Educational Bag

Clinical biochemistry

Assist prof. dr majeed m.a.ali

Department of Nursing

Introduction

Subject	Language	Educational level	Hours / Week			
			Theory	Practical	Total	No. Unit
Clinical Biochemistry	English	1ts Stage	3	2	4	4

Objectives

General Objective

1. The nature of the biochemistry,
2. composition related to the compounds of the bio chemistry.
3. General techniques used in the work of the biochemistry and diagnosis.
4-chemical reaction of bio compounds
5-chemical analysis for different elements
6- Study the different metabolism for carbohydrates , protein ,lipids…..etc

Specific objective

At the end of the school year, the student will be able to understand and realize

1. Defining biochemistry and its relationship to other sciences and its importance to the student of chemical analyzes.
2. The components of the biochemistry, which include the cells and organs that are related to the formation of the biochemistry.
3. The concept of natural and enzymes, humoral factors and cellular factors, carbohydrates, amino acids. Fatty acids
4. The relationship between chemical components and cellular factors and the biology of the cells.
5. Mechanisms of laboratory diagnosis and identification of some diseases that depend on biochemical compounds

	المفردات النظرية/ كيمياء حياتيه سريريه
Week	تفاصيل المفردات
1	INTRODUCTION TO METABOLISM - Food energy
3-4	CARBOHYDRATE METABOLISM - Oxidation of Glucose: a) glycolysis 1- Transport of glucose into cells 2- Reaction of glycolysis 3- Hormonal regulation of glycolysis 4- Clinical notes 5- Inherited enzyme deficiencies of glycolysis: i) Pyruvate Kinase deficiency ii) Lactic acidosis
5-6	b) TCA cycle 1- The reactions of the TCA cycle: i) Oxidation of Acetyl CoA by the TCA cycle ii) Energy production by the TCA cycle 2- Synthetic function of the TCA cycle 3- Regulation of the TCA cycle

Week	Subject
7-8	Fructose & Galactose metabolism i) Disorders of Fructose metabolism ii) Disorders of Galactose metabolism
9-10	Glycogen metabolism i) Regulation of glycogen synthesis and degradation ii) Glycogen storage diseases
11	Blood glucose and its regulation i) Diabetes mellitus and Insulin metabolism ii) Hypoglycemia
12	**Monoclonal Antibody production**
13	**Reviewing for all subject**
14	**Short Quiz**

12-15	PROTEIN METABOLISM - Fate of Ammonia - Urea: (normal values, uremia) - Amino acids as buffers - Serum protein components - Insulin structure - Selected inborn errors of amino acid metabolism
	LIPID METABOLISM - Oxidation of Fatty acids - Ketone bodies - Cholestrol metabolism - Lipoprotein metabolism - Atherosclerosis

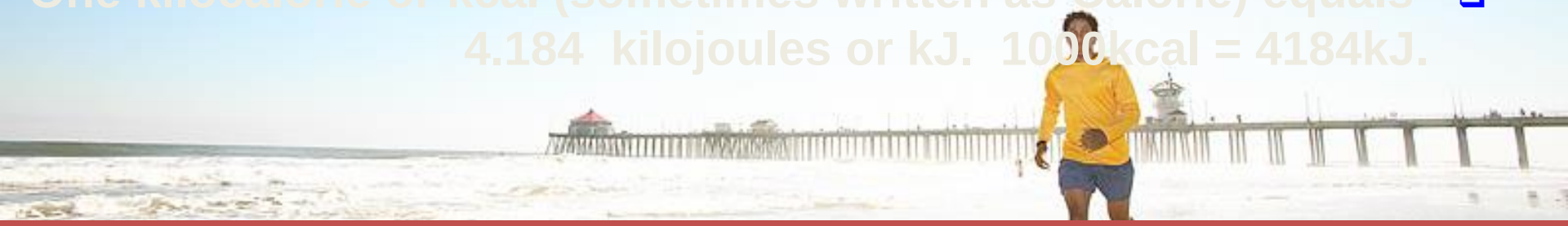
Food and Energy

Revise and Test

How is Energy Measured?

A Answers

- All energy can be measured. This includes energy from the sun, the energy we use and the energy contained in food.
- Energy is measured either in joules or calories.
- Both measures are used in the same way as pints and litres.
- One kilocalorie or kcal (sometimes written as Calorie) equals 4.184 kilojoules or kJ. 1000kcal = 4184kJ.



