polymers built from the same set of 20 amino acids
- A **protein** is a biologically functional molecule that consists of one or more polypeptides



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Amino Acid Monomers

All of them تشابهوا molecular formula

- **Amino acids** are organic molecules with carboxyl and amino groups
- Amino acids differ in their properties due to differing side chains, called R groups

مجموعات الكربوكسيل الامينية

خصائصها

السلاسل الجانبية

بتختلف بخصائصها بسبب اختلافها بالسلاسل الجانبية 🤓

تتكون من ذرة كربون مركزية ترتبط بـ 4 مجموعات مختلفة

تسمى ألفا كربون

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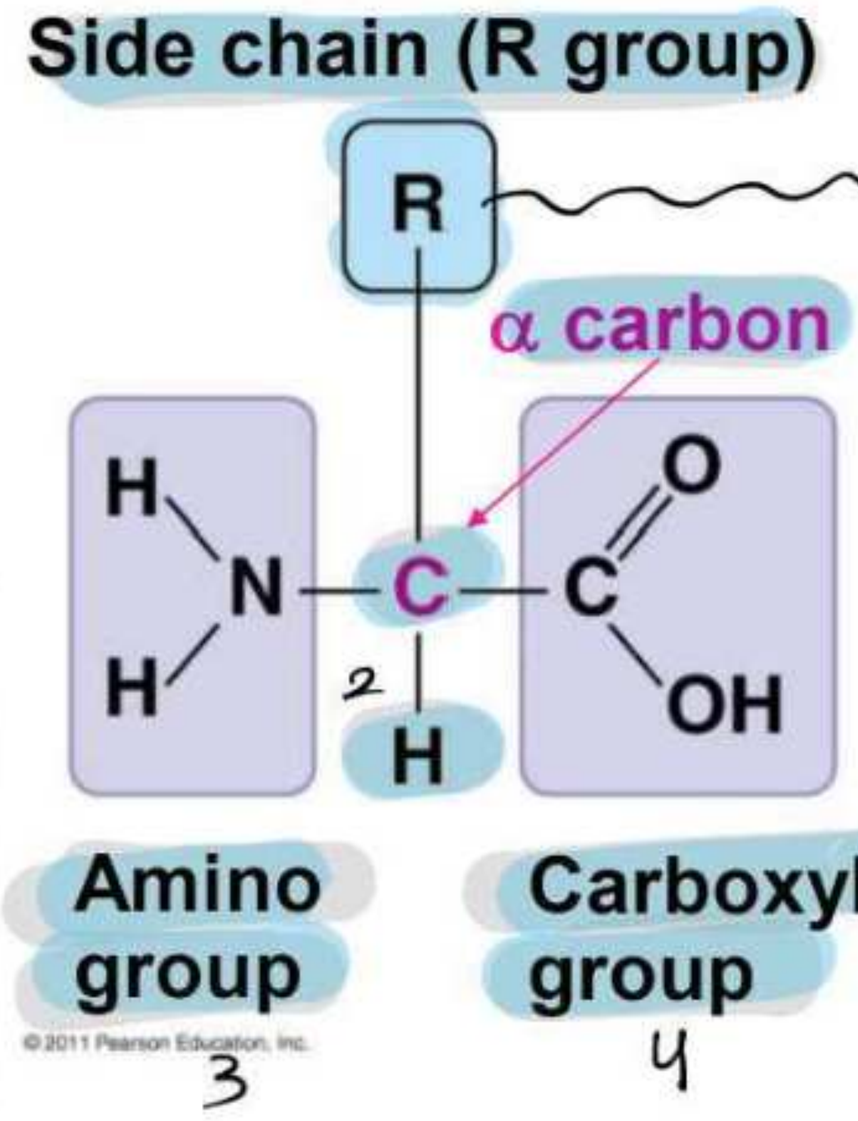
Figure 5.UN01

المجموعات



الاساس في تنوع ال Amino acids

جسم الانسان يحتاج ال ٢٠ نوع من ال amino acids لكن ما بيقدر يصنعهم كلهم شو رح يعمل ؟😟

بنحصل عليهم من الغذاء يلي بيحتوي على البروتين وخصوصا البروتينات الحيوانية او بناخذ مجموعة كاملة من البروتينات النباتية (خلط اكثر من بروتين نباتي) بنسمي ال amino acids يلي ما بنقدر نصنعها essential amino acids 😎

Figure 5.16

R group ←

ماعنده كربون α
عنده تشابه

حسب الـ R-group
تصنف الـ Amino acids إلى :

Nonpolar side chains; hydrophobic

Side chain (R group)

تكون

Amino Acid ← ابسط

Glycine (Gly or G)

Alanine (Ala or A)

Valine (Val or V)

Leucine (Leu or L)

Isoleucine (Ile or I)

Methionine (Met or M)

Phenylalanine (Phe or F)

Tryptophan (Trp or W)

Proline (Pro or P)

- حفظ اكثر جدول
- اذا اجاني واحد منهم لازم اعرف كصنيفه

Polar side chains; hydrophilic

Serine (Ser or S)

Threonine (Thr or T)

Cysteine (Cys or C)

Tyrosine (Tyr or Y)

Asparagine (Asn or N)

Glutamine (Gln or Q)

R مجموعة عليها شحنه

Electrically charged side chains; hydrophilic

Basic (positively charged)

Acidic (negatively charged)

Aspartic acid (Asp or D)

Glutamic acid (Glu or E)

Lysine (Lys or K)

Arginine (Arg or R)

Histidine (His or H)

اذا كانت R-group تحتوي على extra COOH شحنتها سالبة تكون

extra تحتوي على NH_3^+ تكون موجبة

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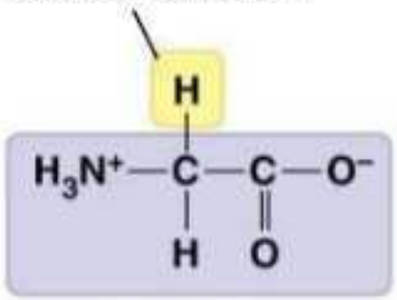
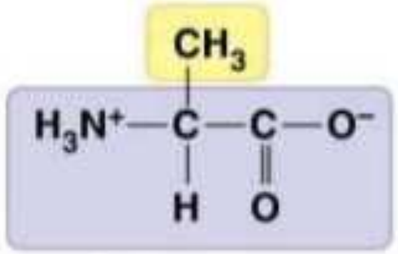
Figure 5.16a

Nonpolar side chains; hydrophobic

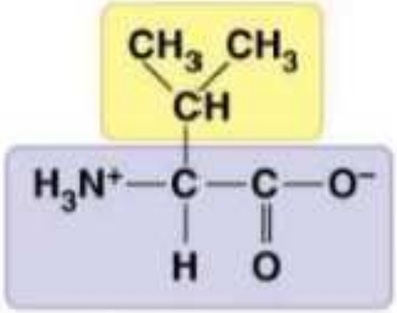
Side chain



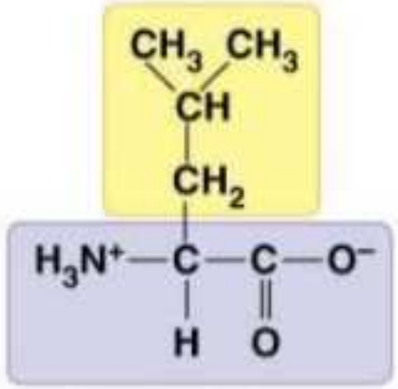
Glycine
(Gly or G)



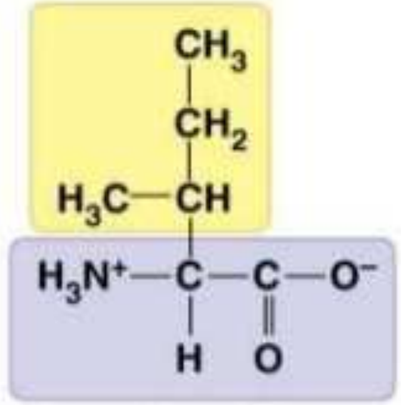
Alanine
(Ala or A)



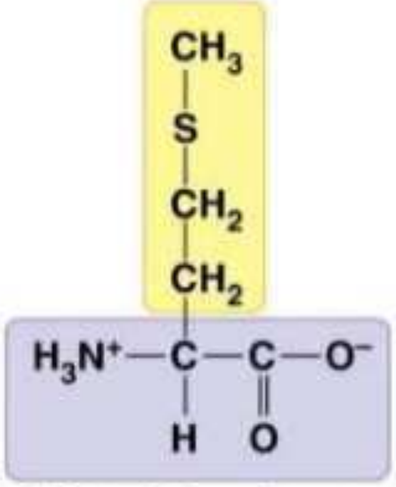
Valine
(Val or V)



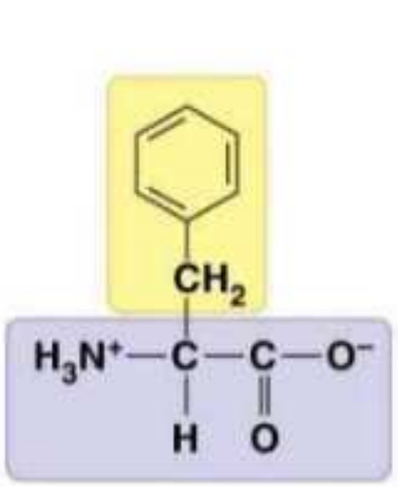
Leucine
(Leu or L)



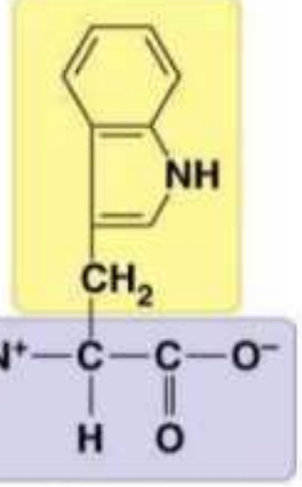
Isoleucine
(Ile or I)



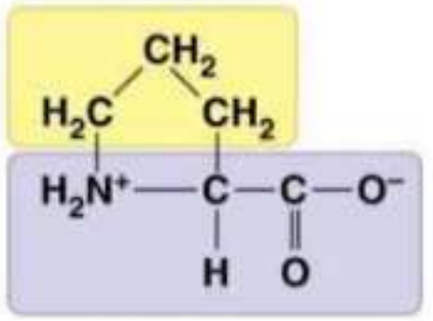
Methionine
(Met or M)



Phenylalanine
(Phe or F)



Tryptophan
(Trp or W)



Proline
(Pro or P)

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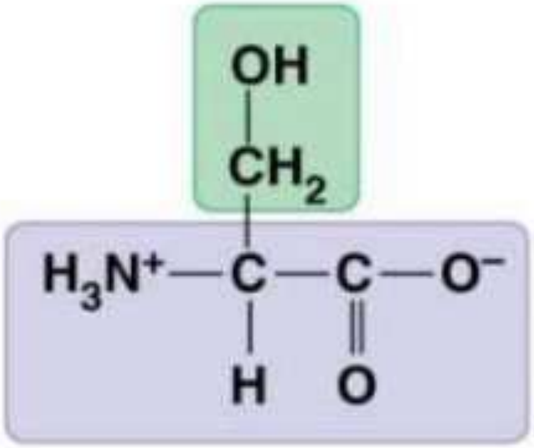
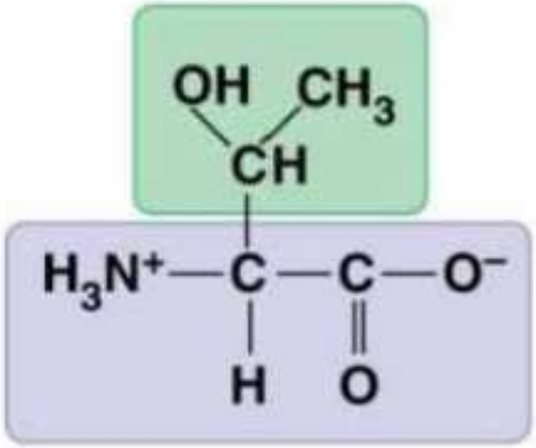
Figure 5.16b

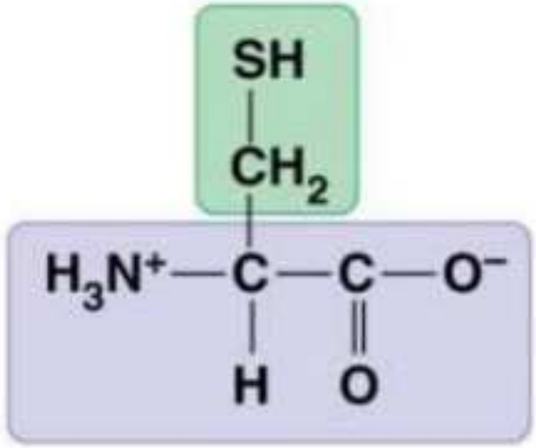
Polar side chains; hydrophilic



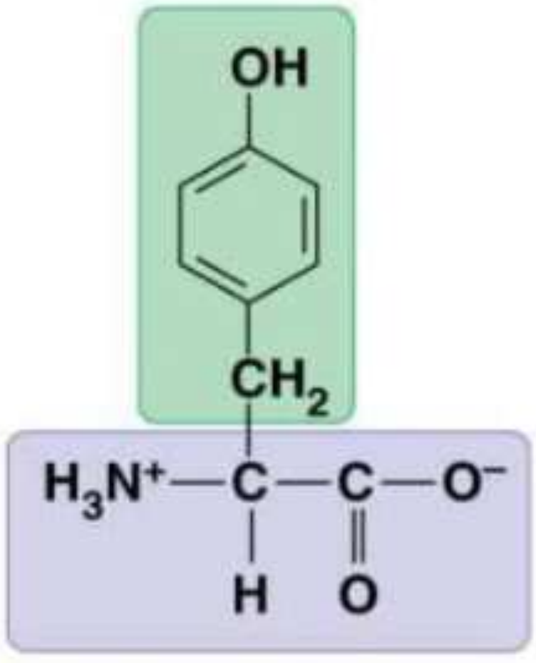
Serine (Ser or S)



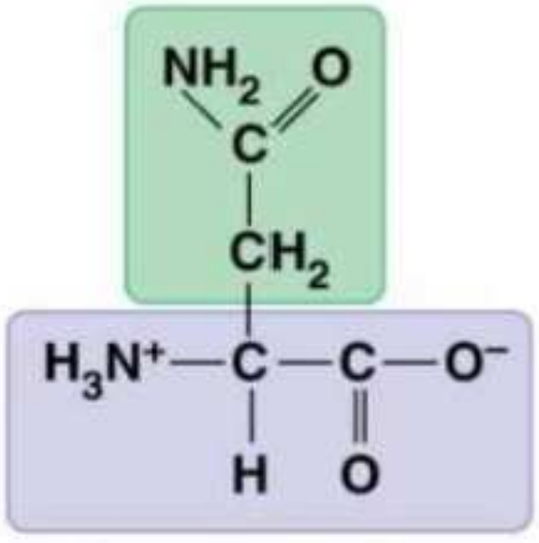
Threonine (Thr or T)



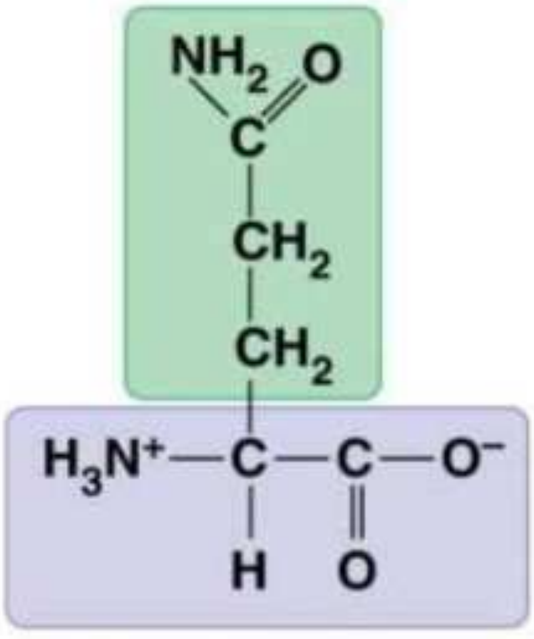
Cysteine (Cys or C)



Tyrosine (Tyr or Y)



Asparagine (Asn or N)



Glutamine (Gln or Q)

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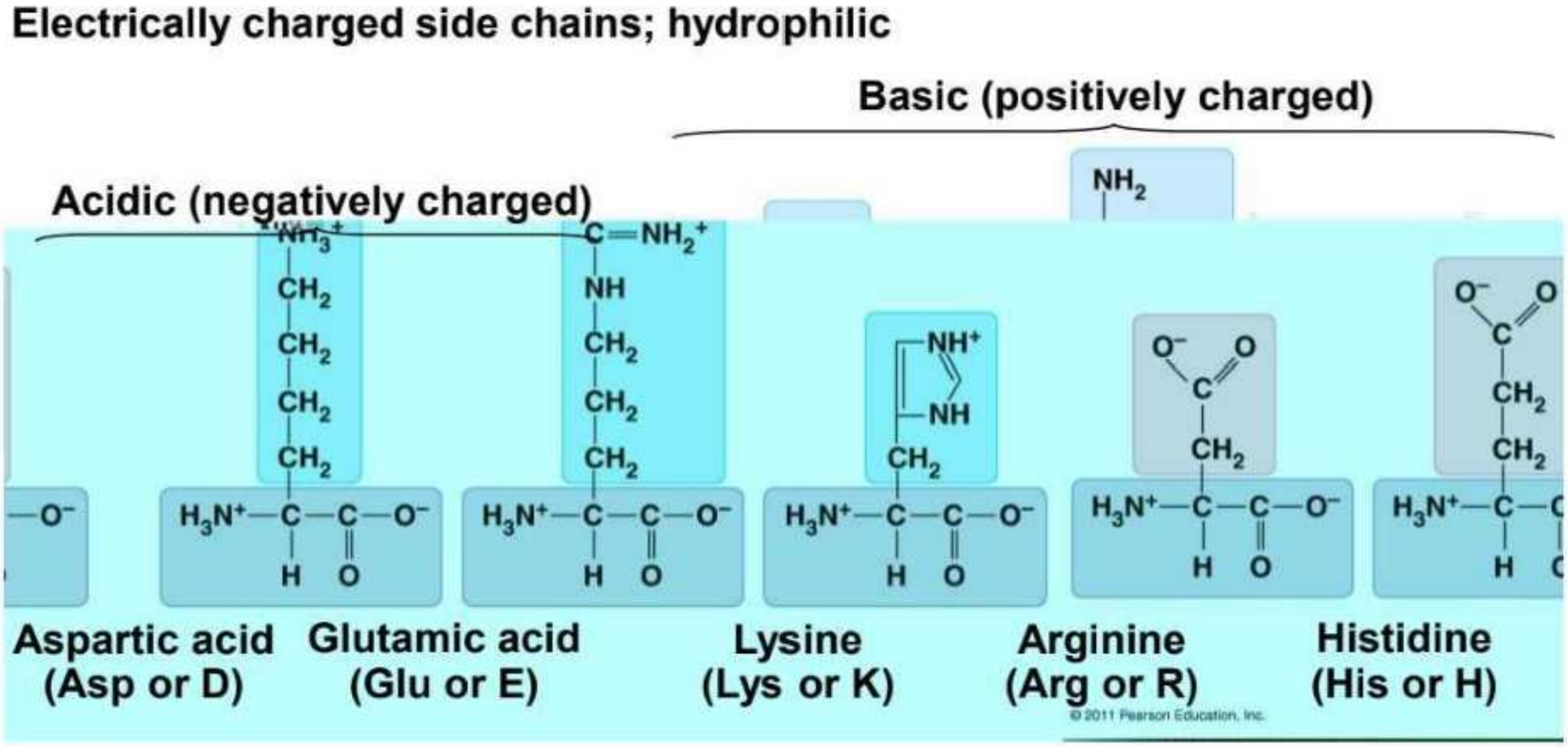
Figure 5.16c


Electrically charged side chains; hydrophilic
Basic (positively charged)
Acidic (negatively charged)
Aspartic acid (Asp or D)
Glutamic acid (Glu or E)
Lysine (Lys or K)
Arginine (Arg or R)
Histidine (His or H)
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R-group يسقد مضاعفه ب

Amino Acid Polymers

* الي ارابطه

- Amino acids are linked by **peptide bonds**
- A polypeptide is a polymer of amino acids
- Polypeptides range in length (هو لها يتفاوت) from a few to more than a thousand monomers
- Each polypeptide has a unique linear sequence of amino acids, with a carboxyl end (C-terminus) and an amino end (N-terminus)

تسلسل خطي

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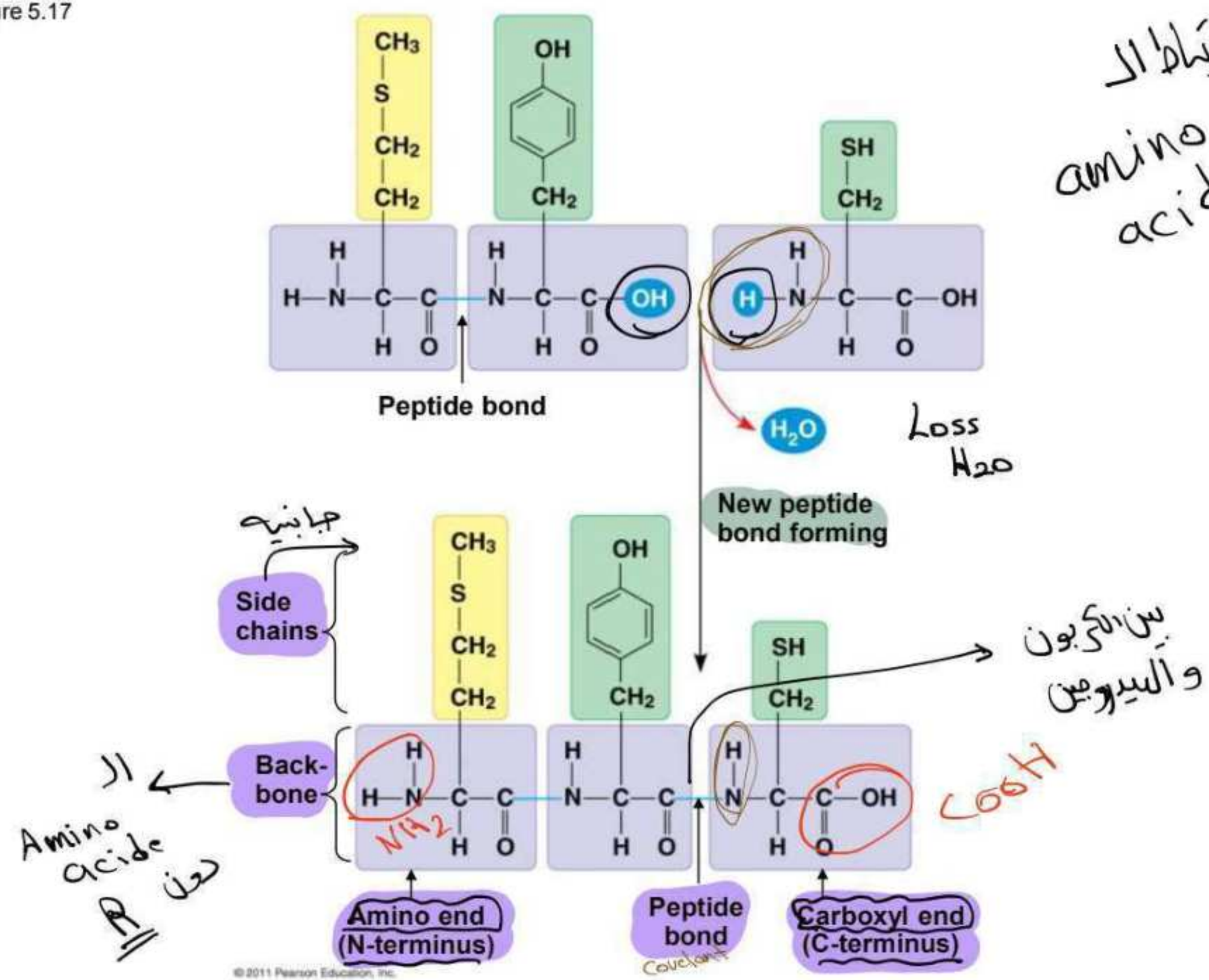
Figure 5.17