- . Approximately what are the missing values below?
  - **(a.)** 1 gram protein = 4kcal or ……**kJ.** (*answer: 17kJ, 30kJ or 170KJ)*
  - **(b.)** 1 gram fat = ….**kcal** or 38kJ. (*answer: 4kJ, 9kJ or 19kJ)*
  - **(c.)** 1 gram carbohydrate = 3.75 or …. **kJ.** *(ans: 12kJ, 16kJ or 24kJ)**

Activity Levels and Energy

- The estimated average requirement **(EAR)** for energy for a 15-18 year old male is 2755kcal.
- . Is the average requirements for a 15-18 year old female **(a.) less, (b.) the same, or (c.) more,** than for a male of the same age?
- EAR is based on age, sex and how active we are;
- . Name one group of people who will have extra energy needs? *

A Answers

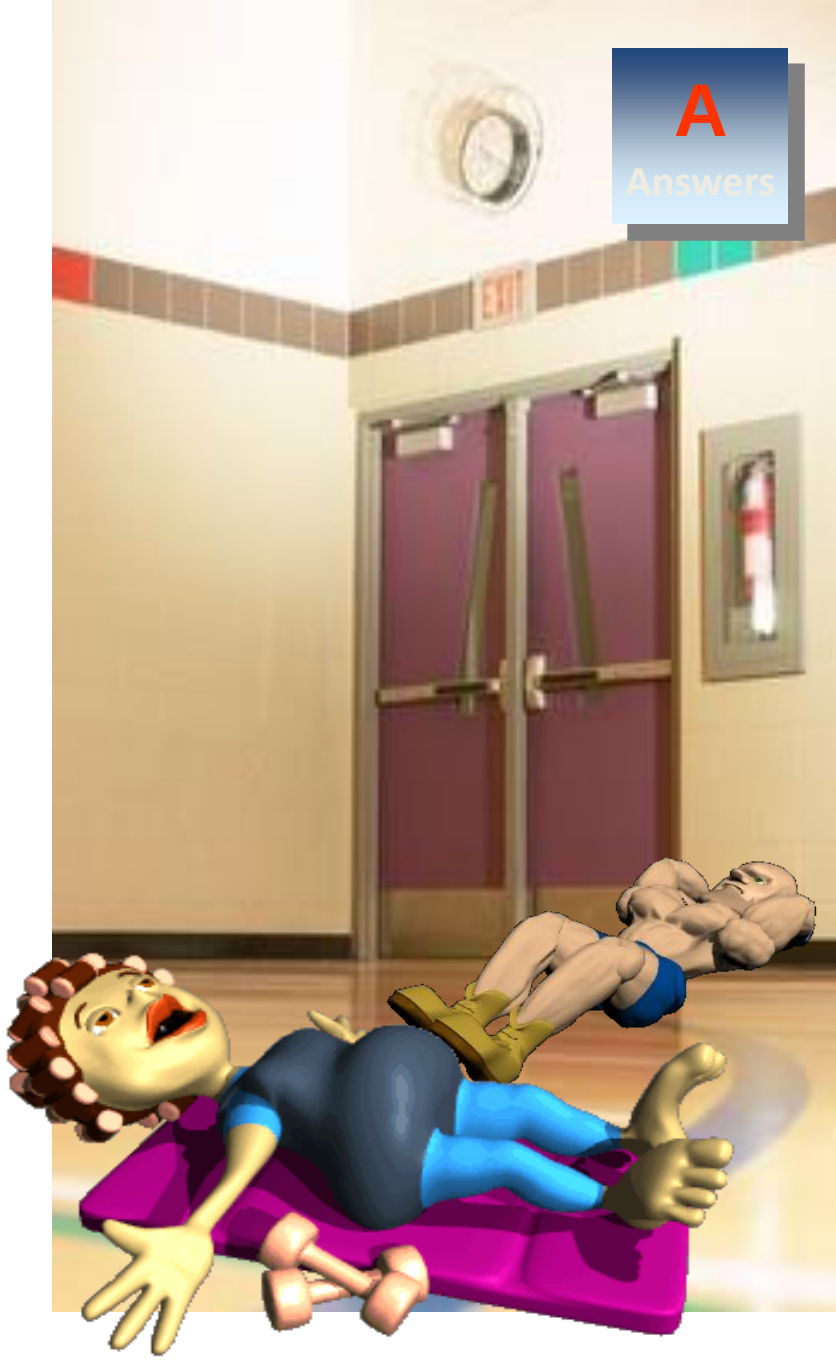
The Energy Balance

- . Where is energy stored in the body?
- . What will happen if our diet provides more energy than we need?
- . What does ‘energy balance’ mean? *

Exercise

- During your teenage years you are building the body for the rest of your life.
- Not taking exercise may well condemn you to a shorter unhealthier life.
- . What is the recommended amount of exercise for a teenager?
- . Which of these are a benefit of taking exercise. **(Strengthens the body, / helps digestion,/ helps mental health, / improves concentration, / improves appetite, / helps keep desired weight.) ***

A
Answers



Compare and Contrast:
How do lipids and carbohydrates differ in ATP production?

- Lipids provide more ATP than carbohydrates do.
- Carbohydrates produce about 36, and lipids produce about 146.

What about plants?

More on them later…….

- **<u>Lipids or Fats</u> store the most energy and provide the most ATP when broken down.**
  - Store 80 percent of the energy in your body
  - Obtain about 146 ATP molecules from a triglyceride

- **<u>Proteins</u>** are least likely to be broken down to make ATP.
  - amino acids not usually needed for energy, but for making new proteins!
  - store about the same amount of energy as a carbohydrate

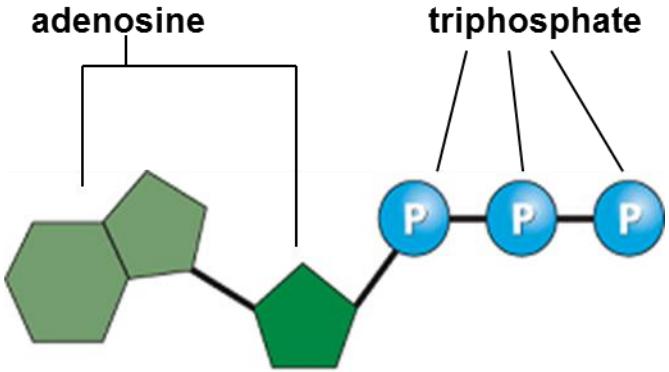
MOLECULE	ENERGY
Carbohydrate	4 calories per mg
Lipid	9 calories per mg
Protein	4 calories per mg

<u>Carbohydrates</u> are the molecules **most commonly broken down** to make ATP.

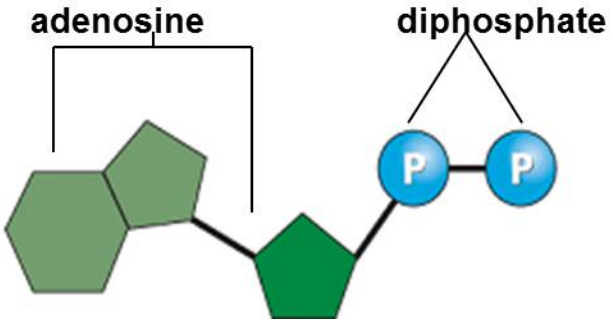
- not stored in large amounts in our bodies
- you can get up to 36 ATP molecules from one glucose molecule

Let's Compare ATP and ADP!

tri=3



di=2

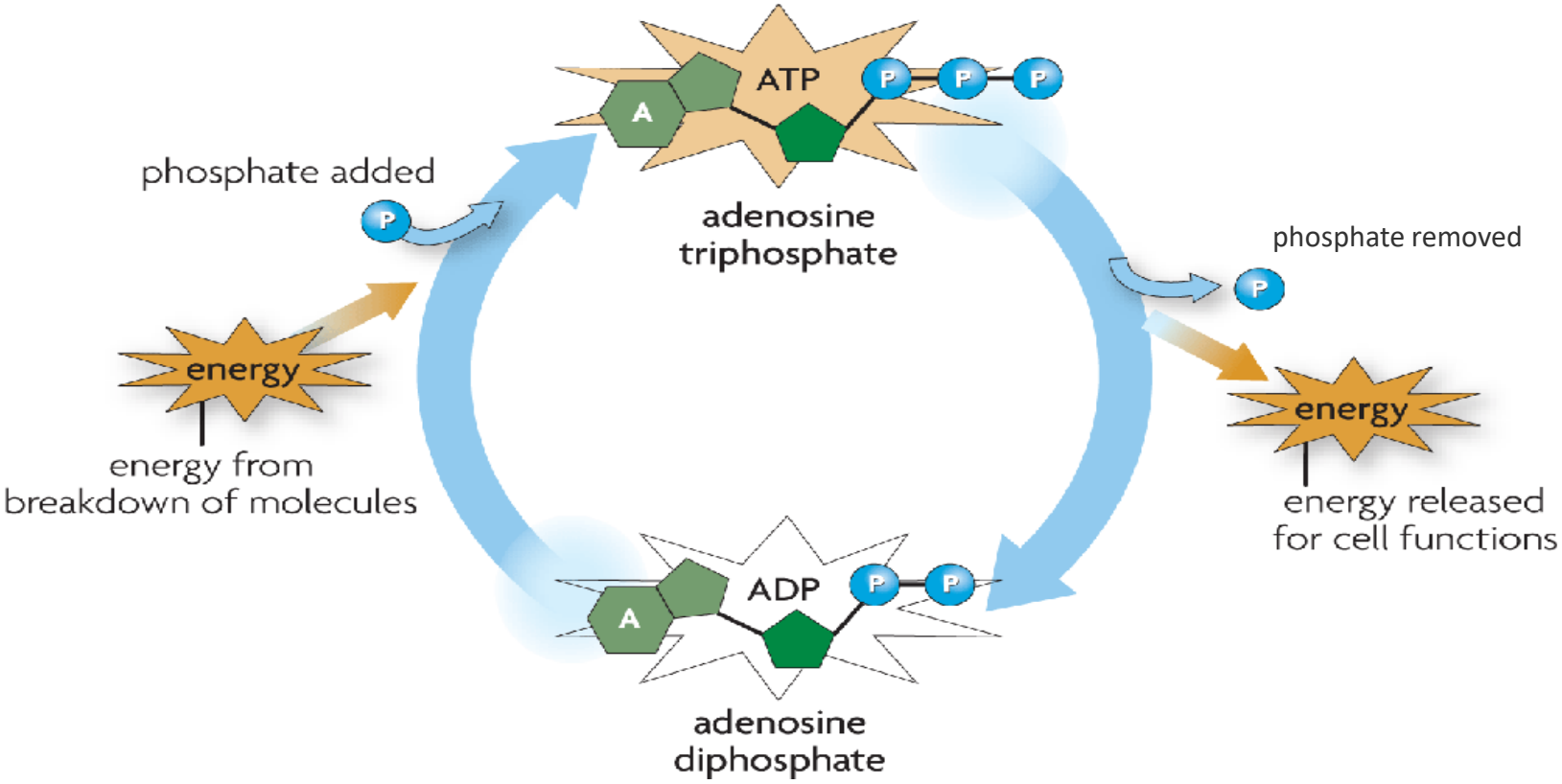


Describe the relationship between energy stored in food and ATP.