CH3
S
CH2
CH2
OH
CH2
SH
CH2
H
N
C
C
O
OH
Peptide bond
H2O
New peptide bond forming
Side chains
Back-bone
Amino end (N-terminus)
Peptide bond
Carboxyl end (C-terminus)
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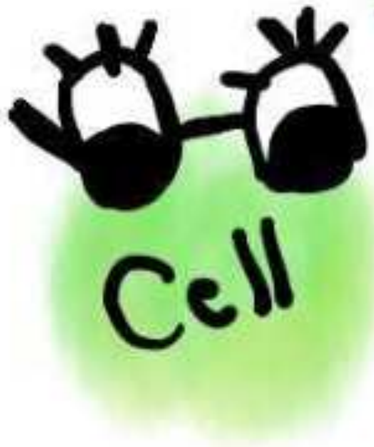
Protein Structure and Function

- A functional protein consists of one or more polypeptides precisely twisted (ملتوية), folded (مطويه), and coiled (للفونه) into a unique shape

Each protein consists of one or more than one polypeptides 😚

يف بتكون البروتين وكيف بصير Functional ؟

The polypeptide is non-functional عشان هيك ما بحكي عنها بروتين



عن طريق الشيفرة الوراثية

خلية طلب منها الجسم تصنع بروتين معين لا تعلم صفاته او مكوناته ؟ بتاخذ معلومات هذا البروتين عن طريق الخلية الام التي انقسمت منها وبالتالي تكون المعلومات عن هذا البروتين متوارثه

تخزن اي معلومة بتحملها عن هذا البروتين

* اذا معلومات عن تركيب البروتين تاخذها من الخلية الام

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اي بروتين يتكون من مجموعة polypeptides او one polypeptide وهذا ال polypeptide يتكون من مجموعة Amino acids (praimary stracture) ترتيبهم يختلف من بروتين لاخر اي خلل يغير البروتين الناتج

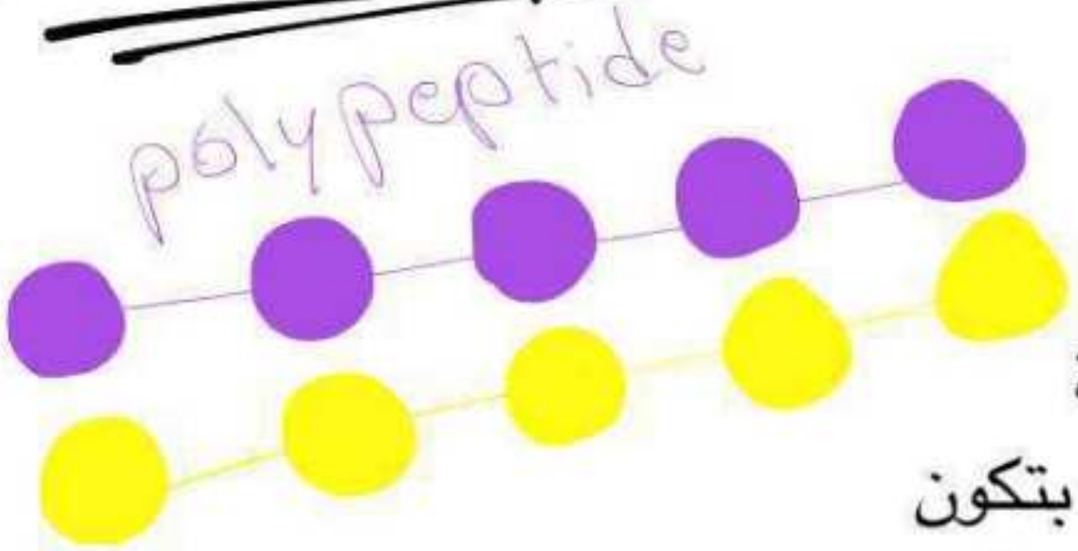
التركيب الاساسي

اول Level تتكونه الخلية عندما تبدأ تصنيع البروتين

مثلا :
الخلية عرفت انه (ب) بروتين يتكون من (٤) polypeptides كل واحد يحتوي على (١٢٧) Amino acids مرتبات بطريقه معينه اي خلل في الترتيب يغير البروتين كامل

⇒ praimary stracture

praimary stracture



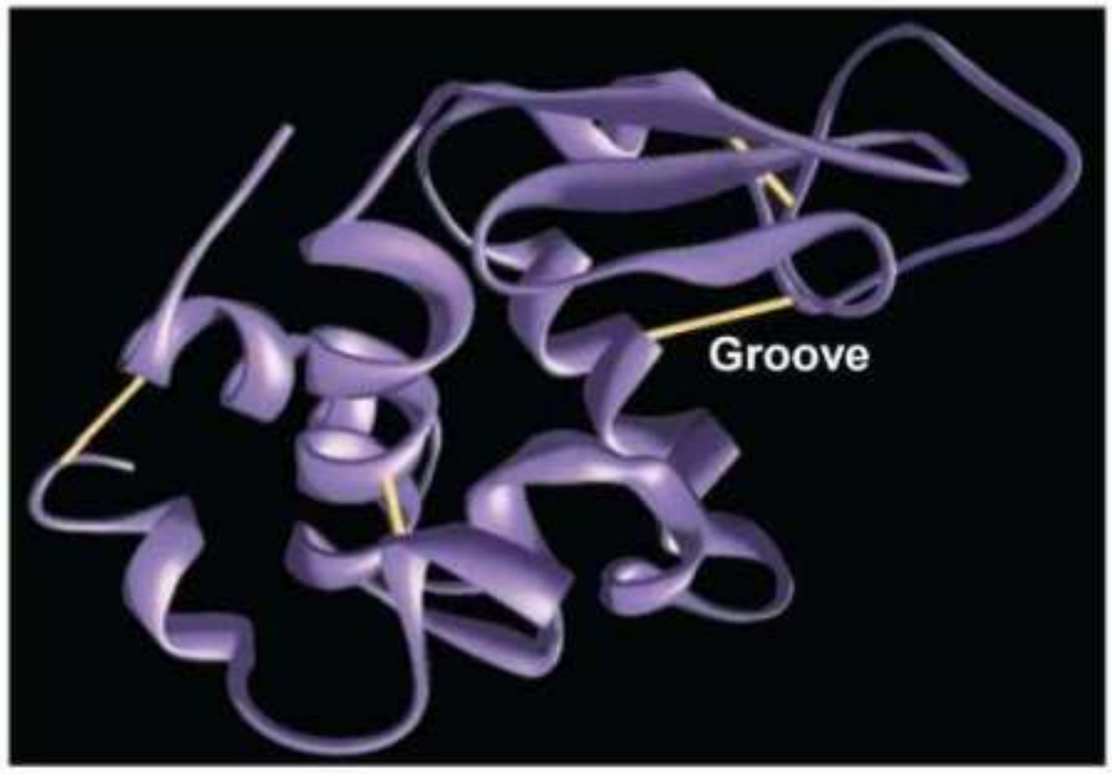
الخلية بتجي على مستوى كل وحدة
polypeptide وبتجي تبنيها لانها بتكون
عارفه ترتيب ال amino acids المرتبطة مع
بعضها بالرابطة الببتيدية فيها بالتالي بتبلش
تبني ال polypeptide المكون للبروتين

انواع البروتينات

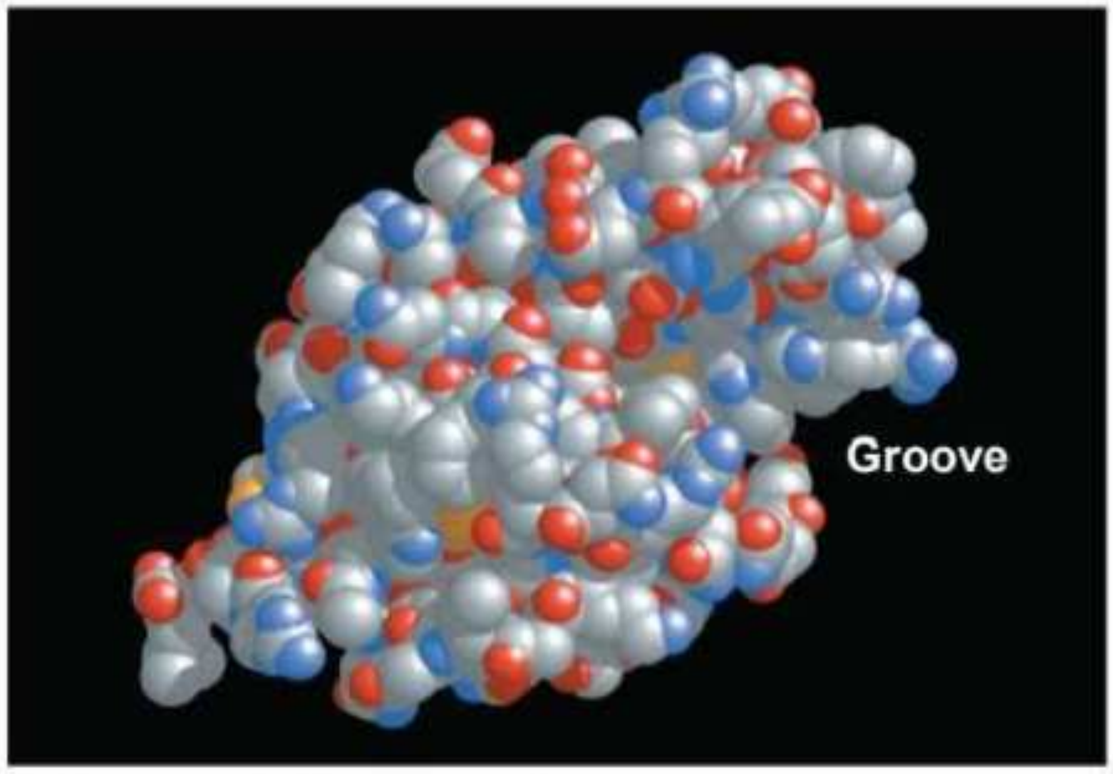
- one polypeptide
- more than one polypeptides

Figure 5.18

اشکال از protein :



(a) A ribbon model



(b) A space-filling model

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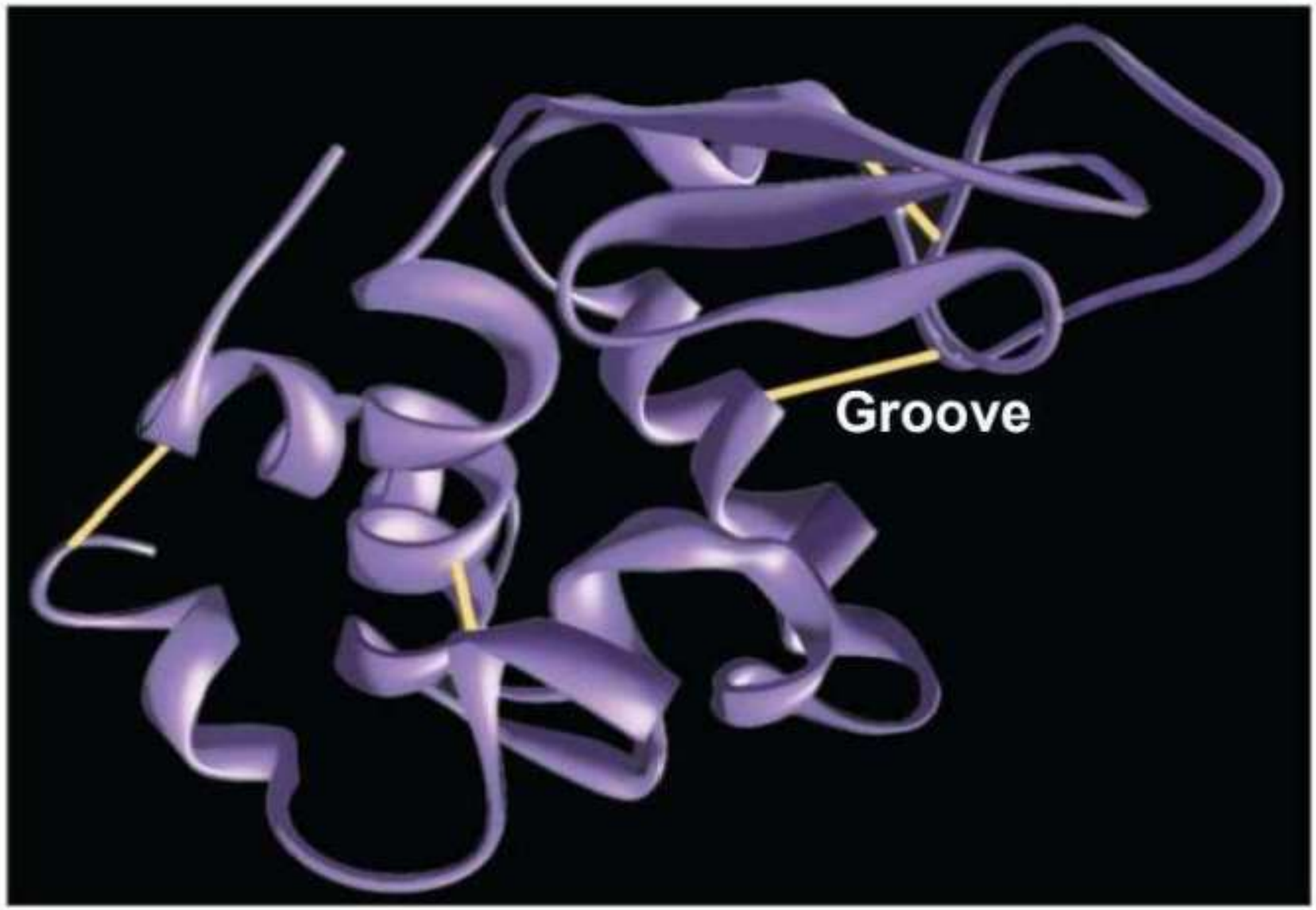
Figure 5.18a



(a) A ribbon model

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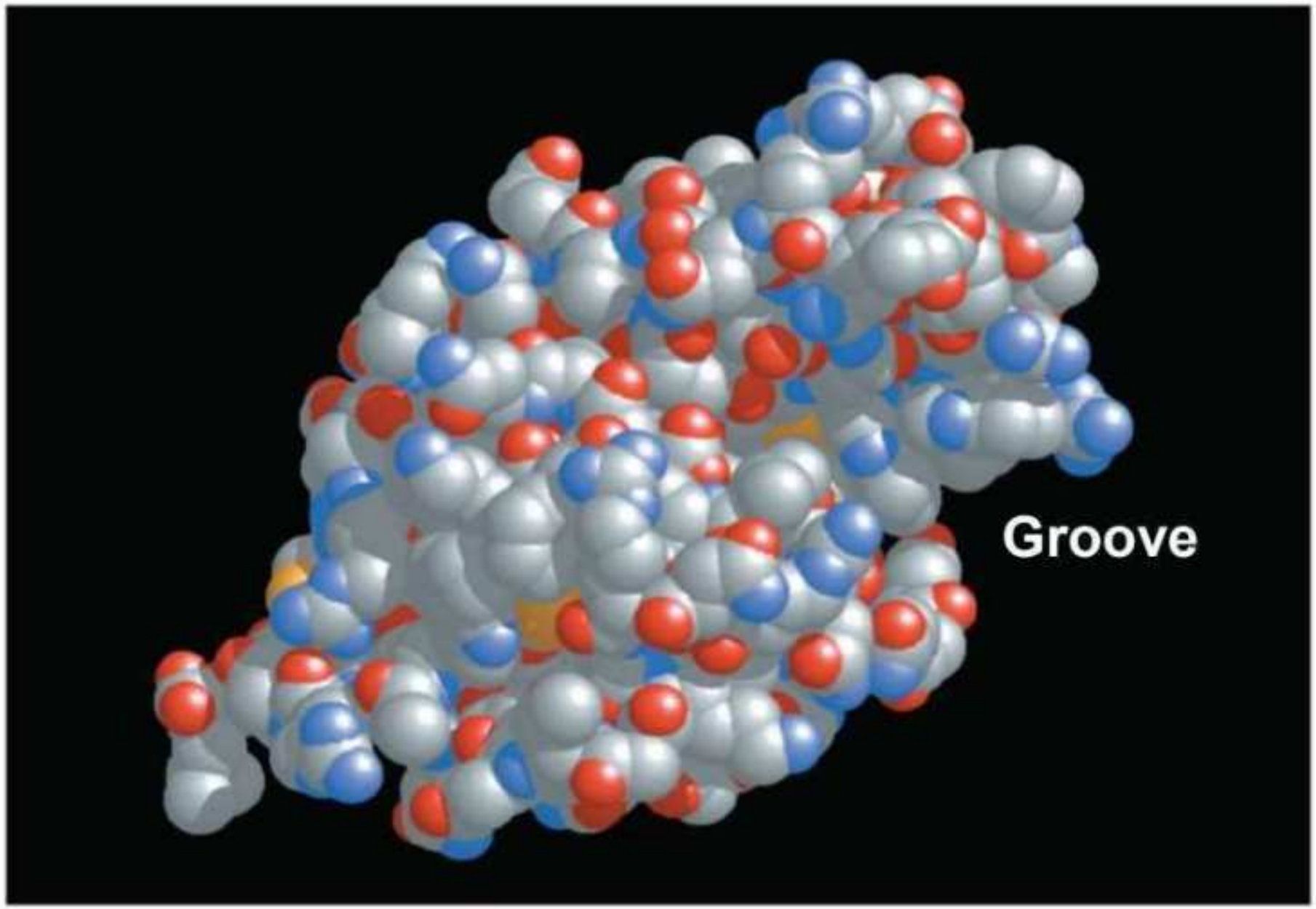
Figure 5.18b



(b) A space-filling model

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- The sequence of amino acids determines a protein's three-dimensional structure
- A protein's structure determines its function

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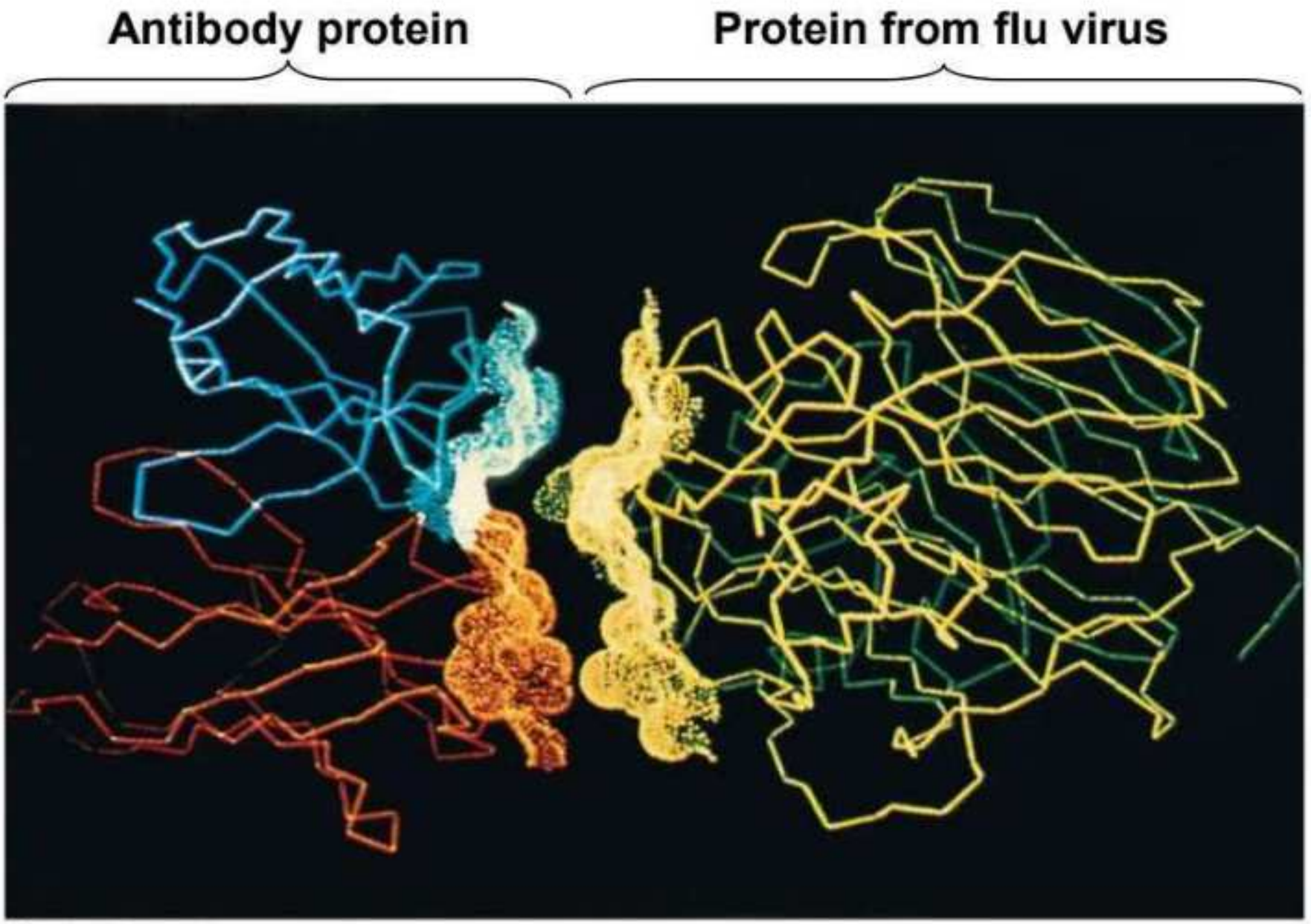
Figure 5.19



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Four Levels of Protein Structure

- The primary structure of a protein is its unique sequence of amino acids
- Secondary structure, found in most proteins, consists of coils and folds in the polypeptide chain
- Tertiary structure is determined by interactions among various side chains (R groups)
- Quaternary structure results when a protein consists of multiple polypeptide chains

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Praimary stracture

is unique sequence of Amino acids

كيف بده يصير protein ⟸ بينتقل

it is not functional

The polypeptide still not functional

backbone و R-group مابنا

صارت تطبخ

روابط هيدروجينيه

بتعمل روابط جديده غير عن الموجودة في التركيب الاولي

مثل ⟸ α helix * β pleated sheet *

Secondary stracture

it is functional

protein تتكون من polypeptide ⟸ 1

native protein

R-group بسبب التنوع في توقع وجود جميع الروابط

بدها تجمع تلف وتطبع هي تطبع 3D

وهي تلف تزيد الطبقات بتتكون روابط جديده Amin acids Rغيرها

* اذا تكون الـ protein ⟸ more than polypeptide بدها تعمل Level 4 ⟸ non-functional ⟸ 3 stracture

بتتكون وحده وحده ⟸ ويرتبطوا مع بعض ⟸ ينتج البروتين في الطور الرابع

polypeptide ⟸

hydrogen bond

Tertiary stracter

Quaternary stracture

* اذا كان البروتين يحتوي اكثر من poly peptide لكي يستحيل يكون functional ⟸ في Tertiary stracter ↓ stacture لكي يشتغل

Protein

Functional if:

3 stracter

Protein with one poly peptide ↙

stracter

Protein with more than one ↙

Animation: Protein Structure Introduction

Right-click slide / select "Play"

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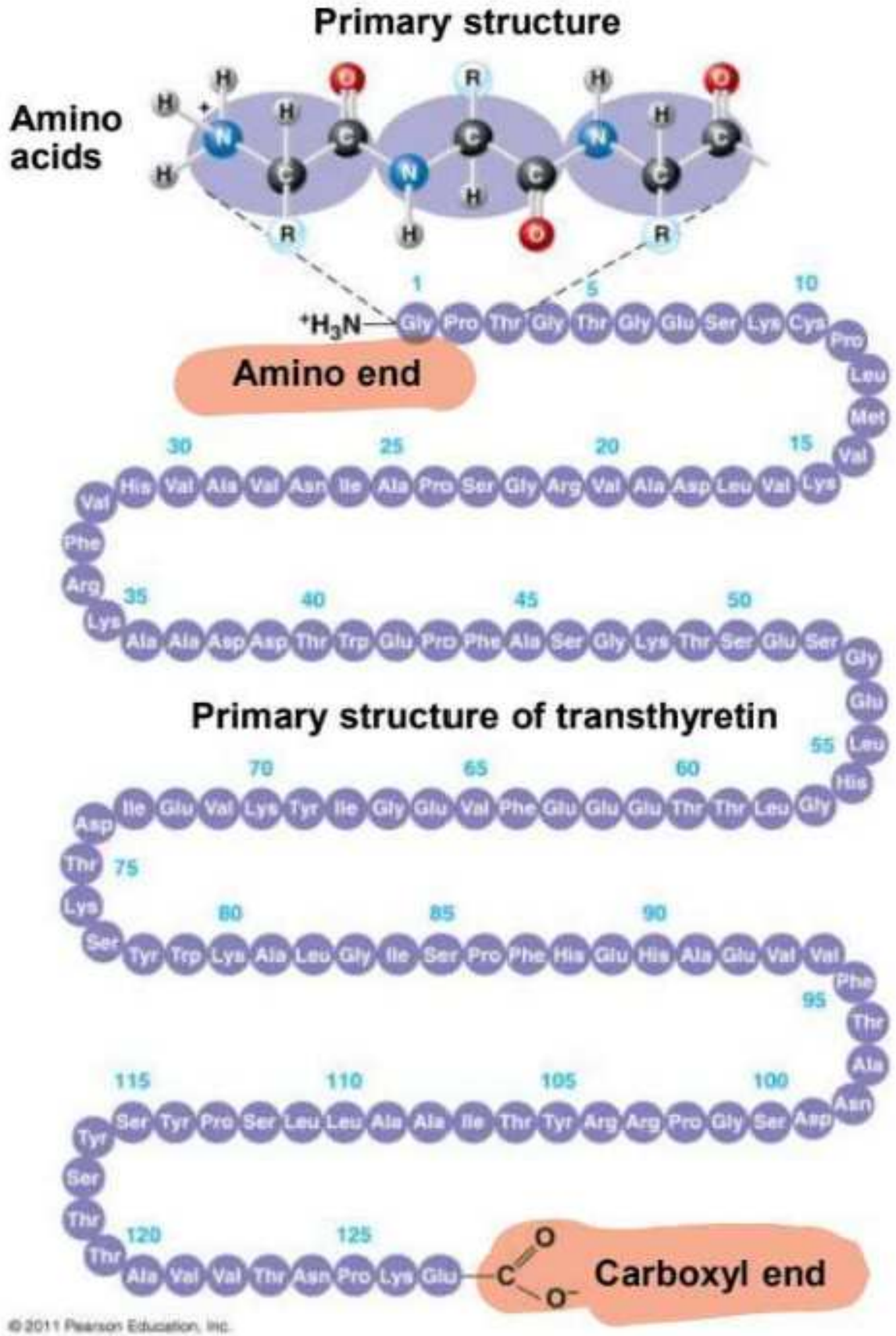
Figure 5.20a


Primary structure
Amino acids
Amino end
Primary structure of transthyretin
Carboxyl end
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→ The most important Level in protein ⇒ اي خلل نيصير عمل خلل بالبروتين

- **Primary structure**, the sequence of amino acids in a protein, is like the order of letters in a long word
- Primary structure is determined by inherited genetic information

بحكيلي انه التركيب الاولي هو عبارة عن تسلسل ال Amino acids طيب الخلية كيف عرفت هذا التسلسل ؟ ورثته من جينات الخلية الام

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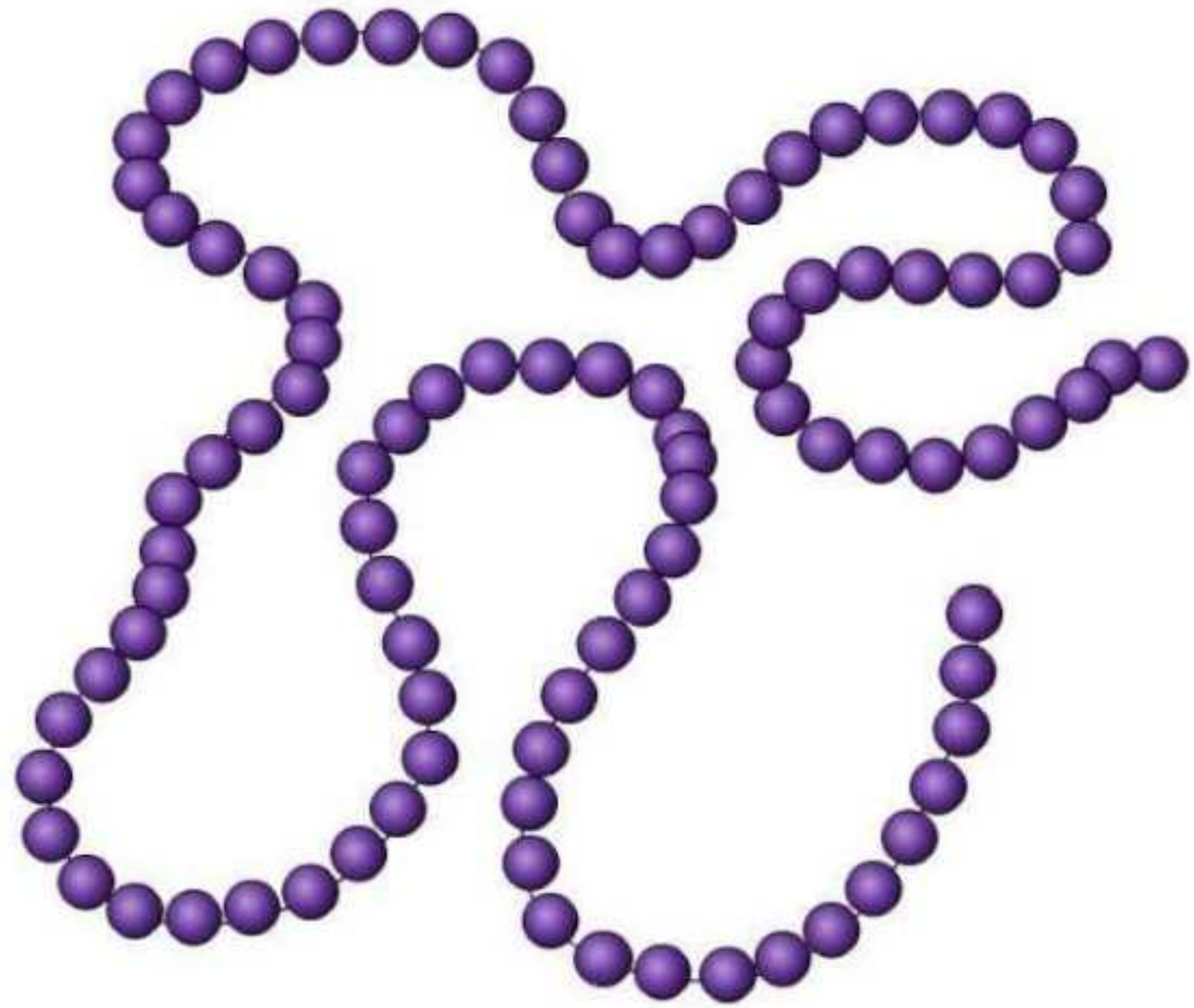

Animation: Primary Protein Structure

Right-click slide / select “Play”

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Figure 5.20b

تتكون اذا الرابطة الهيدروجينية تكونت بين
every one and fourth amino acids

يعني كل حمض اميني والرابع يلي بعده وهي
بتلف الاول والرابع عملوا رابطة هيدوجينية

R-group هاي
hydrogen فيا
bond

Secondary structure

Tertiary structure

Quaternary structure

الشكل ①

① α helix

Hydrogen bond

② β pleated sheet

β strand

Hydrogen bond

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صفائح متوازية تتكونت

الشكل ②

التتكون عندما الرابطة الهيدروجينية تتكون بين ال amino acids يلي قبال بعض

Transthyretin polypeptide

Transthyretin protein

حسب ال hydrogen bond بتتكون بين مين ومين من ال amino acids رح ينشأ عندي شكلين الفا helix او بيتا pleated sheet

- The coils and folds of **secondary structure** result from hydrogen bonds between repeating constituents of the polypeptide backbone ⟹ R ولسن group
- Typical secondary structures are a coil called an α **helix** and a folded structure called a β **pleated sheet**

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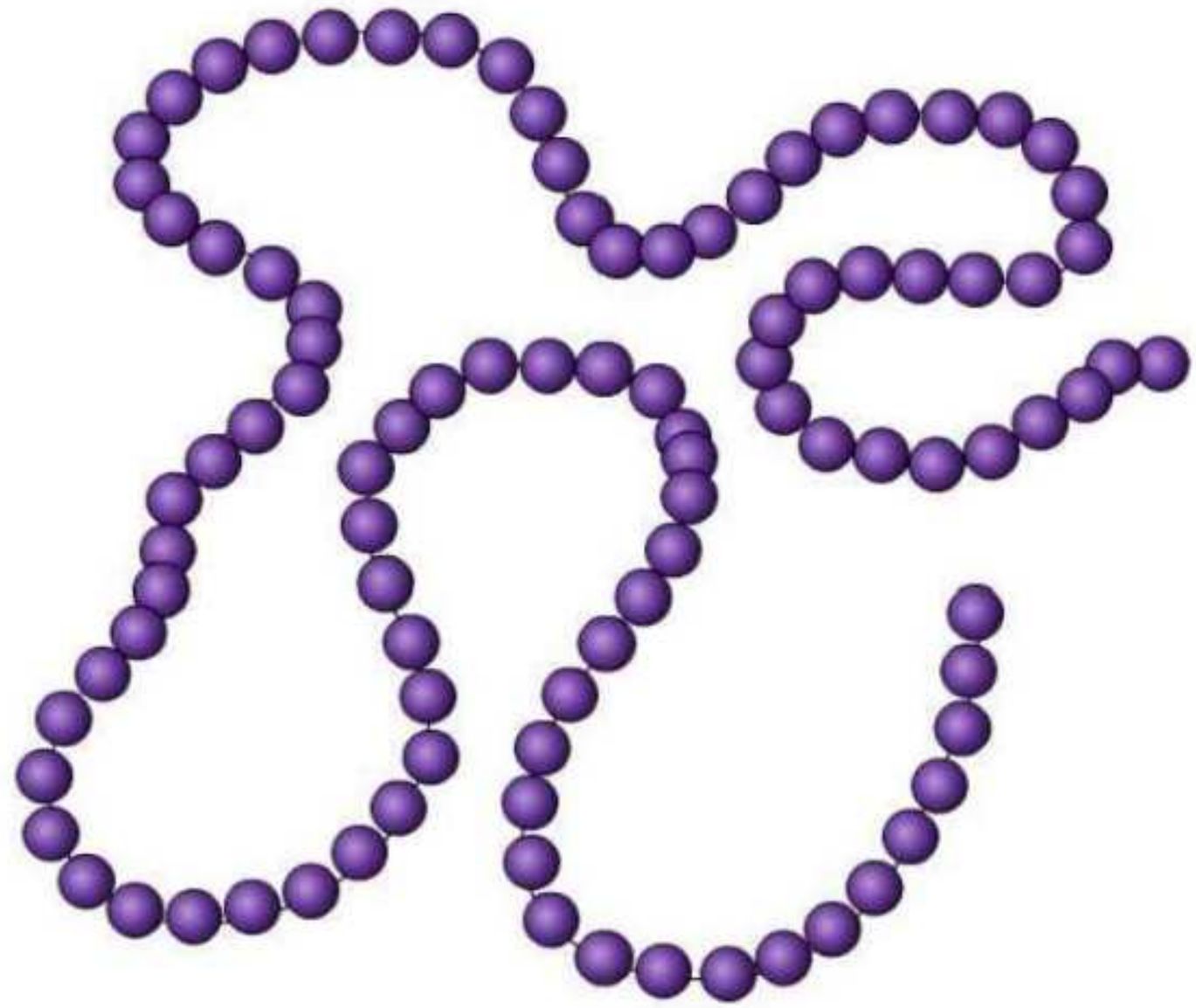

Animation: Secondary Protein Structure

Right-click slide / select “Play”

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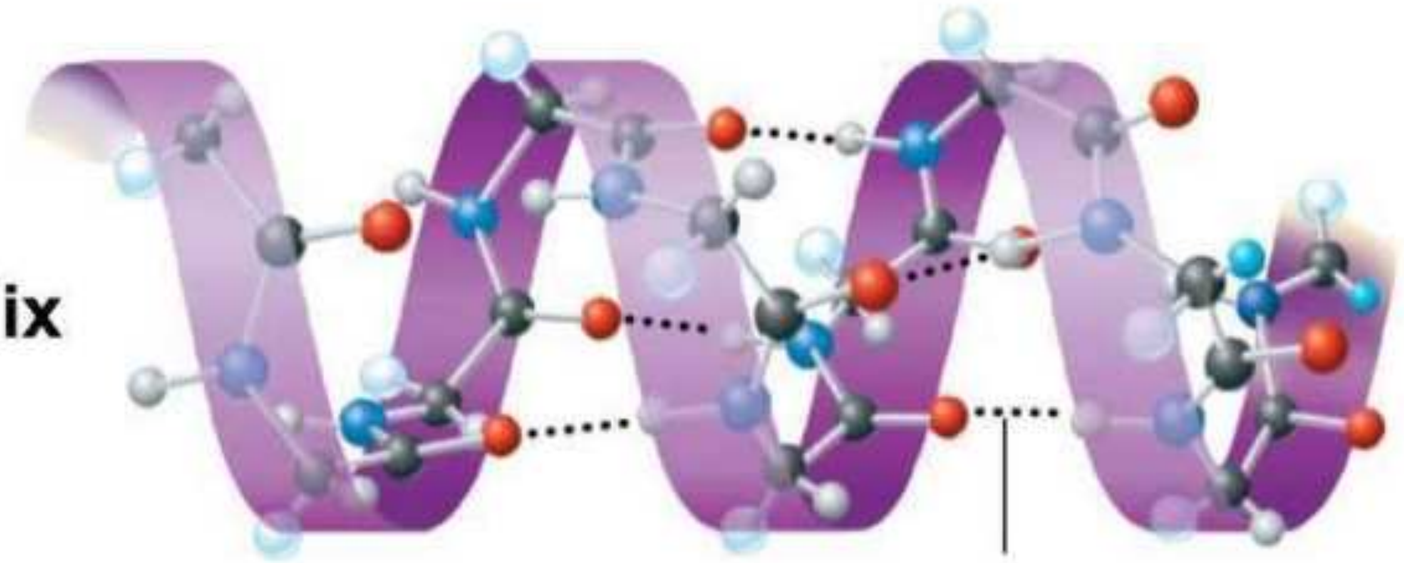
Figure 5.20c

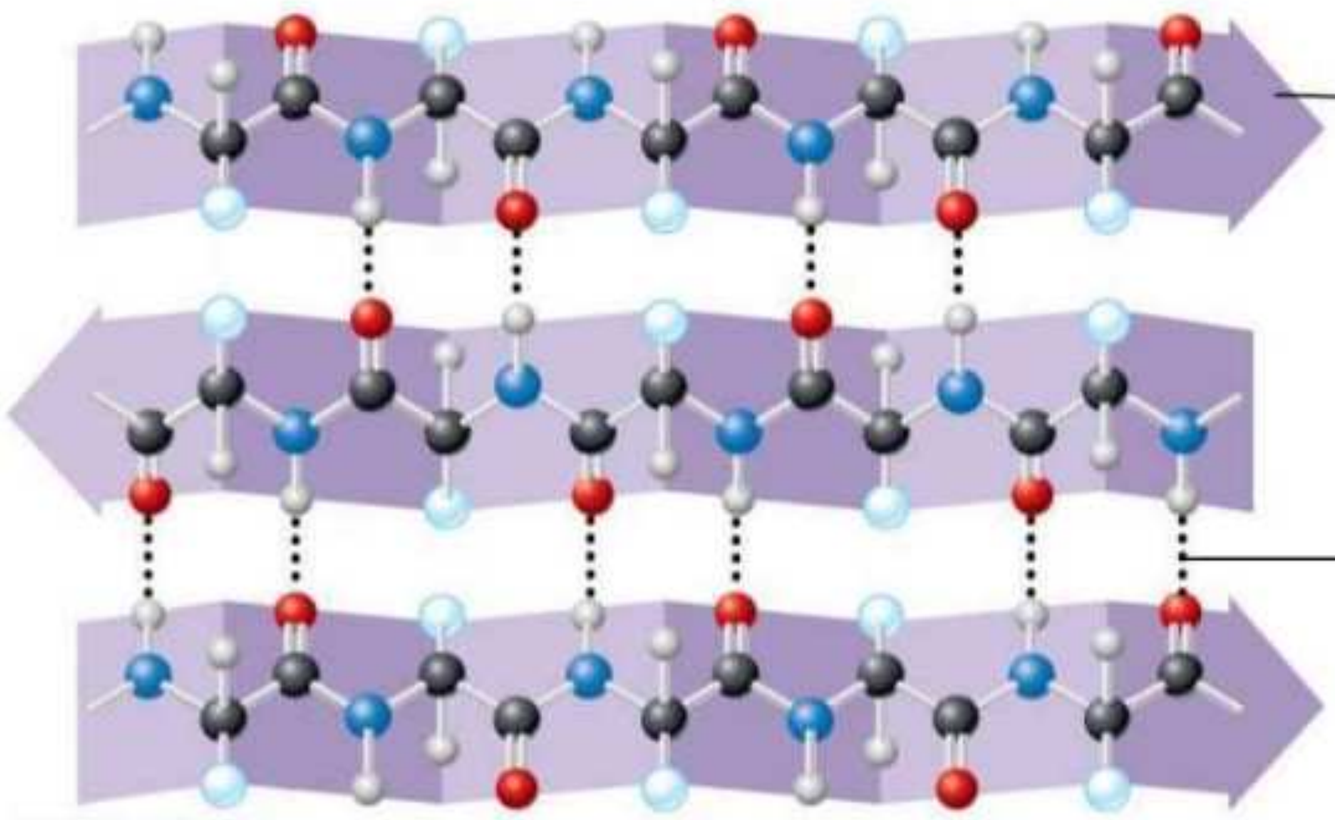
Secondary structure

α helix



Hydrogen bond

β pleated sheet



β strand, shown as a flat arrow pointing toward the carboxyl end

Hydrogen bond

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Figure 5.20d

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- **Tertiary structure** is determined by interactions between R groups, rather than interactions between backbone constituents
- These interactions between R groups include hydrogen bonds, ionic bonds, **hydrophobic interactions**, and van der Waals interactions
- Strong covalent bonds called **disulfide bridges** may reinforce the protein's structure

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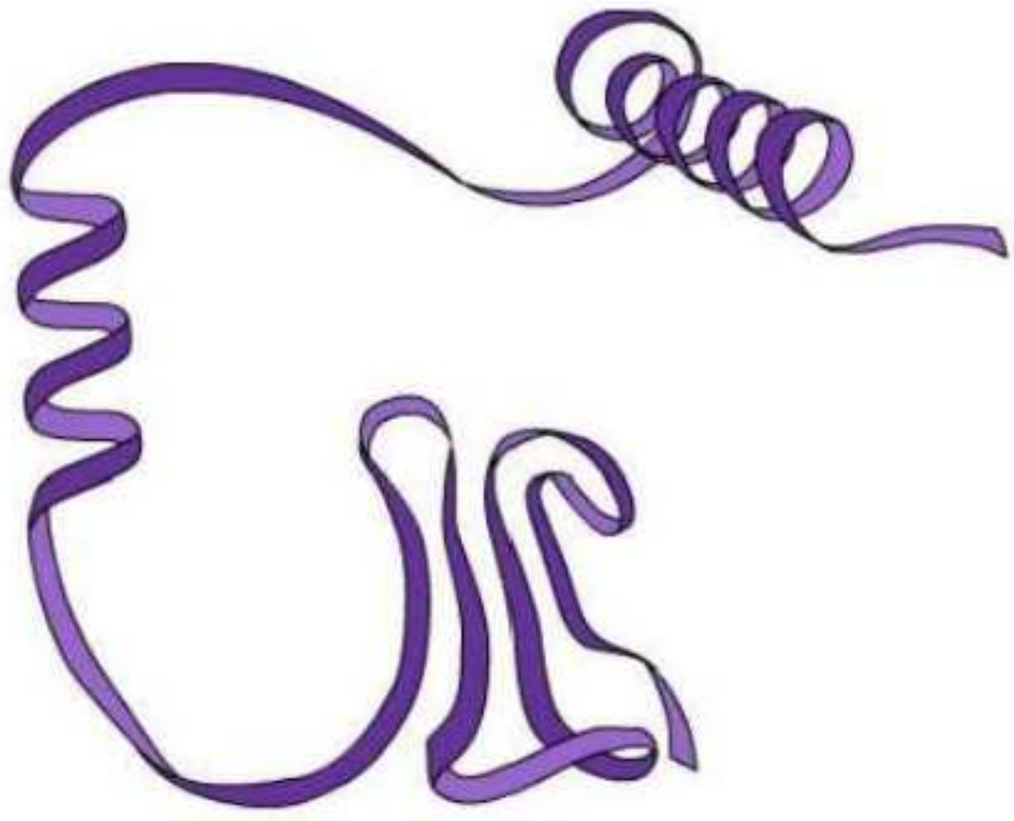