Food molecules store chemical energy in their bonds. .1

Food is broken down into smaller molecules that are broken down further to transfer this energy to ATP. .2

Where are molecules from food involved in the cycle?



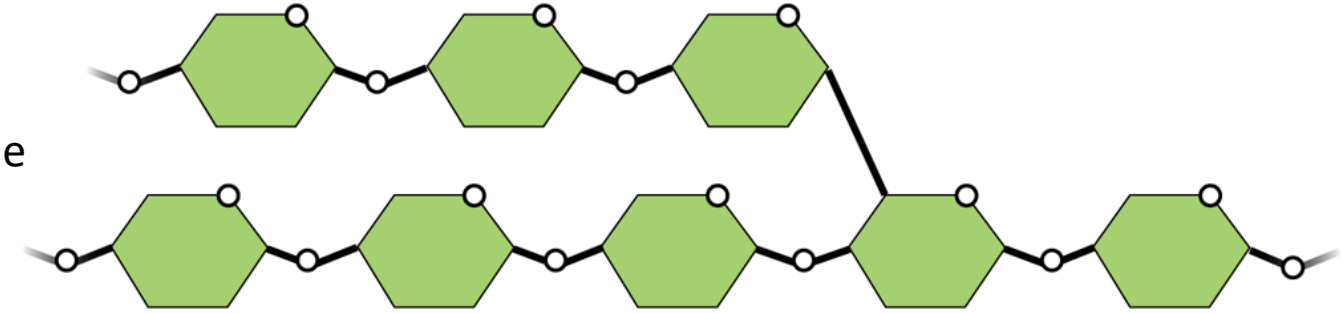
What is ATP?

Adenosine triphosphate, a molecule that transfers energy from the breakdown of food molecules to cell processes.

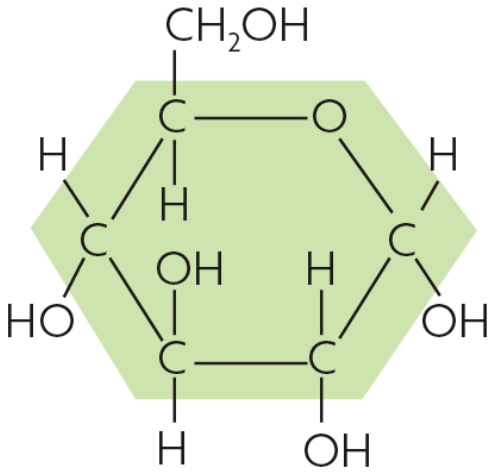
- ATP carries chemical energy that cells can use.
- Cells use ATP to carry out functions:
  - building molecules
  - moving materials by active transport.

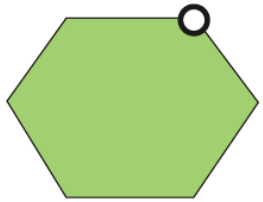
- Molecules in food store chemical energy in their bonds.
- What is a glucose molecule?

Starch molecule



Glucose molecule





A six-carbon sugar made by plants during photosynthesis. Used for energy!