Animation: Tertiary Protein Structure

Right-click slide / select “Play”

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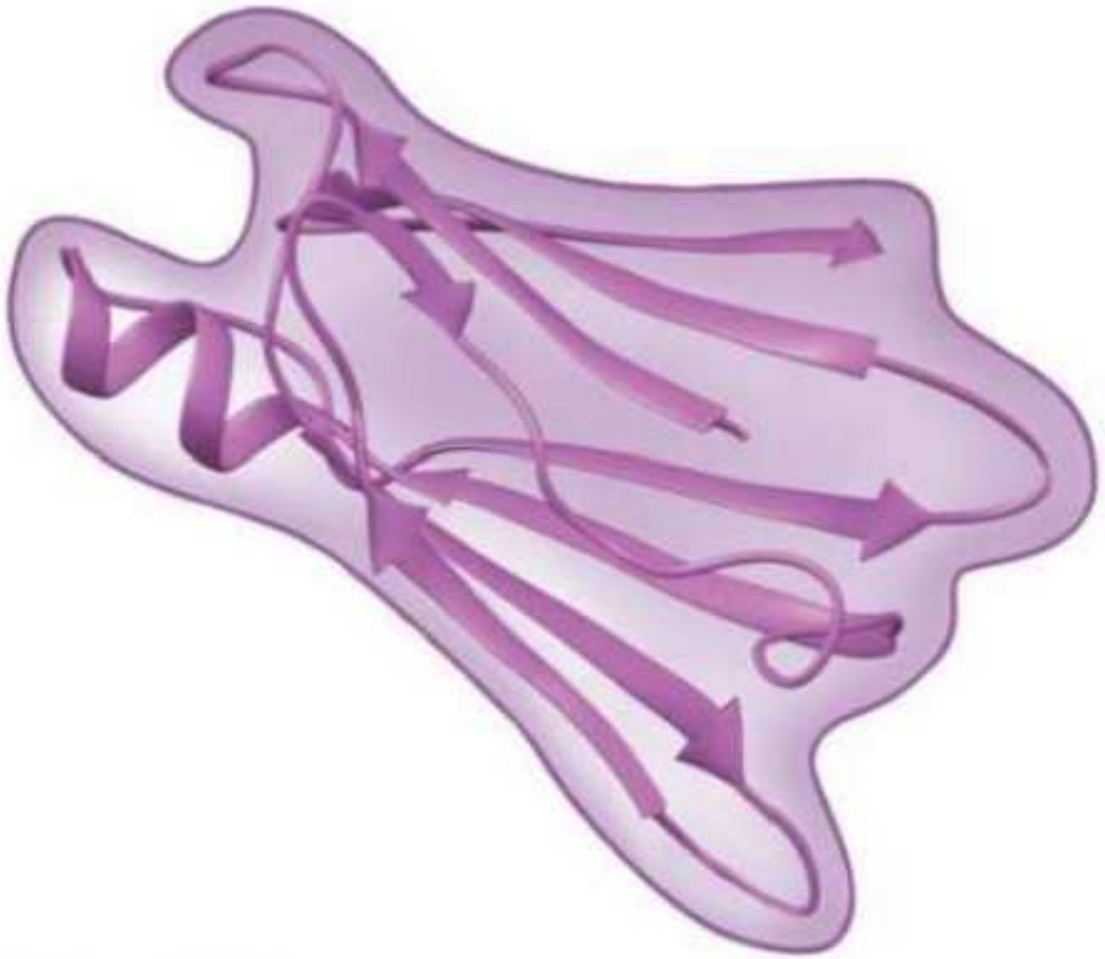
Figure 5.20e

Tertiary structure



Transthyretin polypeptide

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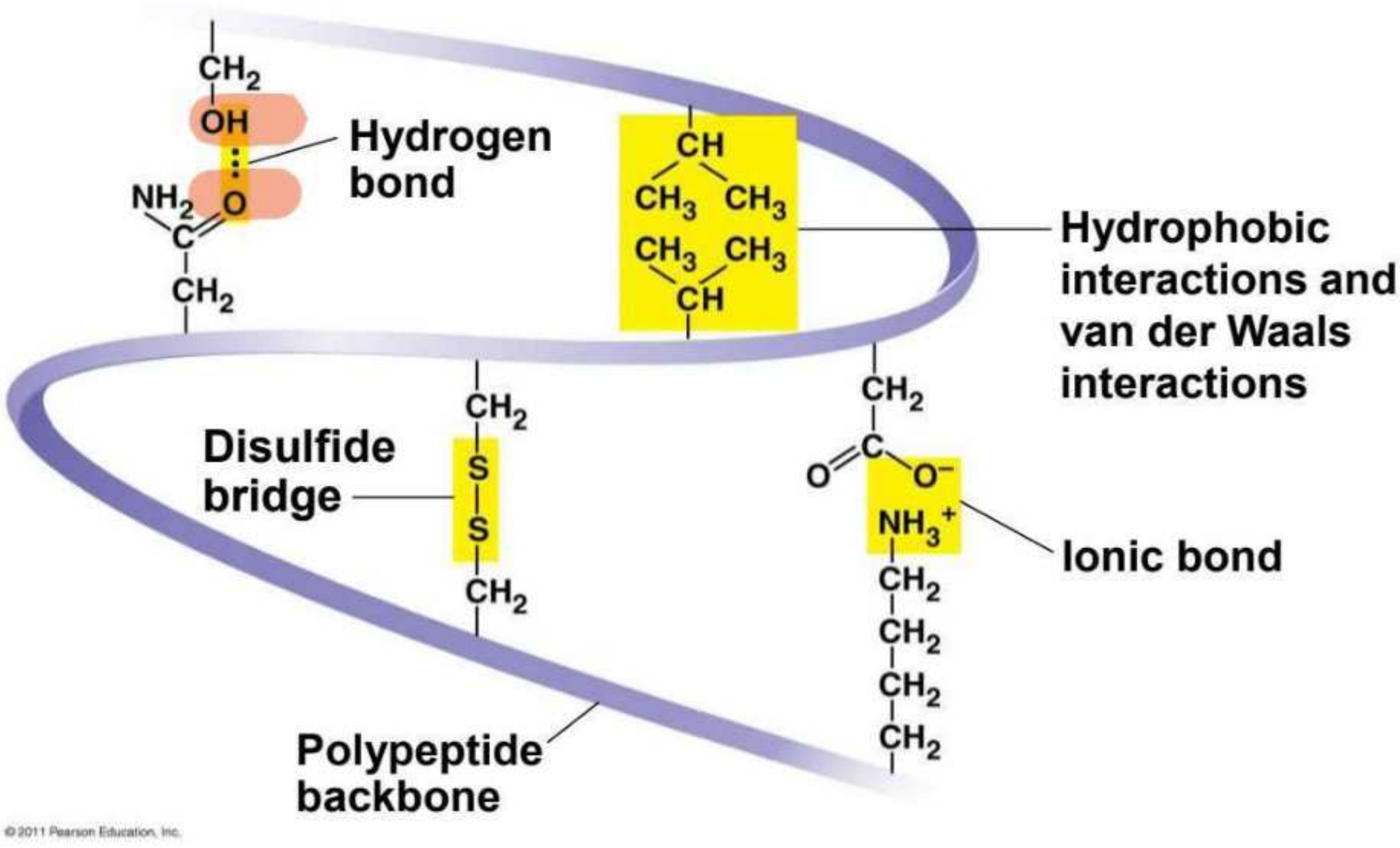
Figure 5.20f



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hydrophobic R-group + hydrophobic R-group ⟹ Hydrophobic interactions

رابطة ضعيفه جدًا لاتكون الا اذا انحشروا بالمكان

2 non polar R-group ⟹ non polar bond (الرابط)

2 polar R-group ⟹ hydrogen bond

- charge
+ charge
amino acid ⟹ Ionic bond

S - S ⟹ covalent bond ⟹ Disulfide bridge

اقوى رابطة

يكون حذري كونه صعب تتكسر

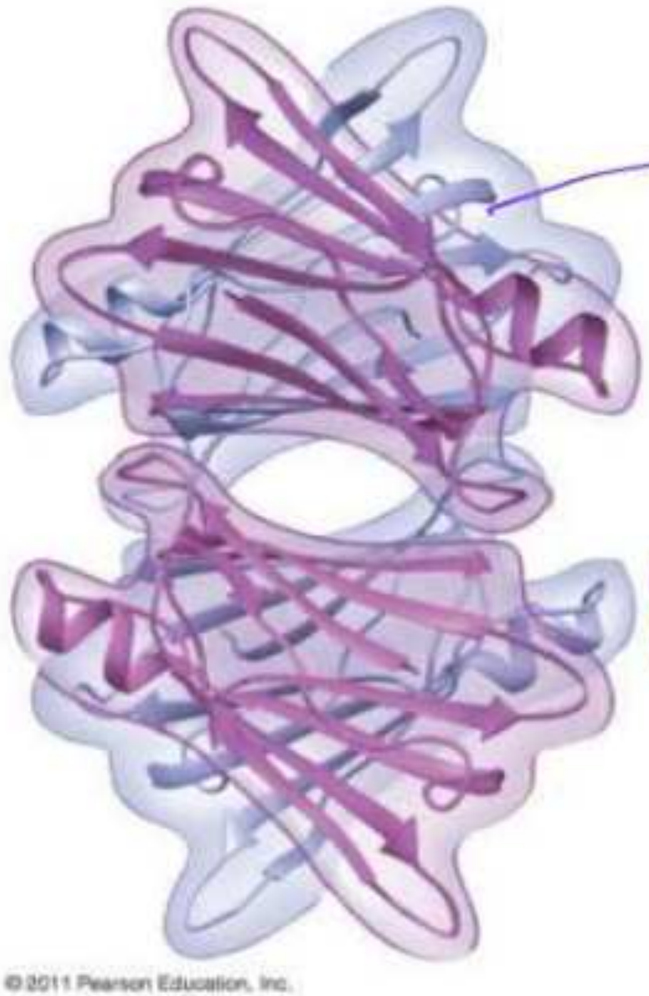
Figure 5.20g

fibers
لیفی (یا تشکیل میوه)

glubular
کروی

له شکلان (ثنائی)

Quaternary structure



کروی
glubular

Transthyretin protein (four identical polypeptides)

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Figure 5.20h

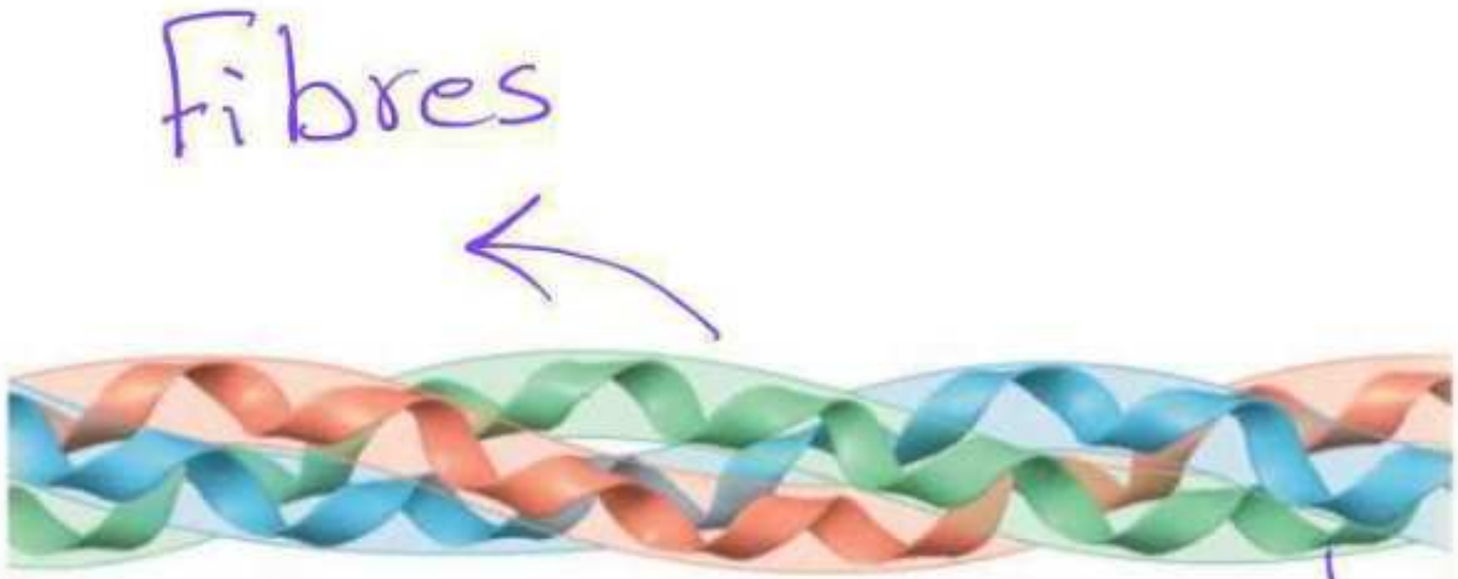

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Figure 5.20i

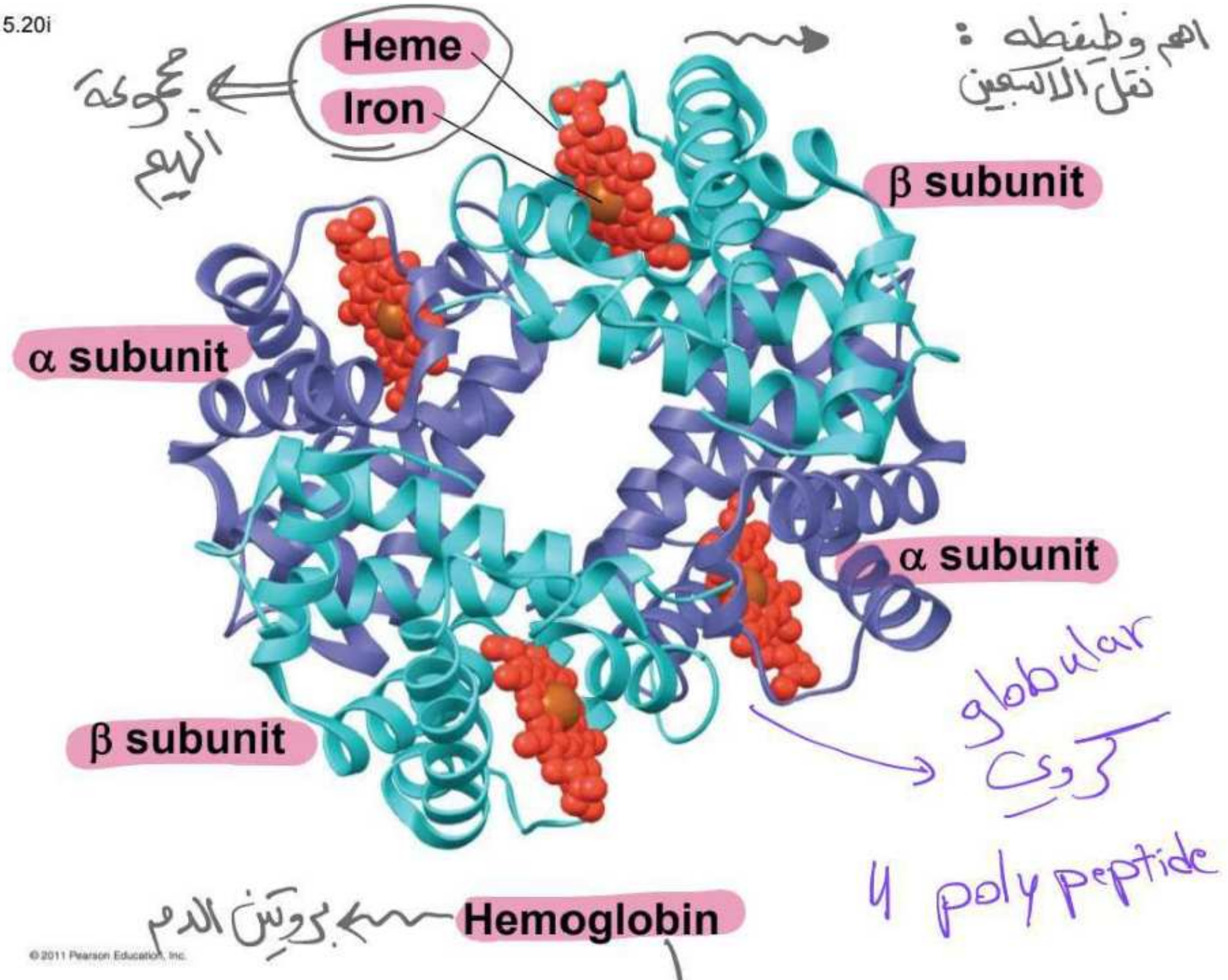

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Figure 5.20j

4 Iron

4 Heme group

4 O_2 molecule

كريَطة دزة
الحديد

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- **Quaternary structure** results when two or more polypeptide chains form one macromolecule
- Collagen is a fibrous protein consisting of three polypeptides coiled like a rope
- Hemoglobin is a globular protein consisting of four polypeptides: two alpha and two beta chains

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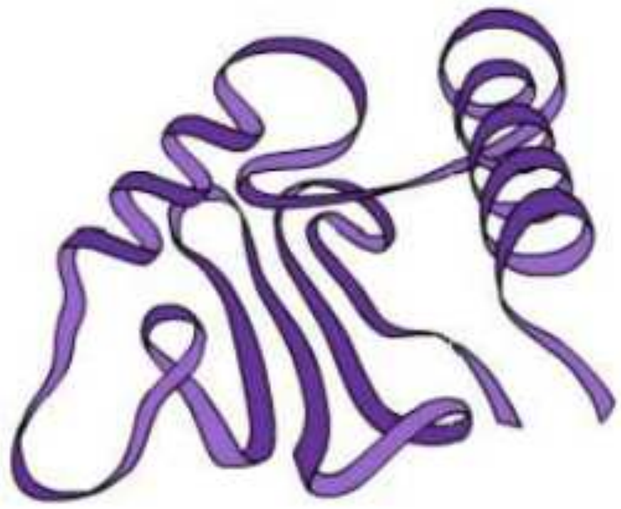

Animation: Quaternary Protein Structure

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فقر الدم المنجلي (الانيميا)

Sickle-Cell Disease: A Change in Primary Structure

مرض وراثي

- A slight change in primary structure can affect a protein's structure and ability to function

التغير الخفيف

اي خلل في الطور الاول يؤثر على بنية البروتين وعمله

- **Sickle-cell disease**, an inherited blood disorder, results from a single amino acid substitution in the protein hemoglobin

لستبدل

سبب المرض اذا غيرت حمض اميني واحد في الhemoglobin

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Figure 5.21

	Primary Structure	Secondary and Tertiary Structures	Quaternary Structure	Function	Red Blood Cell Shape
Normal hemoglobin	1 Val 2 His 3 Leu 4 Thr 5 Pro 6 Glu 7 Glu	β subunit	Normal hemoglobin α β β α	Molecules do not associate with one another; each carries oxygen.	10 µm
Sickle-cell hemoglobin	1 Val 2 His 3 Leu 4 Thr 5 Pro 6 Val * 7 Glu	Exposed hydrophobic region β subunit	Sickle-cell hemoglobin α β β α	Molecules crystallize into a fiber; capacity to carry oxygen is reduced.	10 µm

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Figure 5.21a

الى متى يرتبط الـ Hemoglobin بـ O_2 لازم ما يرتبط مع بعضه

دائماً كلما المصابين في المرض نسبة الـ O_2 في الدم قليلة

* السبب هو الاختلاف في praimary stracture

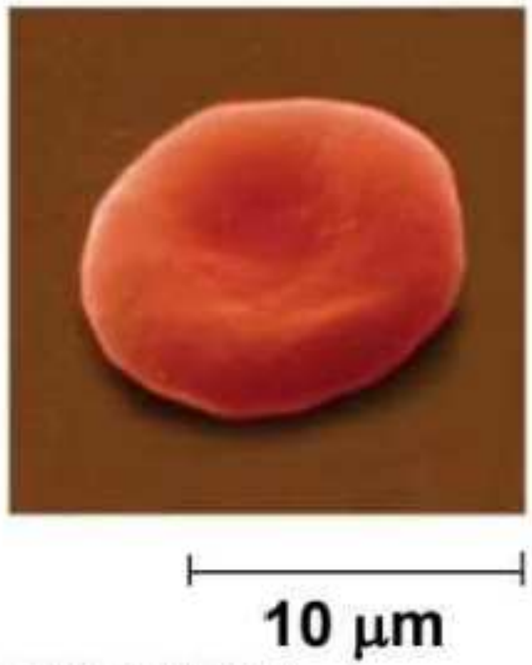

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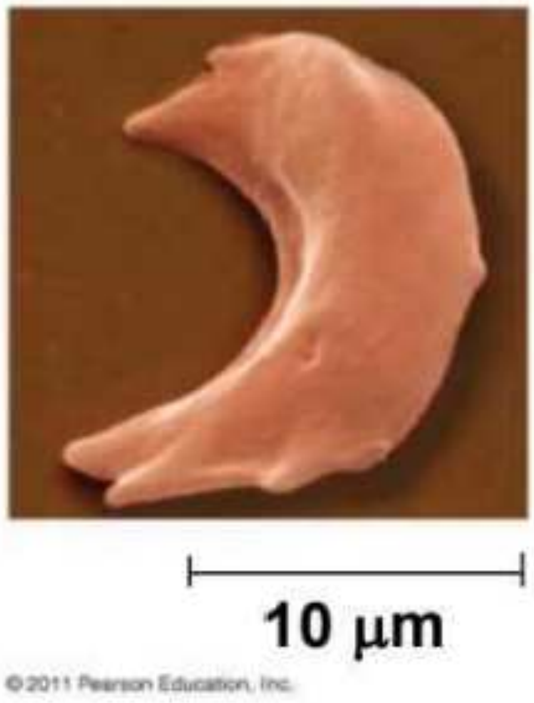
Figure 5.21b



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What Determines Protein Structure?

- In addition to primary structure, physical and chemical conditions can affect structure
- Alterations in pH, salt concentration, temperature, or other environmental factors can cause a protein to unravel
- This loss of a protein's native structure is called **denaturation**
- A denatured protein is biologically inactive

لما تزيد درجة حرارة البروتين رح يبلش يفك بتصيرله عملية denaturation (تاثير الحرارة على البروتين)

لو كان البروتين stracture 3 لما تزيد درجة حرارة الجسم رح تبلش stracture 3 تتفكك عن بعضها لما ترتفع الحرارة اكثر يتحول ال stracture 3 ل stracture 2 بتصير العملية عكسية وبتبلش الطيات تفك ولما ترتفع لاقصى حد تتكسر الروابط الببتيدية (يبطل عندي بروتين) يبطل البروتين شغال بصير inactive

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Figure 5.22

داعمًا داخل الخلية الحية irreversable

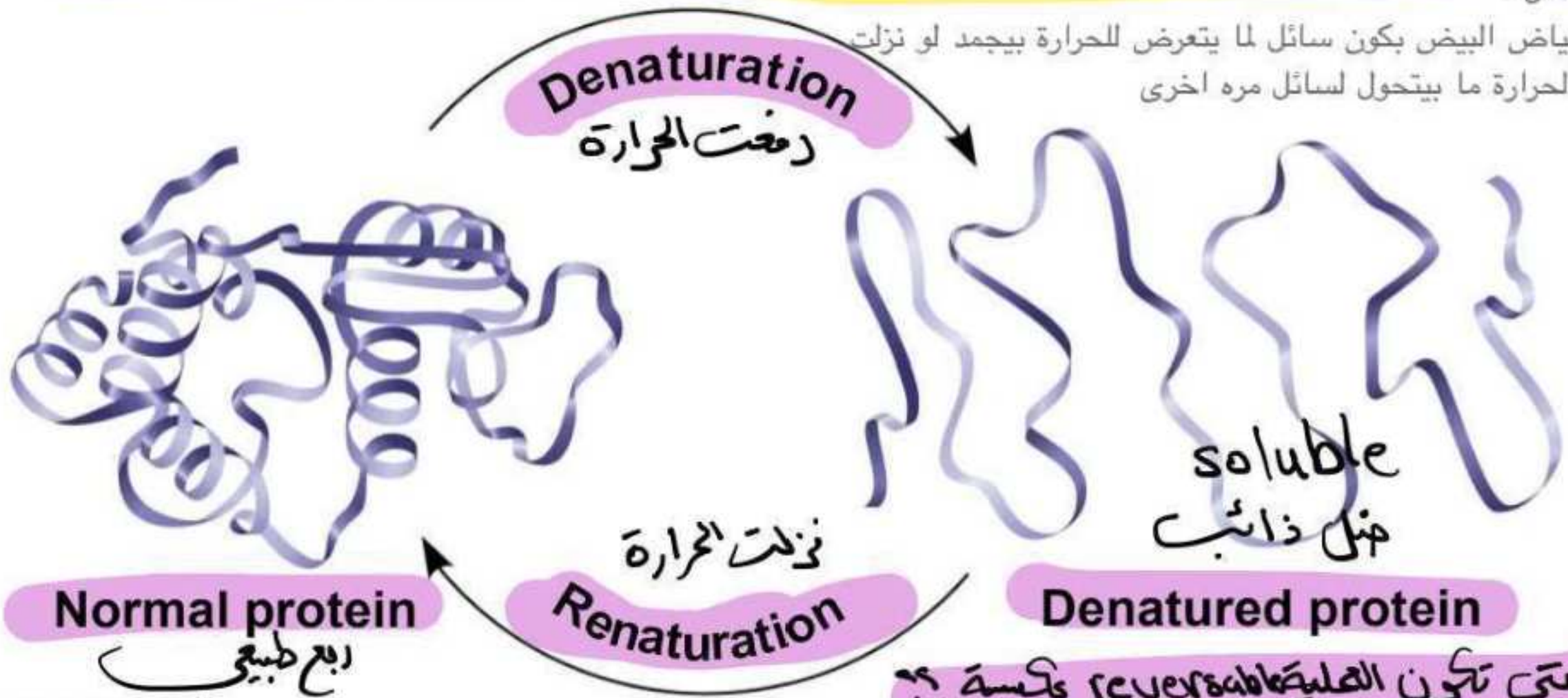
لو خفضت الحرارة هل رح يرجع يشتغل ؟

لا ، لان عملية ال denaturation داخل الجسم الحي تكون inreversable غير عكسية ، ليش؟

لانه البروتين بالوضع الطبيعي يكون soluble (ذائب في سوائل الجسم) لما ترتفع الحرارة رح يتحول ل insoluble

مثال :

بياض البيض بكون سائل لما يتعرض للحرارة بيجمد لو نزلت الحرارة ما بيتحول لسائل مره اخرى



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متى تكون التفاعلات reversable عكسية ؟؟

— خارج الخلية في المختبر

Protein Folding in the Cell

- It is hard to predict a protein's structure from its primary structure
- Most proteins probably go through several stages on their way to a stable structure
- **Chaperonins** are protein molecules that assist the proper folding of other proteins
- Diseases such as Alzheimer's, Parkinson's, and mad cow disease are associated with misfolded proteins

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Figure 5.23

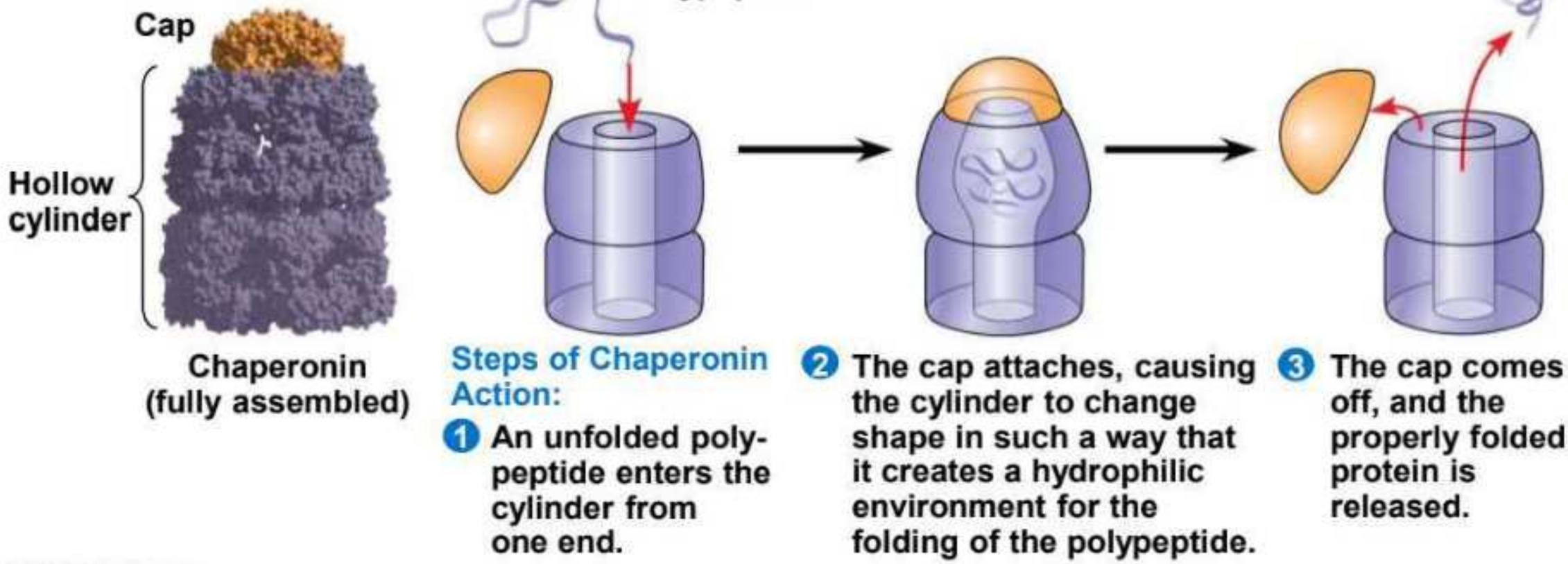

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Figure 5.23a

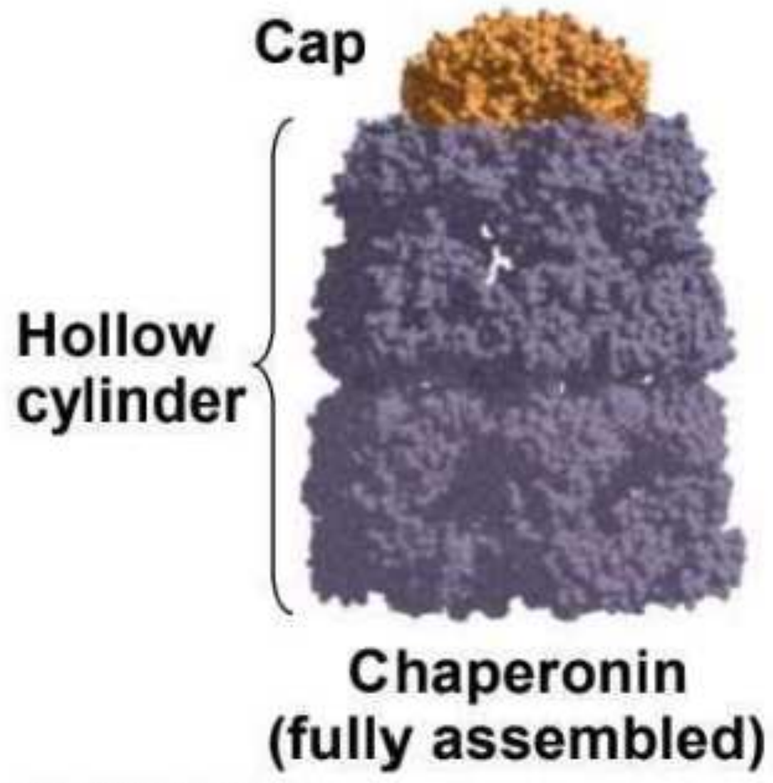

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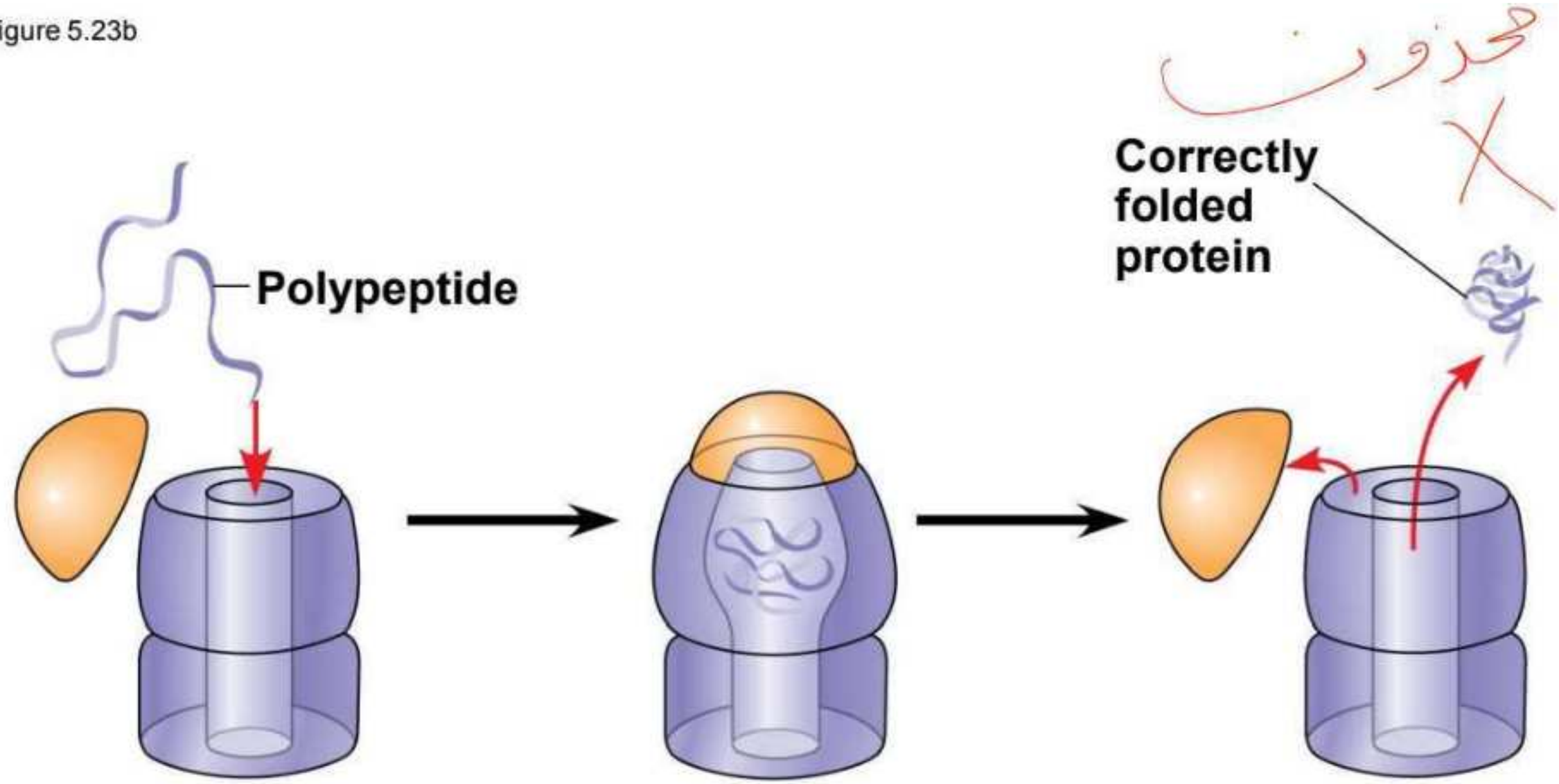
Figure 5.23b



Steps of Chaperonin Action:

1. An unfolded polypeptide enters the cylinder from one end.
2. The cap attaches, causing the cylinder to change shape in such a way that it creates a hydrophilic environment for the folding of the polypeptide.
3. The cap comes off, and the properly folded protein is released.

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- Scientists use **X-ray crystallography** to determine a protein's structure
- Another method is nuclear magnetic resonance (NMR) spectroscopy, which does not require protein crystallization
- Bioinformatics uses computer programs to predict protein structure from amino acid sequences

بجيبوا البروتين وبحولوه لبلورات ويتم تسليط xray ومن الجهه الاخرى digital detector بتصير عندي تدفق من الاشعة السينية بتدخل بلورات البروتين وبتطلع منه على شكل اشعاعات تنعكس على ال detector على شكل نقاط هذه النقاط تترجم وتتحلل عن طريق الكمبيوتر وتعطي الشكل النهائي للبروتين

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Figure 5.24

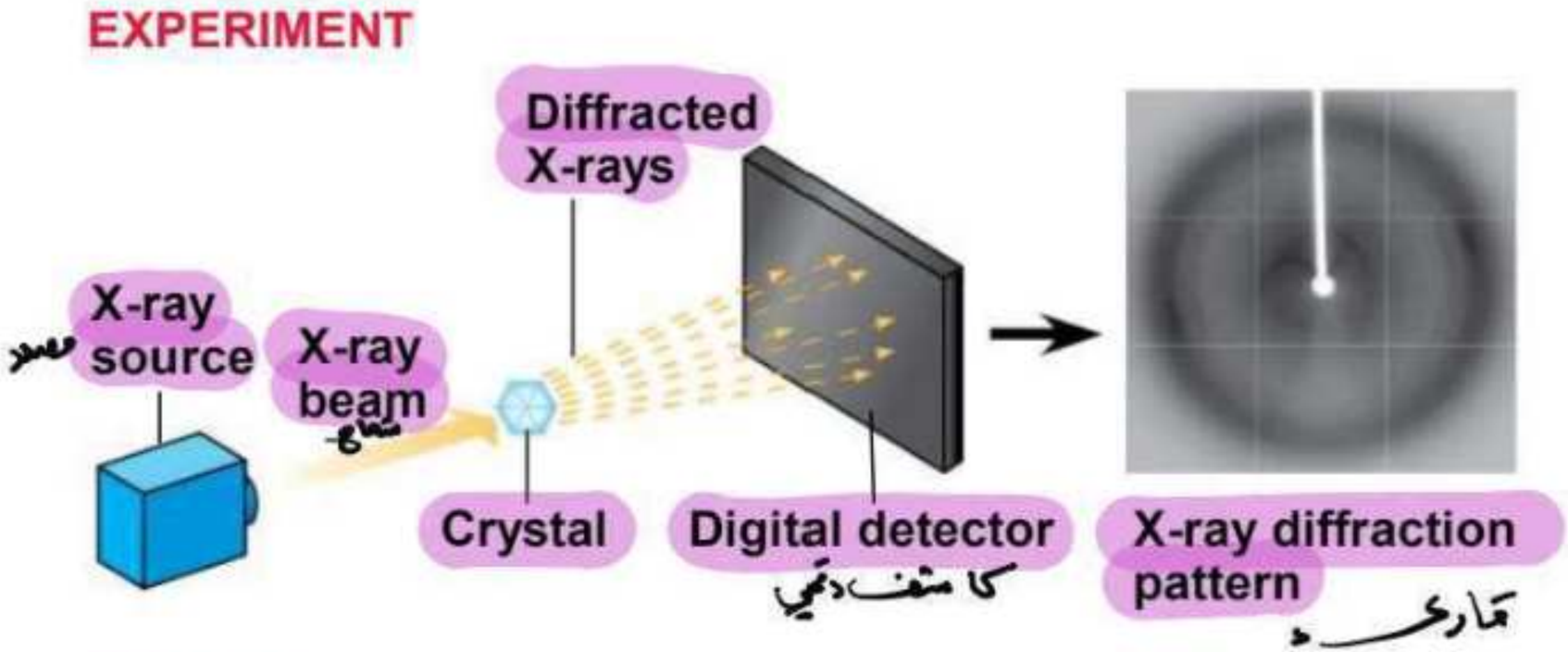

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Figure 5.24a

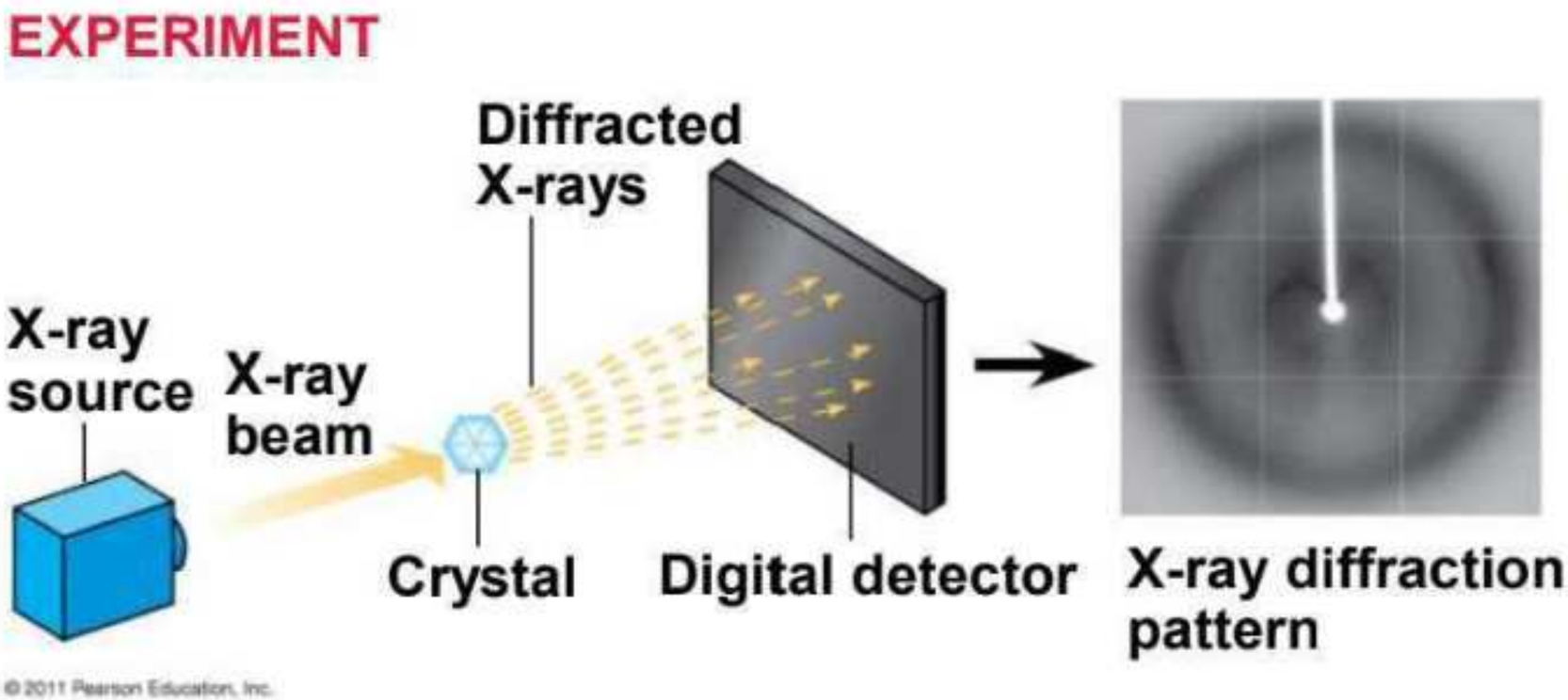

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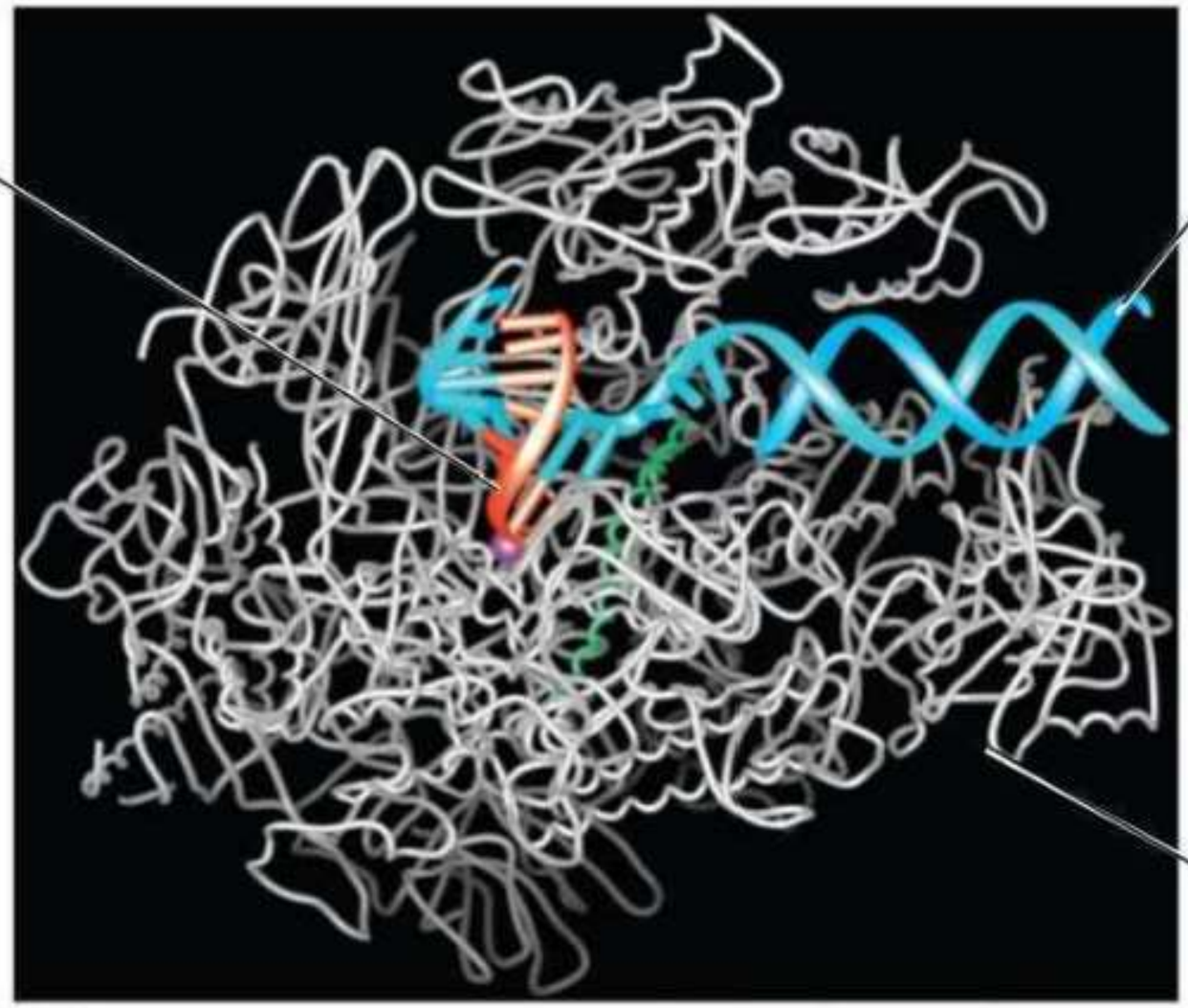
Figure 5.24b