A
Answers

All energy can be measure

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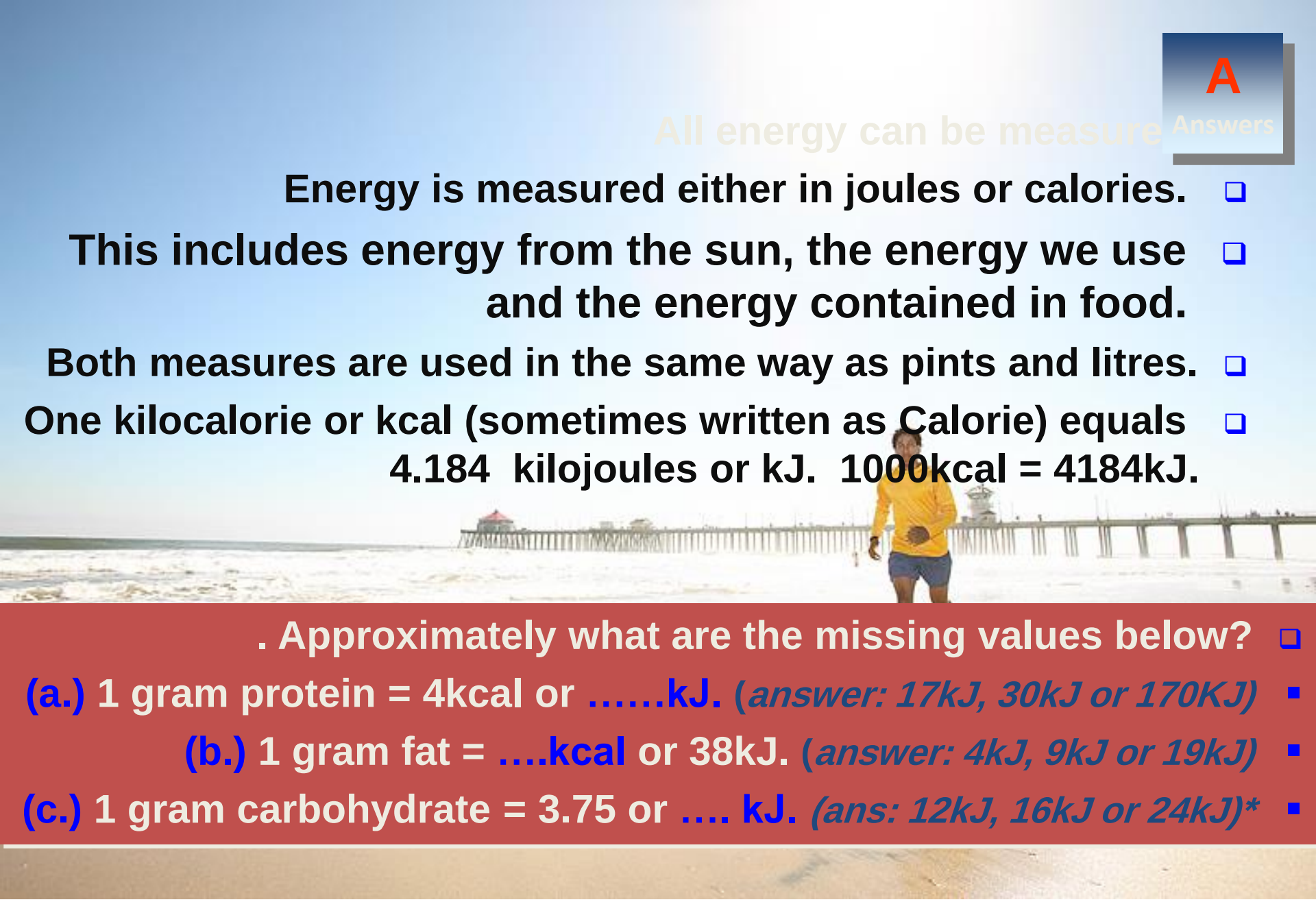

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4&5	CARBOHYDRATE METABOLISM - Oxidation of Glucose: a) glycolysis 1- Transport of glucose into cells 2- Reaction of glycolysis 3- Hormonal regulation of glycolysis 4- Clinical notes 5- Inherited enzyme deficiencies of glycolysis: i) Pyruvate Kinase deficiency ii) Lactic acidosis

Carbohydrates

Assistant Professor

Dr. Majid m.a. ALI

Carbohydrates

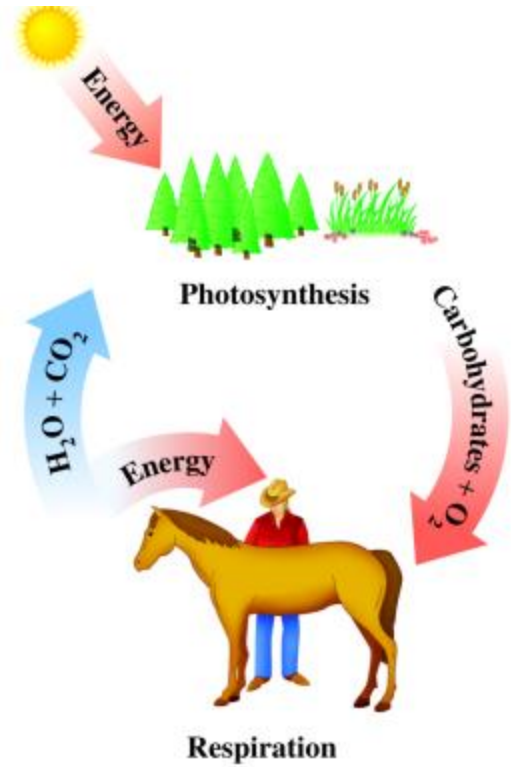
Carbohydrates are

- A major source of energy from our diet.
- Composed of the elements C, H, and O.
- Also called saccharides, which means “sugars.”