RESULTS



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Concept 5.5: Nucleic acids store, transmit, and help express hereditary information

- The amino acid sequence of a polypeptide is programmed by a unit of inheritance called a **gene**
- Genes are made of DNA, a **nucleic acid** made of monomers called nucleotides

لما الخلية اجت تصنع البروتين رجعت للمعلومات الوراثية في ال DNA
عن هذا البروتين في الخلية الام
DNA بيحتوي على الاف الجينات كل جين بكون مخصص لبروتين
الجين محمول على ال DNA قد يحصل له تعبير جيني وقد لا يحصل

اي جين يحدث له عملية تعبير جيني النتيجة النهائية له بروتين

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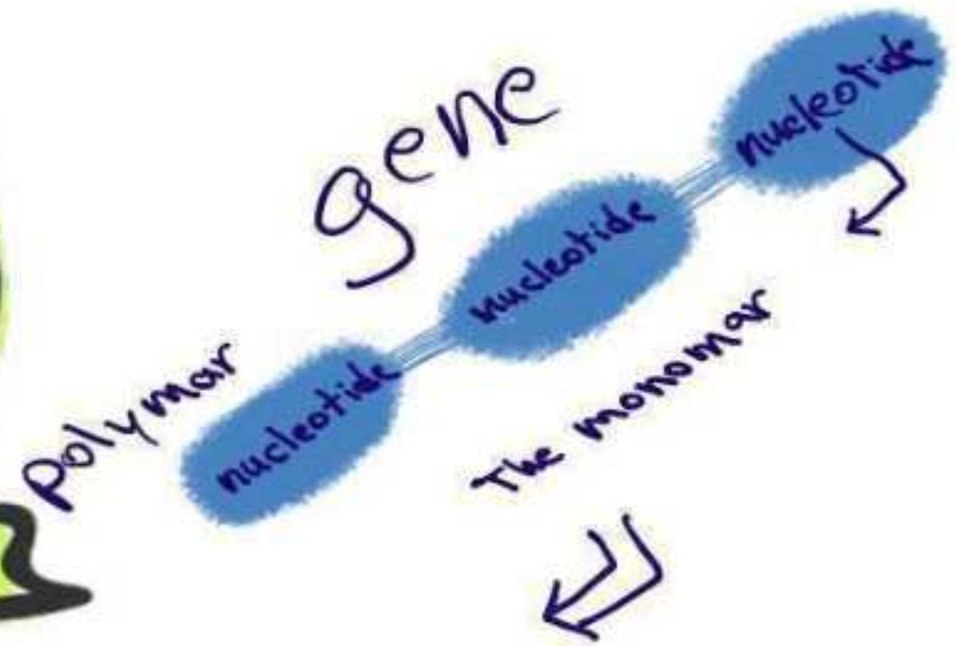
بما انه الجين المسؤول عن الصفات الوراثية
قد يترجم ويحول لبروتين وتظهر الصفة عالفرد
وقد يبقى محمول على ال DNA ولا تظهر
الصفه بل تنتقل للابناء



كل الجينات محمولة على الـDNA

DNA و RNA ← لنفتر نحكي عن الـ

↓

polynucleotides ← لدنا وحدة بنائهم

nucleotides

* polymers of nucleotides *

The Roles of Nucleic Acids

- There are two types of nucleic acids
  - Deoxyribonucleic acid (DNA)
  - Ribonucleic acid (RNA)
- DNA provides directions for its own replication
- DNA directs synthesis of messenger RNA (mRNA) and, through mRNA, controls protein synthesis
- Protein synthesis occurs on ribosomes

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الإصم ⇒ DNA ⇐ يوجد غالبًا في النواة (nucleus)

RNA ⇐ هناك عدة انواع داخل النواه وخارجها

DNA والمسؤول عن انتاجه هو الـ
الي
لانه يحمل الجينات للمسؤوله عن
انتاج البروتين وهو الذي يعطي
اوامر بالانقسام (عندما تبدأ عملية تضاعفة)
عند انقسام الخلية

Figure 5.25-1

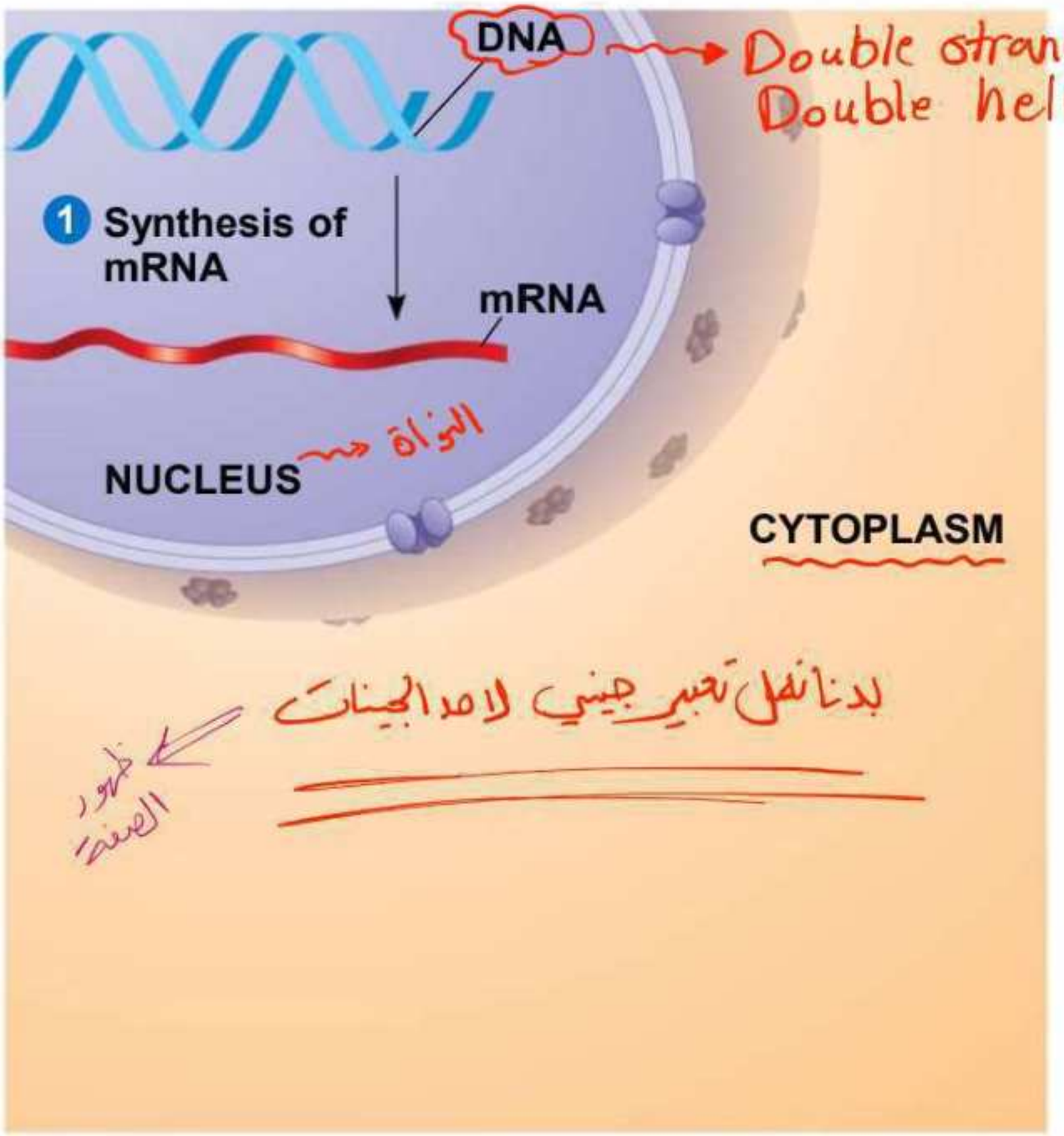

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Figure 5.25-2

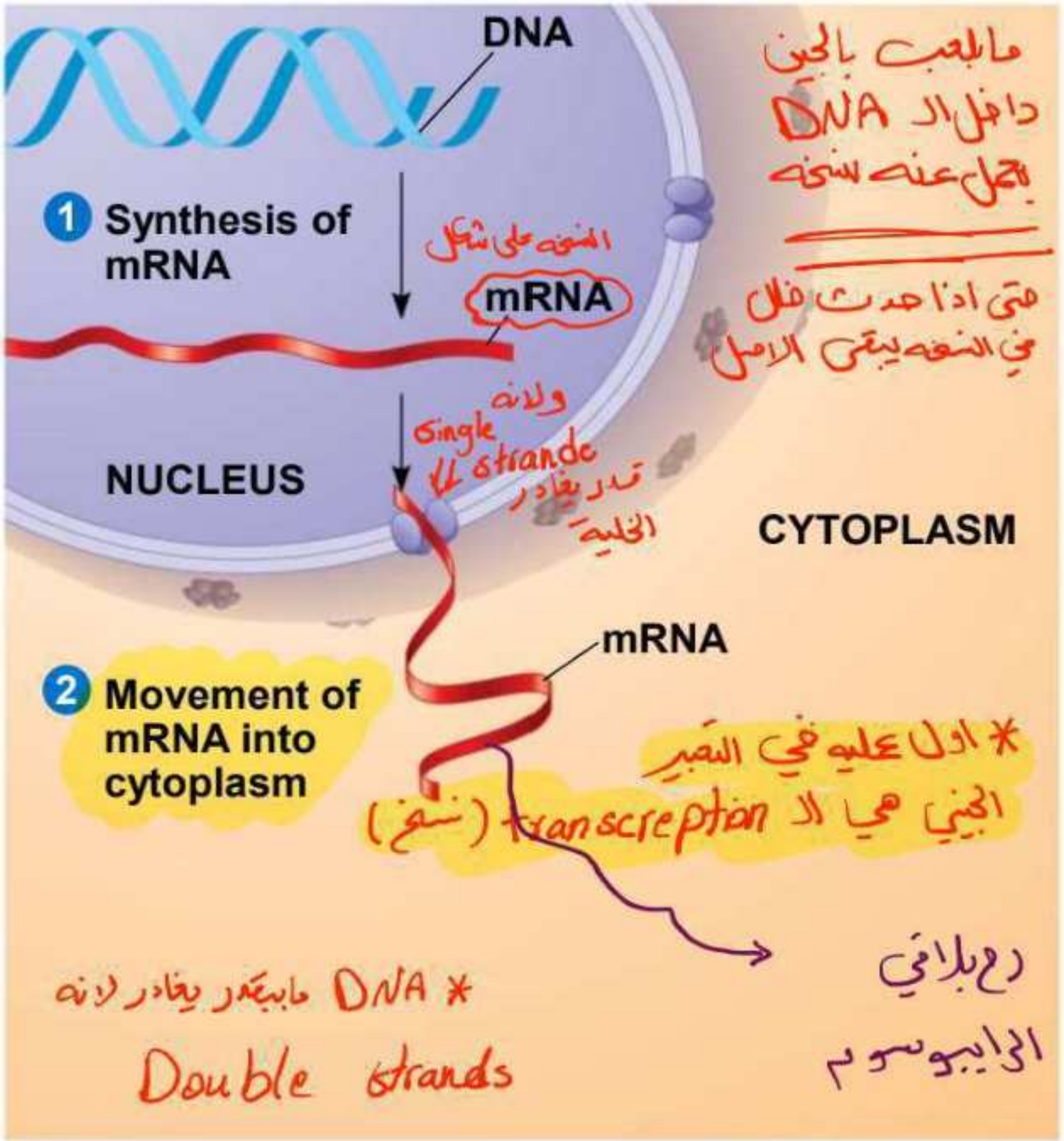

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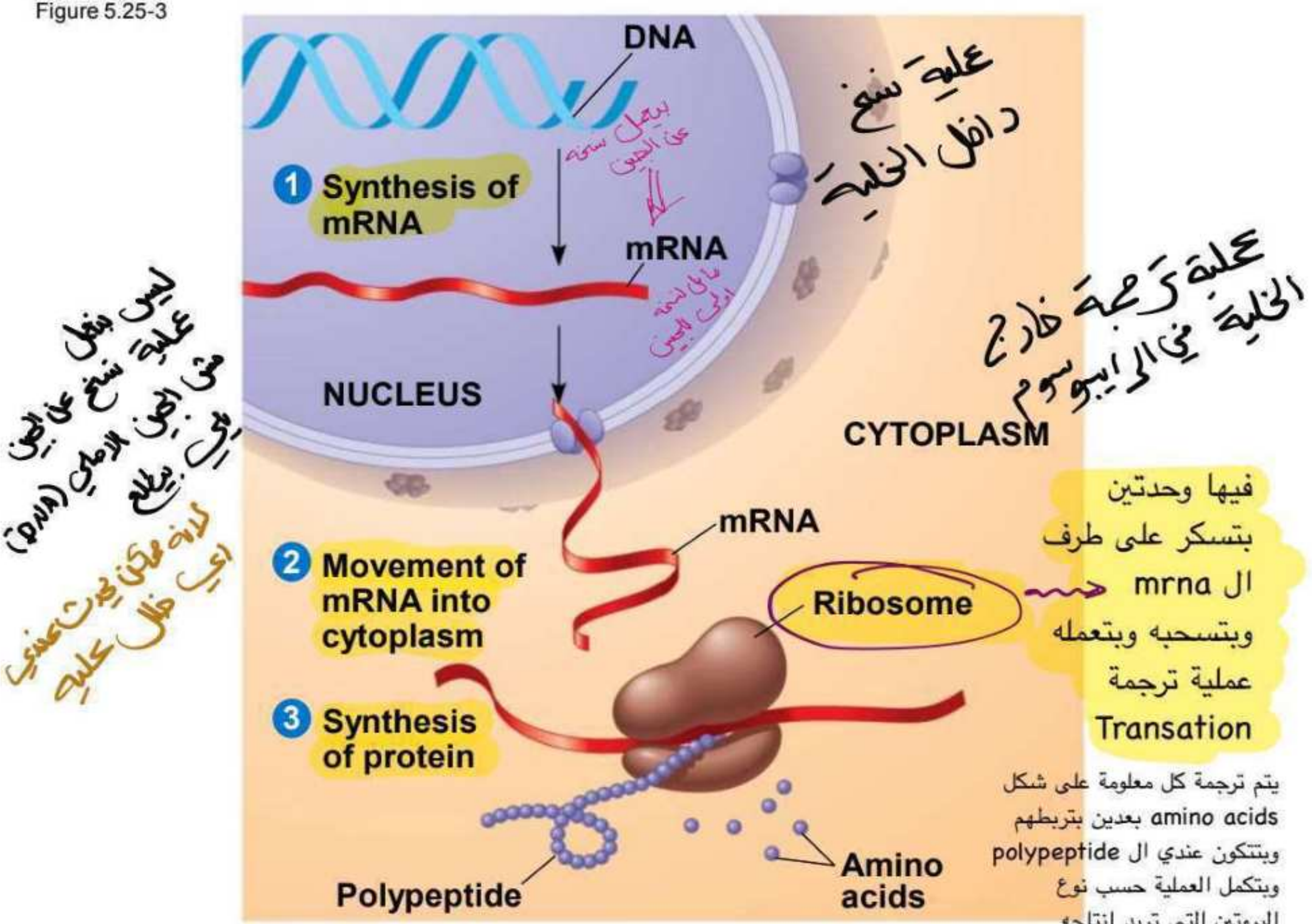
Figure 5.25-3



عمليةَ نسخ داخل الخليةَ

عملية كَرصة خارج الخليةَ في الريبوسوم

فيها وحدتين بتسكر على طرف ال mrna وبتسحبه وبتعمله عملية ترجمة Transation

يتم ترجمة كل معلومة على شكل amino acids بعدين بتربطهم وبتتكون عندي ال polypeptide ويتكمل العملية حسب نوع البروتين التي تريد انتاجه

ليس بكل عملية نسخ عن الحمض النووي (DNA) في الخلية يطلع دنة ممكن يموت عندي ابن ظل عليه

The Components of Nucleic Acids

RNA // DNA

- Nucleic acids are polymers called **polynucleotides**
- Each polynucleotide is made of monomers called **nucleotides**
- Each nucleotide consists of a nitrogenous base, a pentose sugar, and one or more phosphate groups
- The portion of a nucleotide without the phosphate group is called a nucleoside

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Figure 5.26

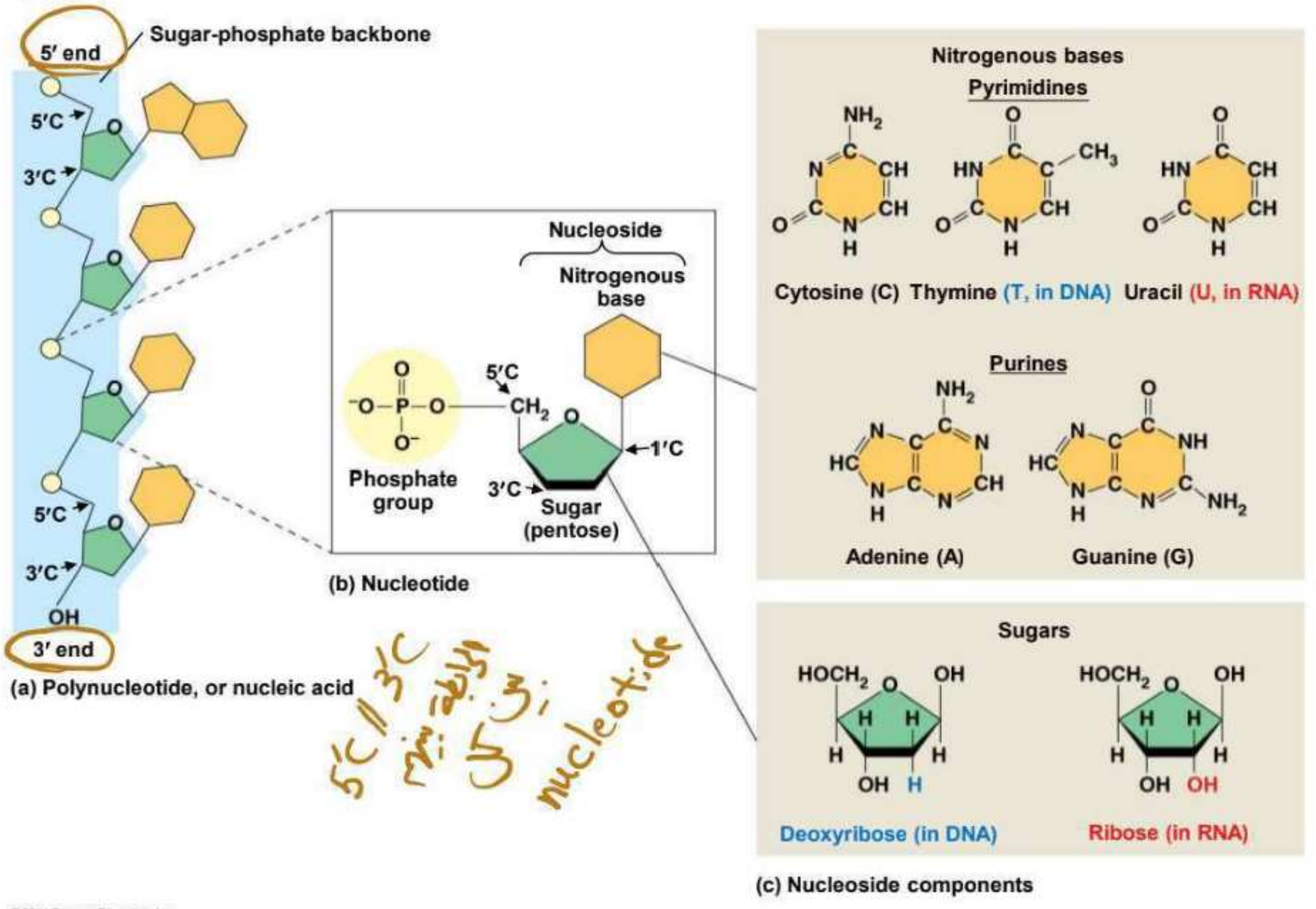

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Figure 5.26ab

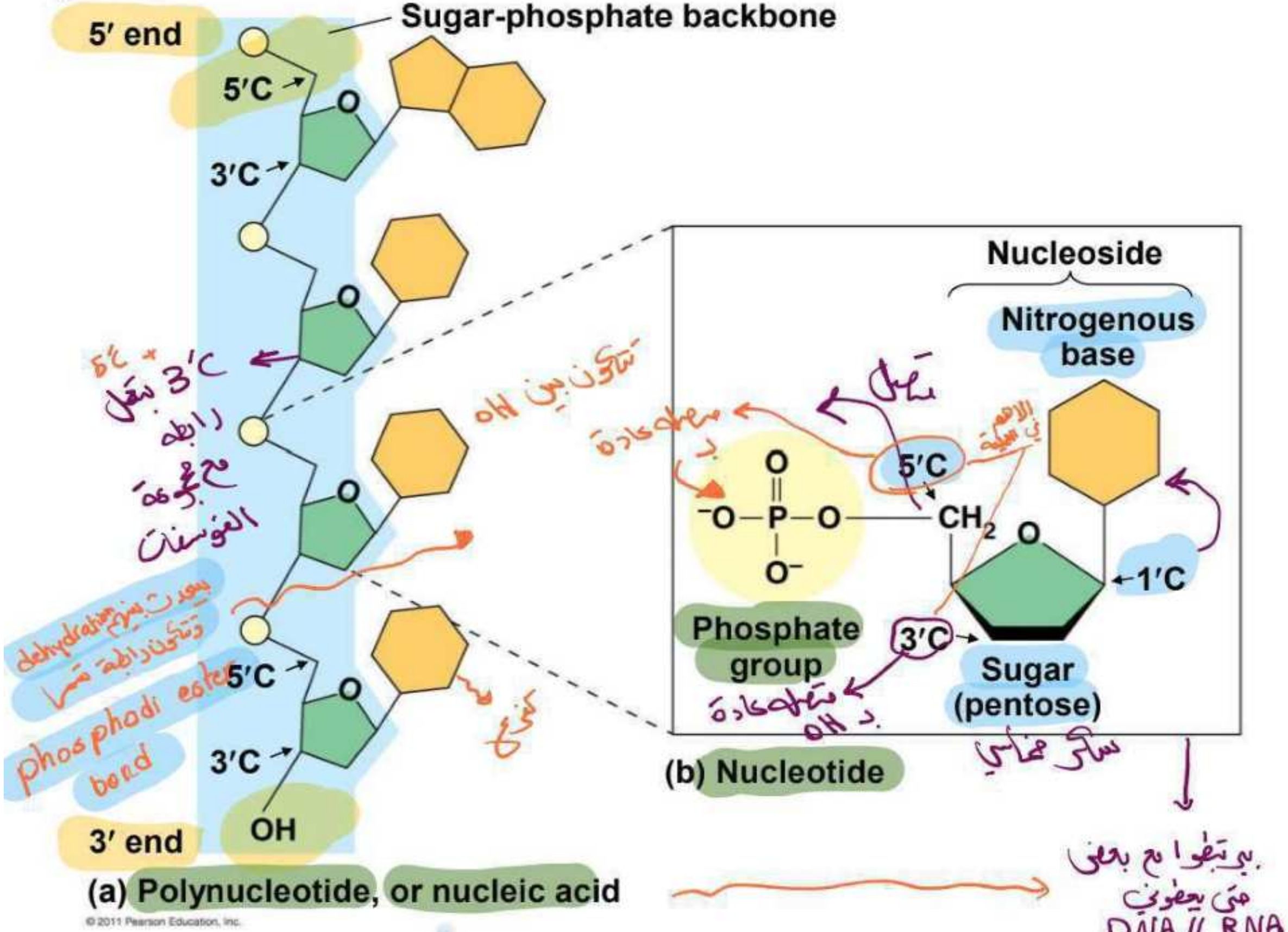

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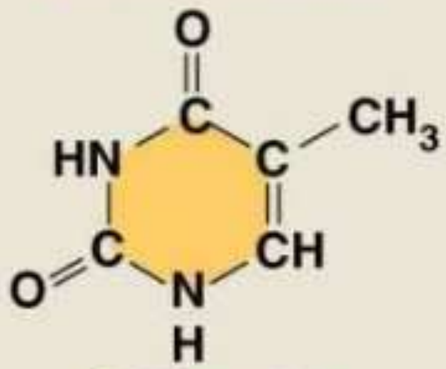
Figure 5.26c

*لا يكون في اختلاف في nucleotide في DNA وفي RNA

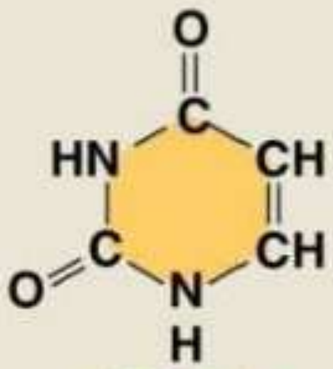
Nitrogenous bases

Pyrimidines ⇒ حلقة واحدة

Cytosine (C)

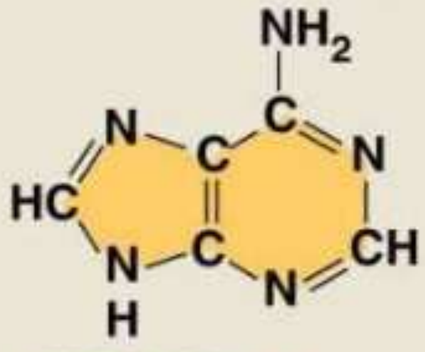


Thymine (T, in DNA)

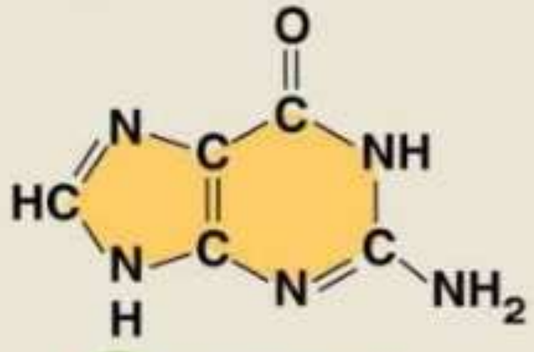


Uracil (U, in RNA)

Purines ⇒ حلقتين

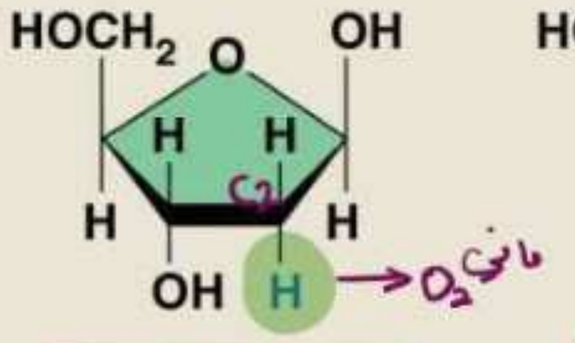


Adenine (A)

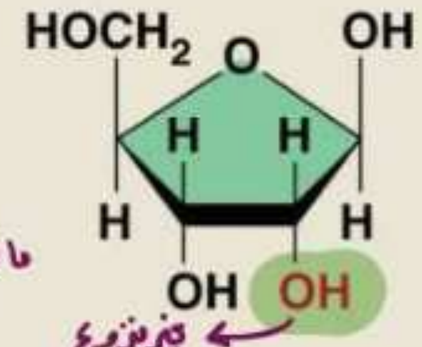


Guanine (G)

Sugars



Deoxyribose (in DNA)



Ribose (in RNA)

(c) Nucleoside components

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A = T
G ≡ C

- Nucleoside = nitrogenous base + sugar
- There are two families of nitrogenous bases
  - **Pyrimidines** (cytosine, thymine, and uracil) have a single six-membered ring
  - **Purines** (adenine and guanine) have a six-membered ring fused to a five-membered ring
- In DNA, the sugar is **deoxyribose**; in RNA, the sugar is **ribose**
- Nucleotide = nucleoside + phosphate group

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Nucleotide Polymers

- Nucleotide polymers are linked together to build a polynucleotide
- Adjacent nucleotides are joined by covalent bonds that form between the —OH group on the 3′ carbon of one nucleotide and the phosphate on the 5′ carbon on the next
- These links create a backbone of sugar-phosphate units with nitrogenous bases as appendages
- The sequence of bases along a DNA or mRNA polymer is unique for each gene

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The Structures of DNA and RNA Molecules

- RNA molecules usually exist as single polypeptide chains
- DNA molecules have two polynucleotides spiraling around an imaginary axis, forming a **double helix**
- In the DNA double helix, the two backbones run in opposite 5′→ 3′ directions from each other, an arrangement referred to as **antiparallel**
- One DNA molecule includes many genes

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حذي DNA يحتوي على :

A = T
G = C

A ⇐ ٪ 30

كم نسبة الـ T ؟ ٪ 30

كم نسبة الـ G ؟ ٪ 20

كم نسبة الـ C ؟ ٪ 20

* هي اللي تدعم الـ DNA ⇐ Hydrogen bond

- The nitrogenous bases in DNA pair up and form hydrogen bonds: adenine (A) always with thymine (T), and guanine (G) always with cytosine (C)
- Called complementary base pairing
- Complementary pairing can also occur between two RNA molecules or between parts of the same molecule
- In RNA, thymine is replaced by uracil (U) so A and U pair

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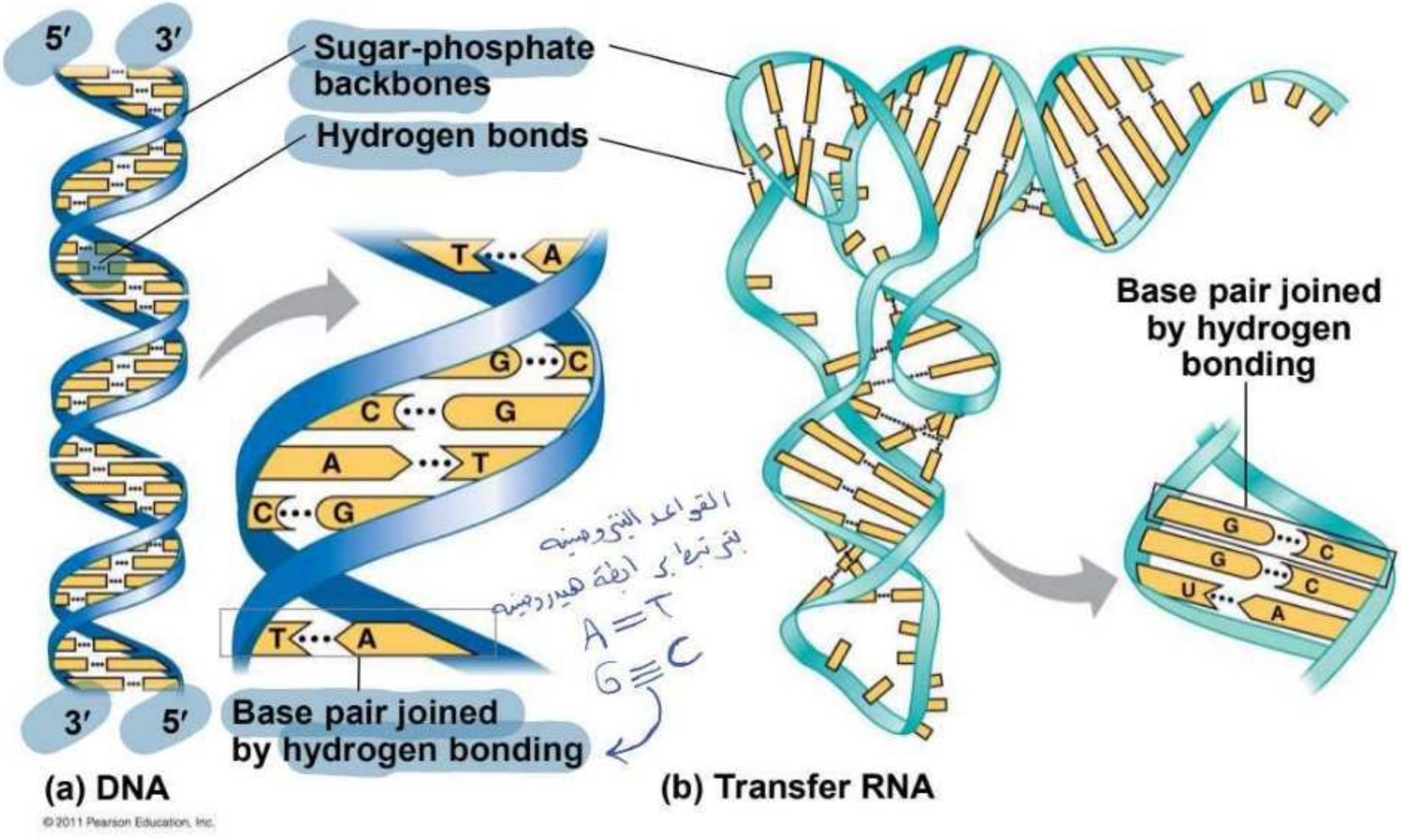
Figure 5.27



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DNA and Proteins as Tape Measures of Evolution

محذوف X

- The linear sequences of nucleotides in DNA molecules are passed from parents to offspring
- Two closely related species are more similar in DNA than are more distantly related species
- Molecular biology can be used to assess evolutionary kinship

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The Theme of Emergent Properties in the Chemistry of Life: *A Review*

- Higher levels of organization result in the emergence of new properties
- Organization is the key to the chemistry of life

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Figure 5.UN02

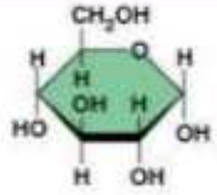
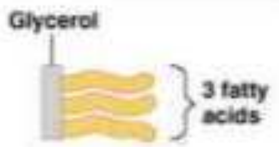
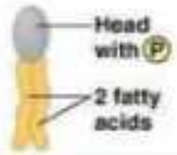
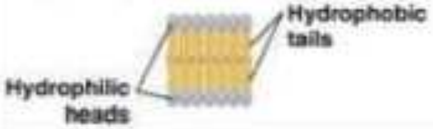
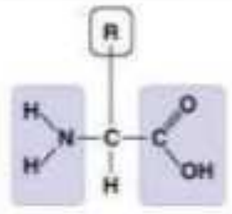
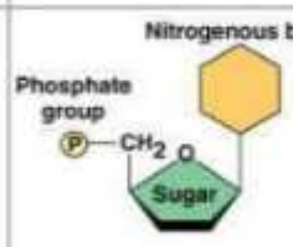
Large Biological Molecules	Components	Examples	Functions
CONCEPT 5.2 Carbohydrates serve as fuel and building material	 Monosaccharide monomer	**Monosaccharides:** glucose, fructose	Fuel; carbon sources that can be converted to other molecules or combined into polymers
		Disaccharides: lactose, sucrose	
		Polysaccharides: • Cellulose (plants) • Starch (plants) • Glycogen (animals) • Chitin (animals and fungi)	• Strengthens plant cell walls • Stores glucose for energy • Stores glucose for energy • Strengthens exoskeletons and fungal cell walls
CONCEPT 5.3 Lipids are a diverse group of hydrophobic molecules	 	**Triacylglycerols** (fats or oils): glycerol + 3 fatty acids	Important energy source
	 	**Phospholipids:** phosphate group + 2 fatty acids	Lipid bilayers of membranes 
	 Steroid backbone	**Steroids:** four fused rings with attached chemical groups	• Component of cell membranes (cholesterol) • Signaling molecules that travel through the body (hormones)
CONCEPT 5.4 Proteins include a diversity of structures, resulting in a wide range of functions	 Amino acid monomer (20 types)	• Enzymes • Structural proteins • Storage proteins • Transport proteins • Hormones • Receptor proteins • Motor proteins • Defensive proteins	• Catalyze chemical reactions • Provide structural support • Store amino acids • Transport substances • Coordinate organismal responses • Receive signals from outside cell • Function in cell movement • Protect against disease
CONCEPT 5.5 Nucleic acids store, transmit, and help express hereditary information	 Nucleotide monomer	**DNA:** • Sugar = deoxyribose • Nitrogenous bases = C, G, A, T • Usually double-stranded	Stores hereditary information
		RNA: • Sugar = ribose • Nitrogenous bases = C, G, A, U • Usually single-stranded	Various functions during gene expression, including carrying instructions from DNA to ribosomes

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Figure 5.UN02a

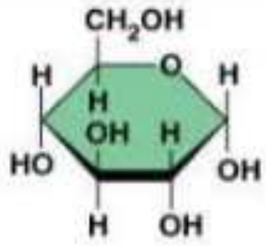
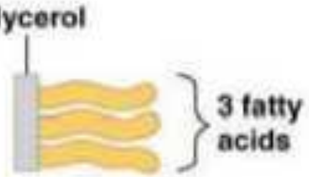
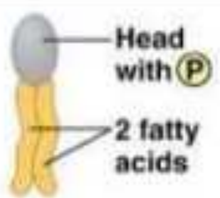
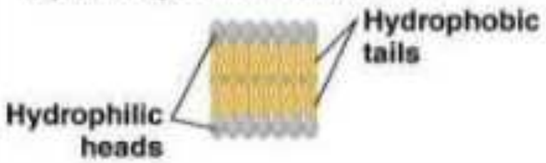
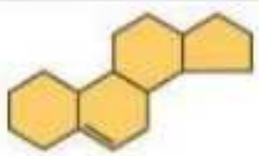
Large Biological Molecules	Components	Examples	Functions
CONCEPT 5.2 **Carbohydrates serve as fuel and building material**	 Monosaccharide monomer	**Monosaccharides:** glucose, fructose	Fuel; carbon sources that can be converted to other molecules or combined into polymers
		Disaccharides: lactose, sucrose	
		Polysaccharides: • Cellulose (plants) • Starch (plants) • Glycogen (animals) • Chitin (animals and fungi)	• Strengthens plant cell walls • Stores glucose for energy • Stores glucose for energy • Strengthens exoskeletons and fungal cell walls
CONCEPT 5.3 **Lipids are a diverse group of hydrophobic molecules**		**Triacylglycerols** (fats or oils): glycerol + 3 fatty acids	Important energy source
		**Phospholipids:** phosphate group + 2 fatty acids	Lipid bilayers of membranes 
	 Steroid backbone	**Steroids:** four fused rings with attached chemical groups	• Component of cell membranes (cholesterol) • Signaling molecules that travel through the body (hormones)

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Figure 5.UN02b

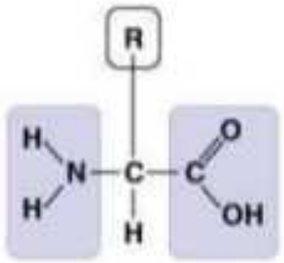
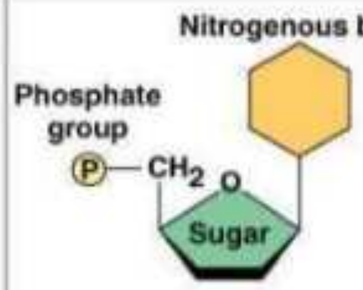
Large Biological Molecules	Components	Examples	Functions
CONCEPT 5.4 **Proteins include a diversity of structures, resulting in a wide range of functions**	 **Amino acid monomer (20 types)**	• Enzymes • Structural proteins • Storage proteins • Transport proteins • Hormones • Receptor proteins • Motor proteins • Defensive proteins	• Catalyze chemical reactions • Provide structural support • Store amino acids • Transport substances • Coordinate organismal responses • Receive signals from outside cell • Function in cell movement • Protect against disease
CONCEPT 5.5 **Nucleic acids store, transmit, and help express hereditary information**	 **Nucleotide monomer**	**DNA:** • Sugar = deoxyribose • Nitrogenous bases = C, G, A, T • Usually double-stranded	Stores hereditary information
		RNA: • Sugar = ribose • Nitrogenous bases = C, G, A, U • Usually single-stranded	Various functions during gene expression, including carrying instructions from DNA to ribosomes

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Figure 5. UN03

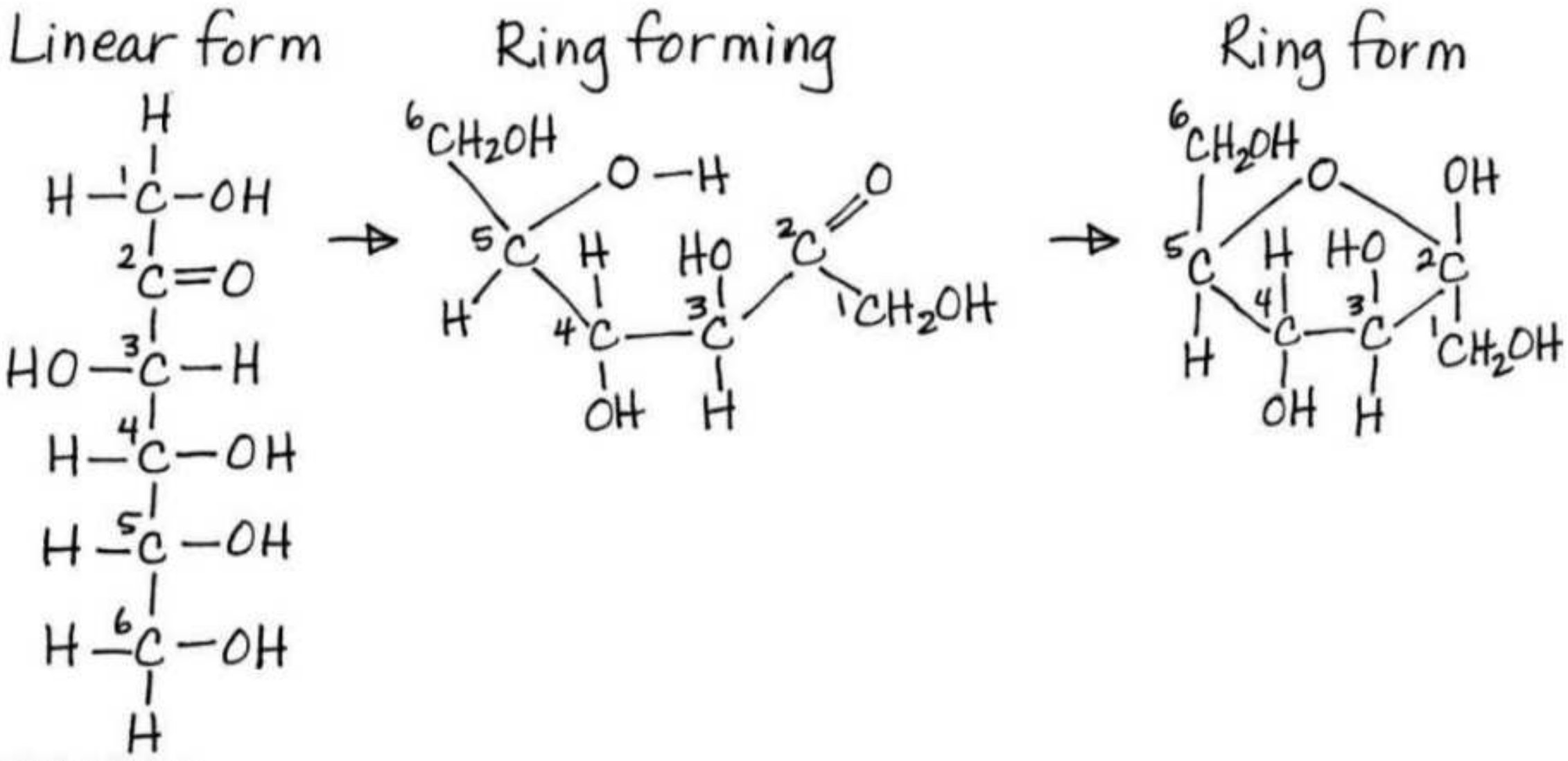

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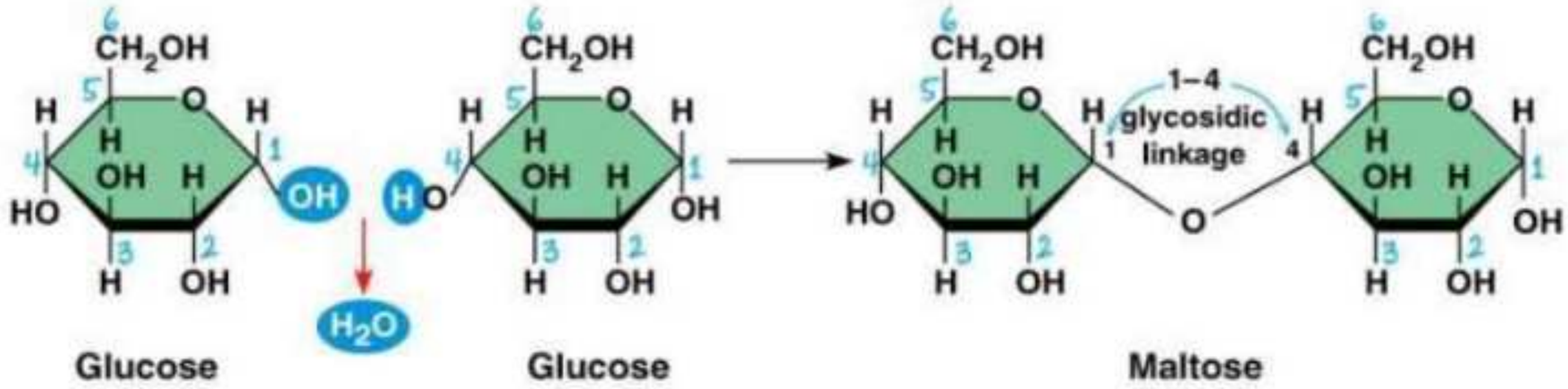
Figure 5. UN04