Carbohydrates

Carbohydrates

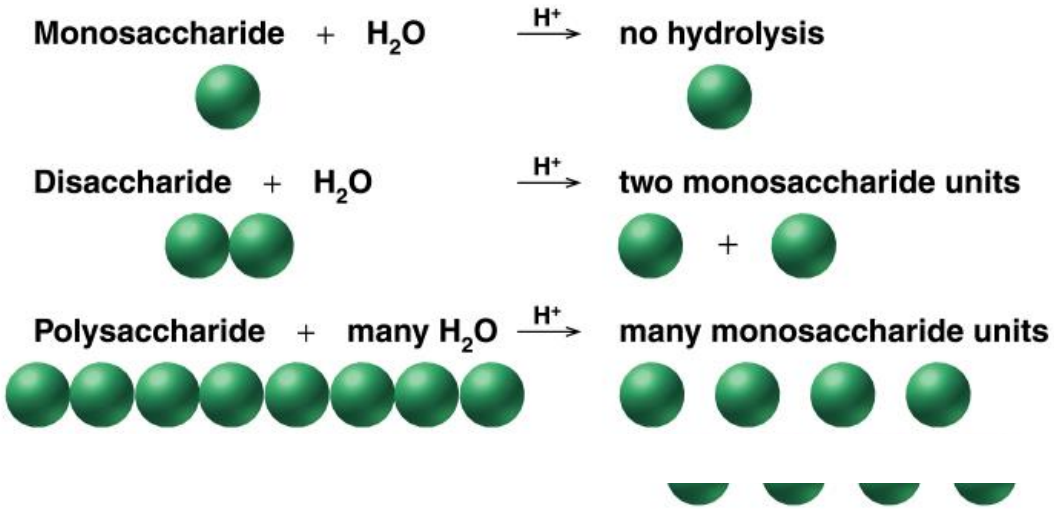
- Are produced by photosynthesis in plants.
- Such as glucose are synthesized in plants from CO_2, H_2O, and energy from the sun.
- Are oxidized in living cells (respiration) to produce CO_2, H_2O, and energy.



Types of Carbohydrates

The types of carbohydrates are

- Monosaccharides, the simplest carbohydrates.
- Disaccharides, which consist of two monosaccharides.
- Polysaccharides, which contain many monosaccharides.



Monosaccharides

Monosaccharides consist of

- 3 to 6 carbon atoms, typically.
- A carbonyl group (aldehyde or ketone).
- Several hydroxyl groups.

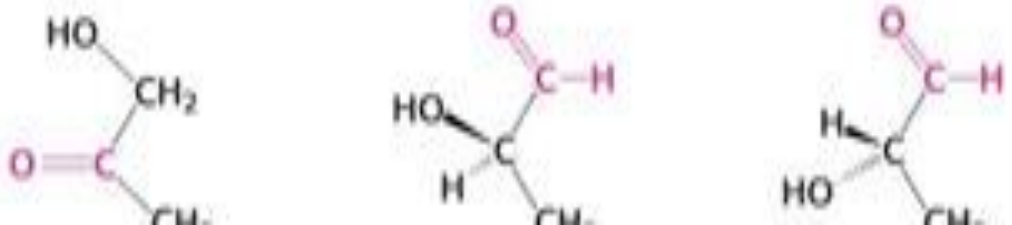
تقسيم السكريات الأحاديه

سكر ثلاثي $C_3H_6O_3$

ابسط السكريات الأحاديه

مثال: الجليسر لدهايد هو سكر ثلاثي الدوزي

الدايهيدروكسي أستون وهو سكر كيتوزي ثلاثي



Aldoses

Aldoses are monosaccharides

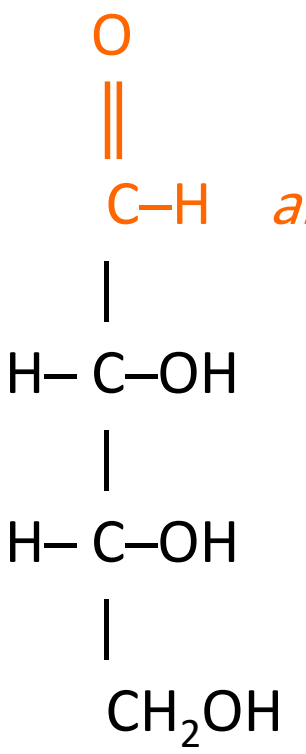
- With an aldehyde group.
- With many hydroxyl (–OH) groups.

triose (3 C atoms)

tetrose (4 C atoms)

pentose (5 C atoms)

hexose (6 C atoms)



Erythose, an aldotetrose

Ketoses

Ketoses are monosaccharides

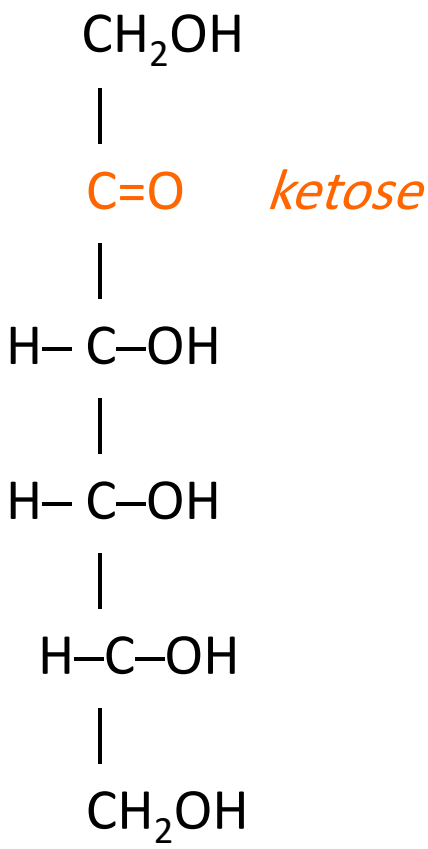
- With a ketone group.
- With many hydroxyl (–OH) groups.