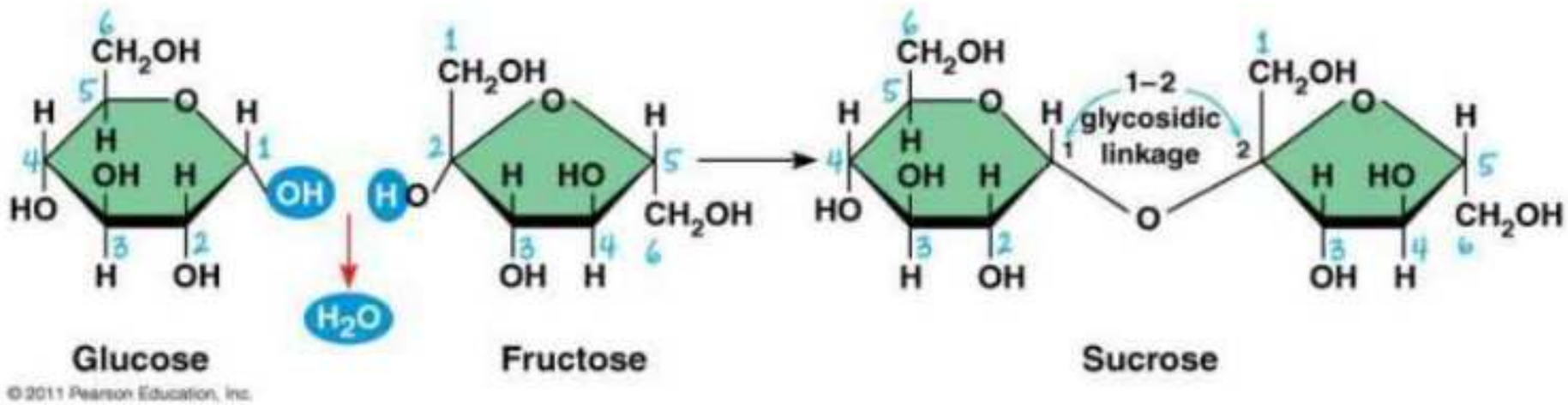


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Figure 5. UN05

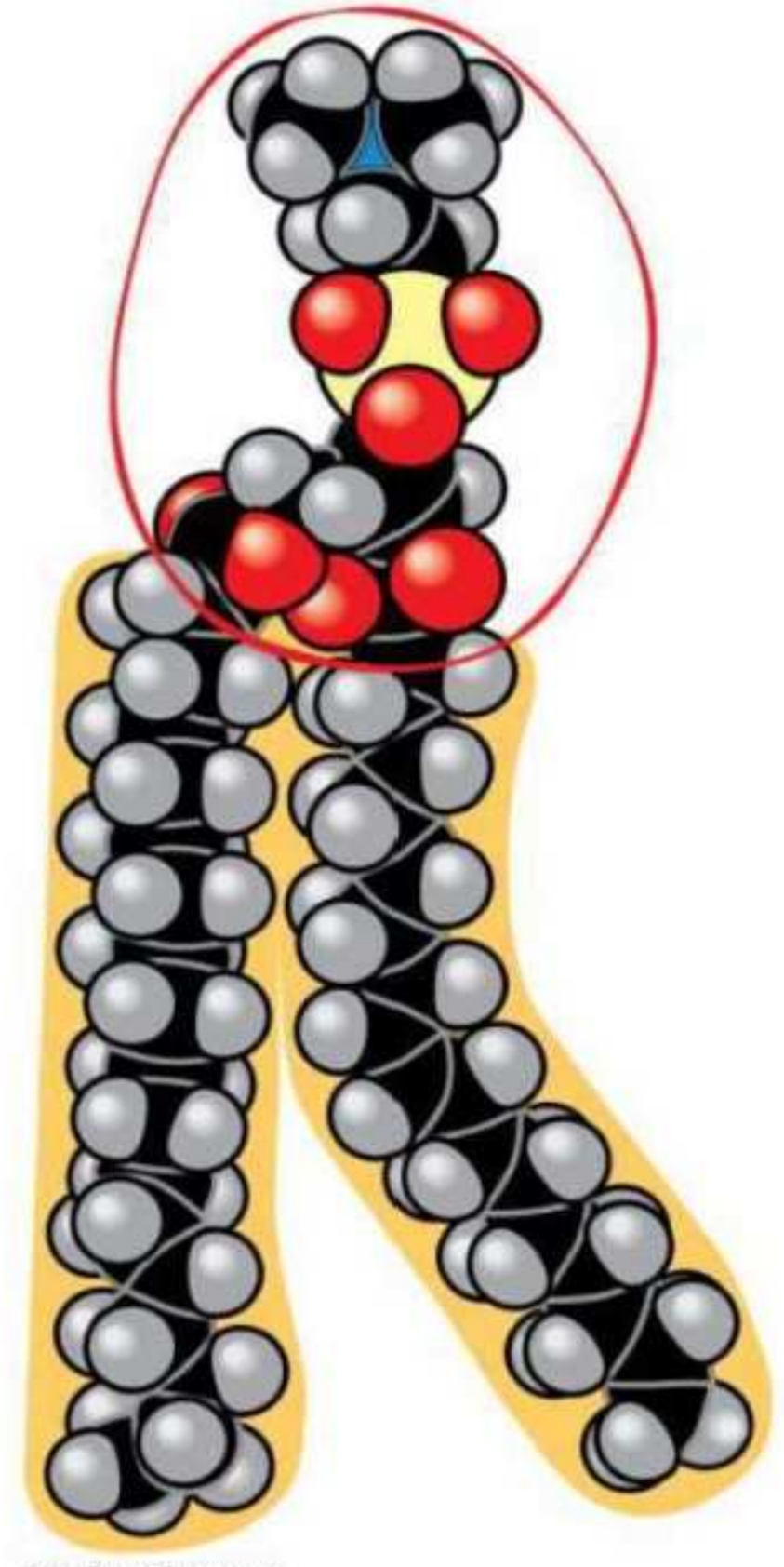

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Figure 5. UN06

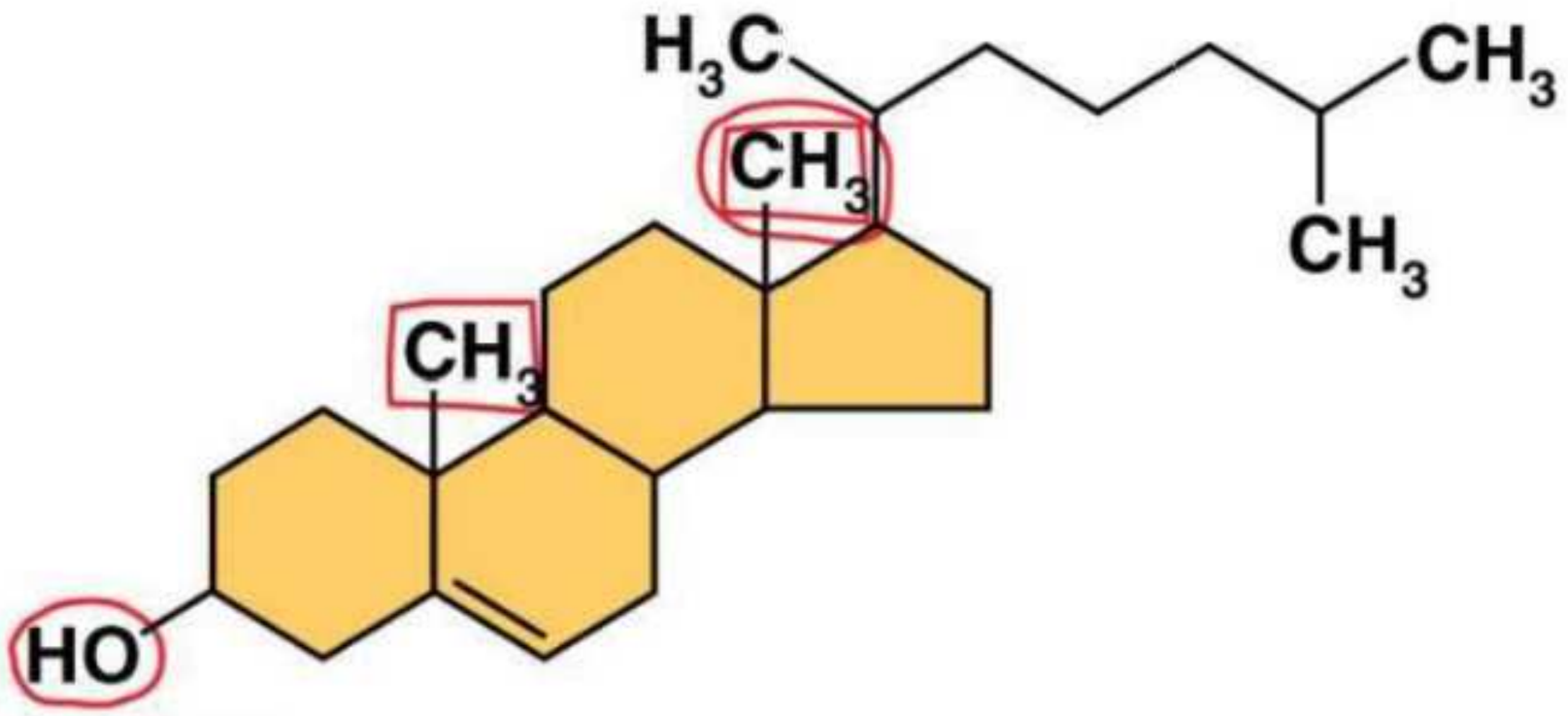

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Figure 5. UN07

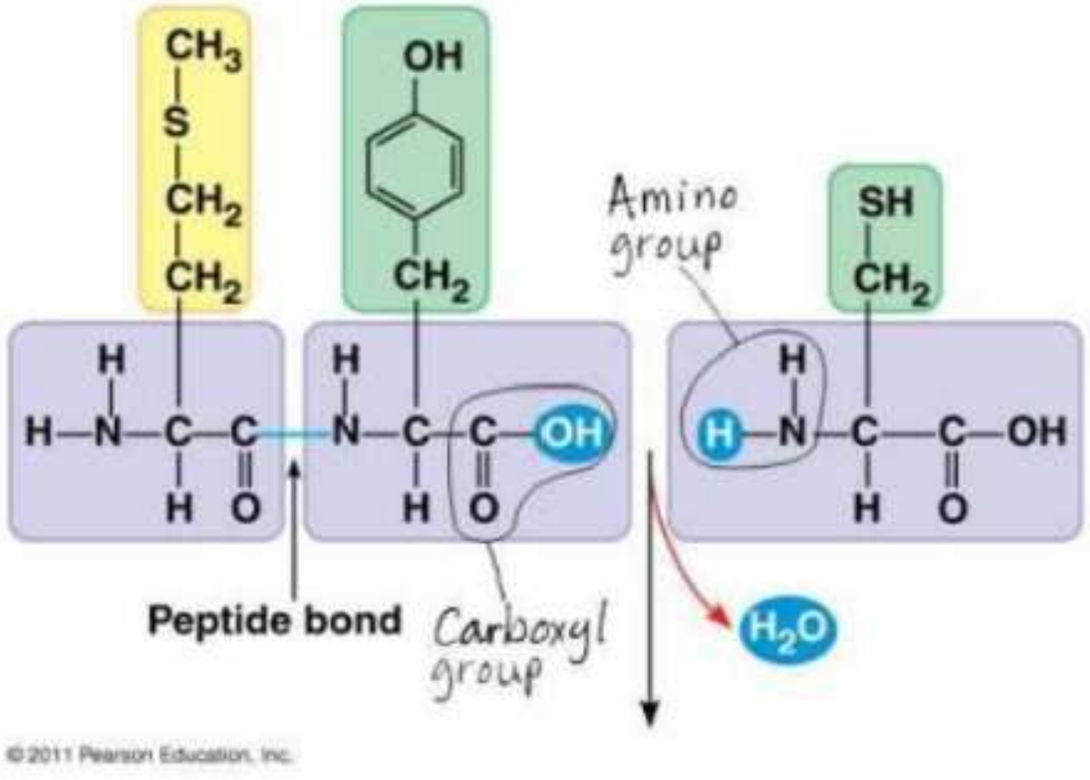

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Figure 5. UN08

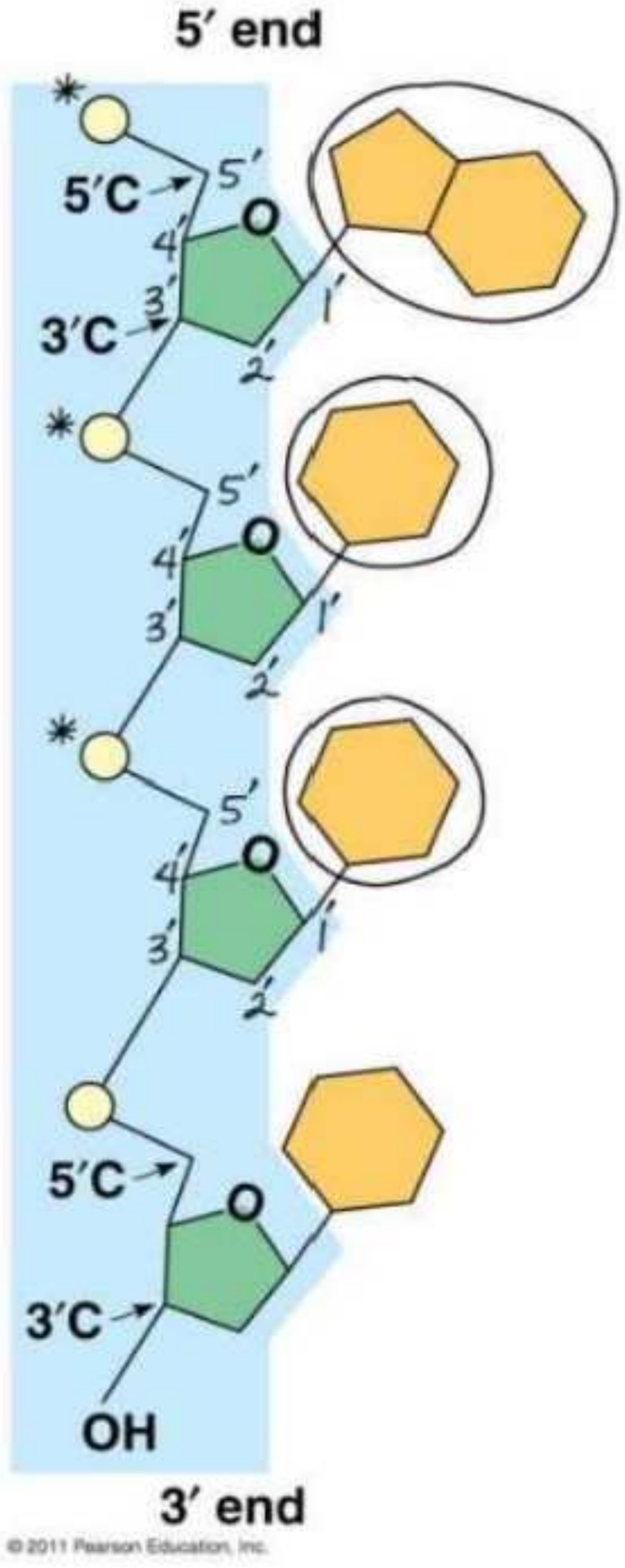

Figure 5. UN09

5′–T A G G C C T–3′

3′–A T C C G G A–5′

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Figure 5. UN10

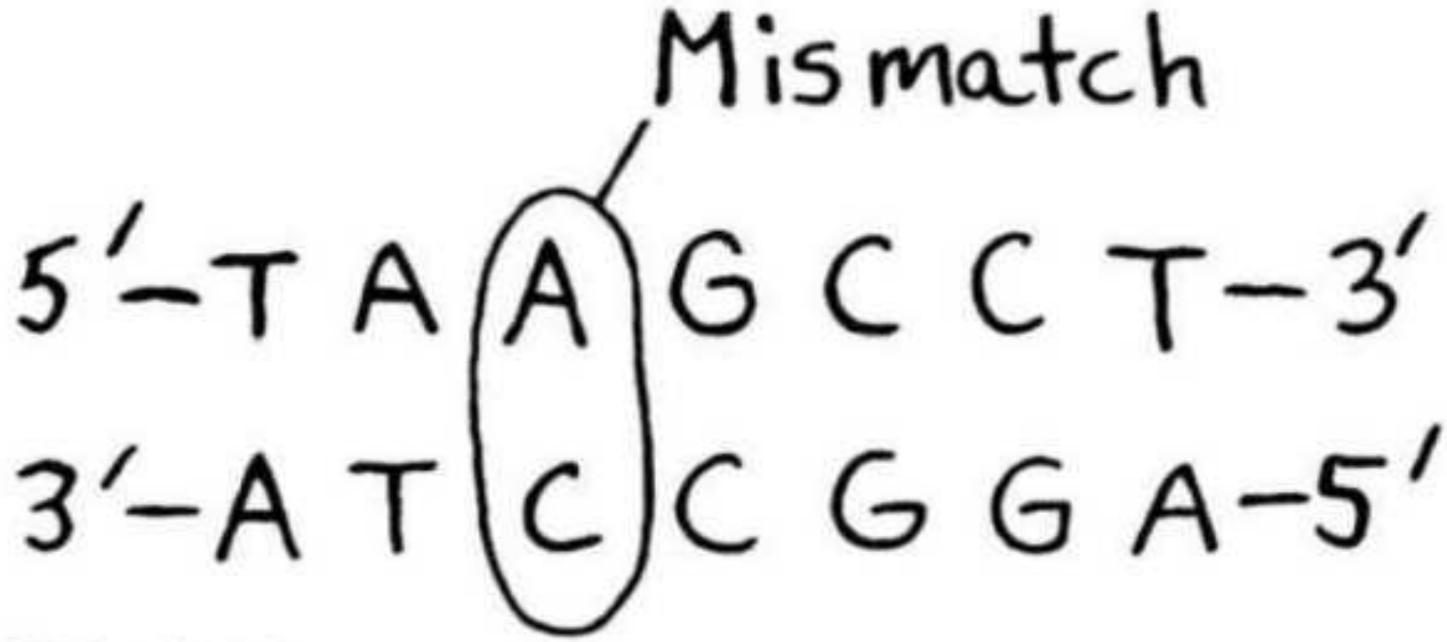

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Figure 5. UN11

3′-A T T C G G A-5′

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Figure 5. UN12

	Monomers or Components	Polymer or larger molecule	Type of linkage
Carbohydrates	Monosaccharides	Polysaccharides	Glycosidic linkages
Lipids	Fatty acids	Triacylglycerols	Ester linkages
Proteins	Amino acids	Polypeptides	Peptide bonds
Nucleic acids	Nucleotides	Polynucleotides	Phosphodiester linkages

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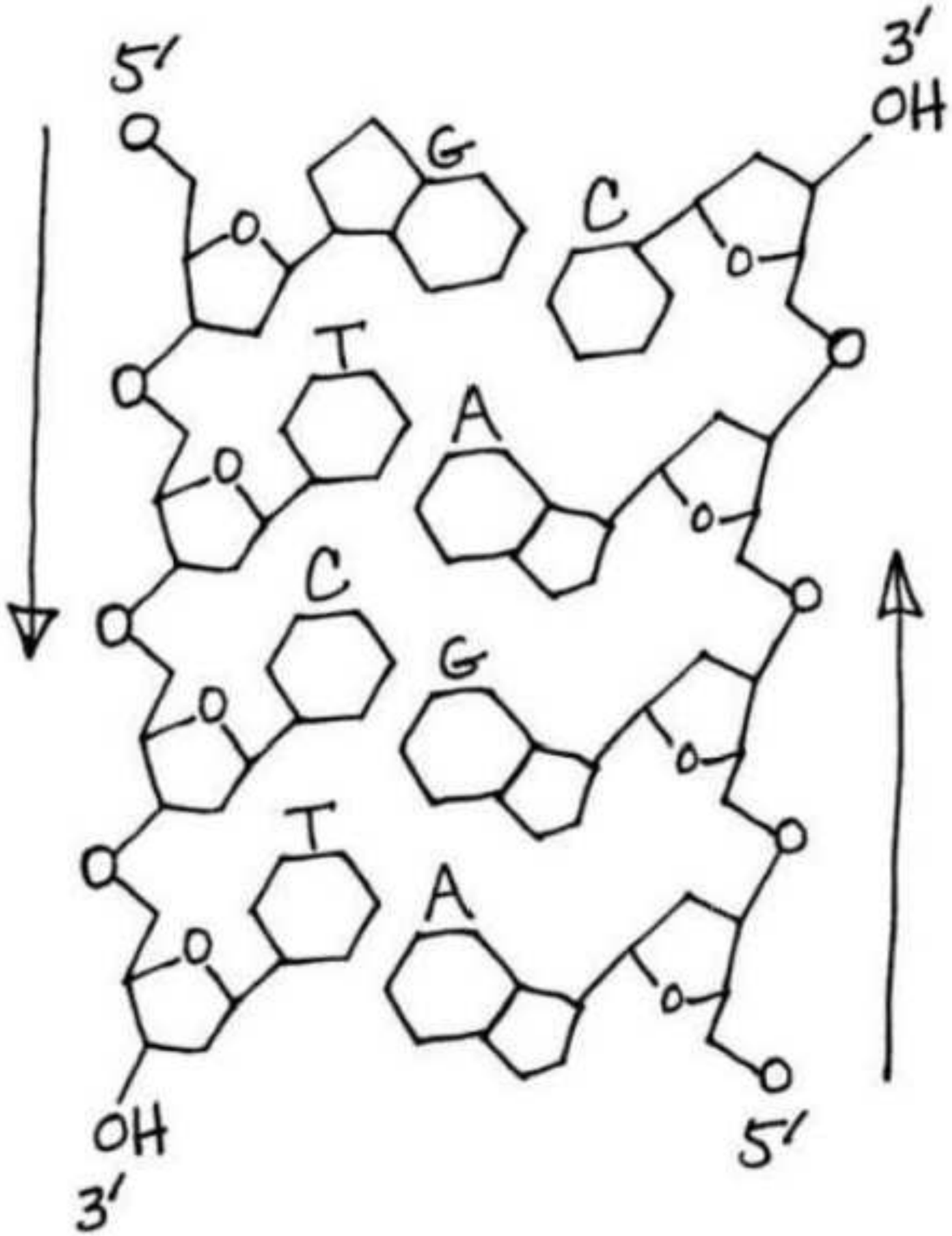
Figure 5. UN13



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