triose (3 C atoms)

tetrose (4 C atoms)

pentose (5 C atoms)

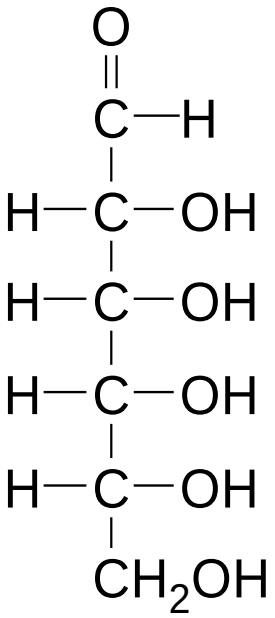
hexose (6 C atoms)



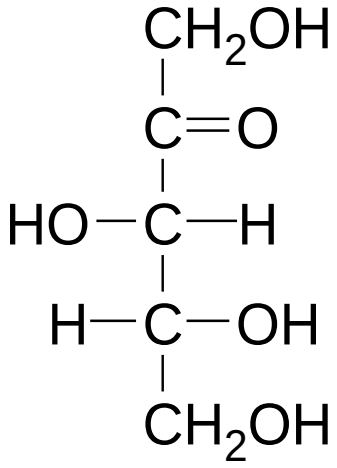
Fructose, a ketohexose

Learning Check

Identify each as aldo- or keto- and as tetrose, pentose, or hexose:



B



A

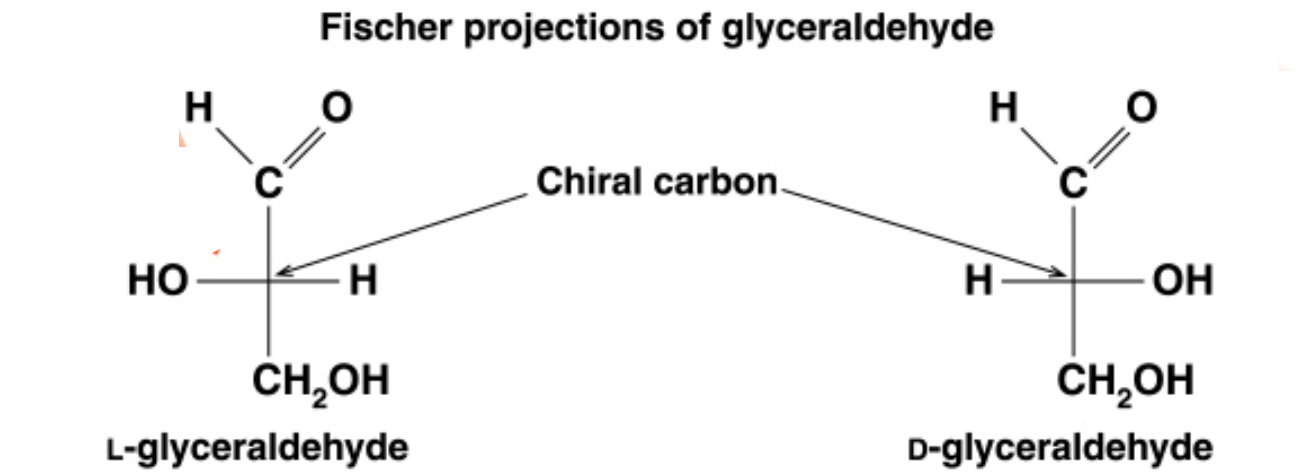
Carbohydrates

Structures of Monosaccharides

Fischer Projections

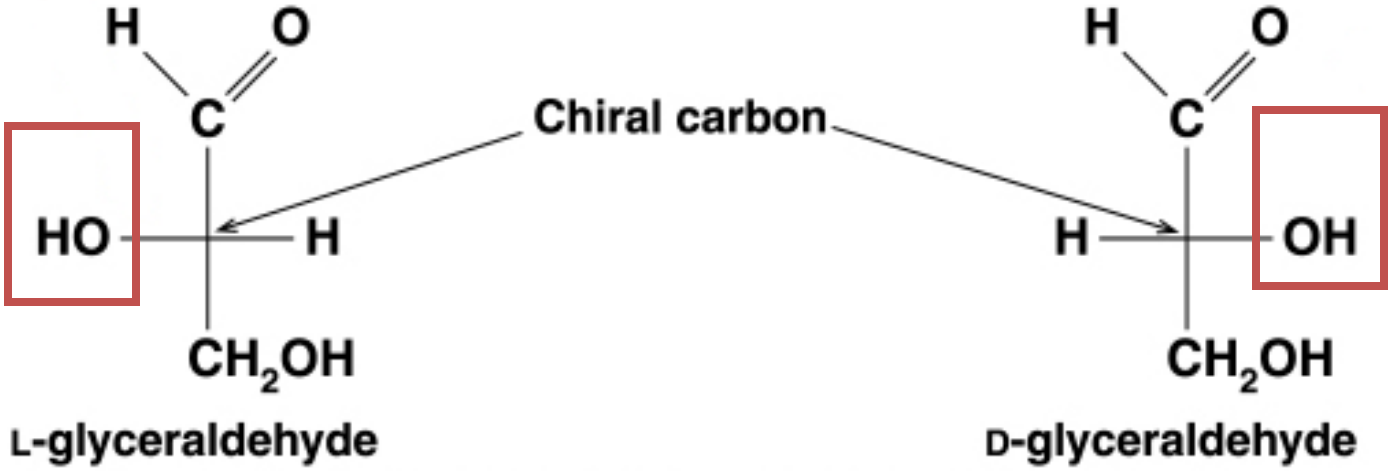
A Fischer projection

- Is used to represent carbohydrates.
- Places the most oxidized group at the top.
- Shows chiral carbons as the intersection of vertical and horizontal lines.

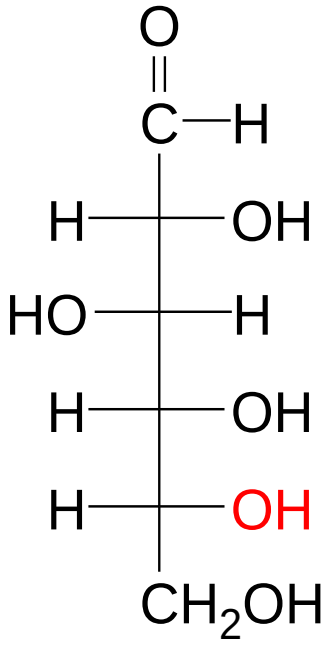


D and L Notations

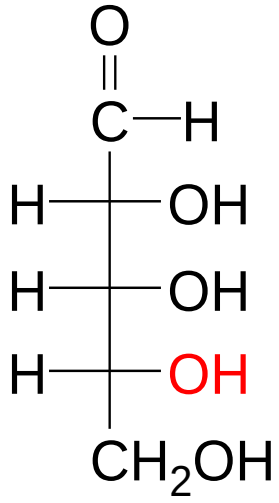
- In a Fischer projection, the –OH group on the Chiral carbon *farthest from the carbonyl group* determines an L or D isomer.
- Left is assigned the letter L for the L-isomer.
- Right is assigned the letter D for the D-isomer.



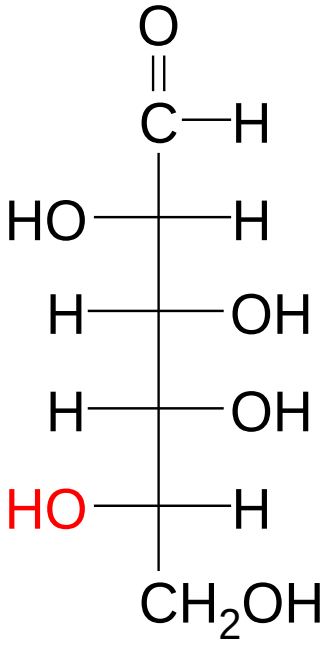
Examples of D and L Isomers of Monosaccharides



D-glucose



D-ribose

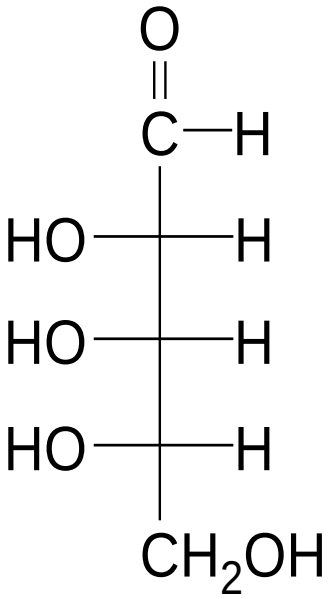


L-galactose

Learning Check

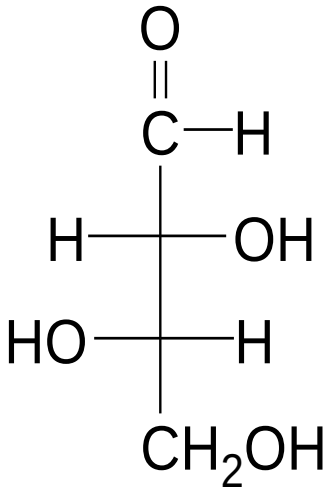
Identify each as the D or L isomer.

C.



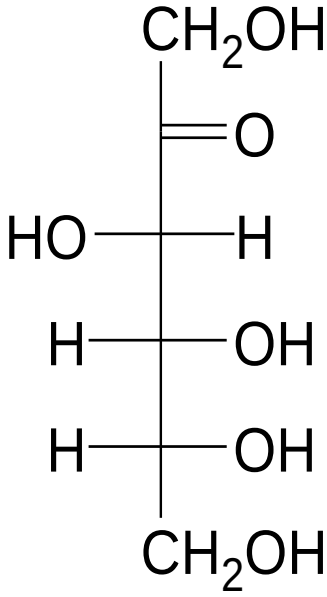
__-

B.



__- threose

A.



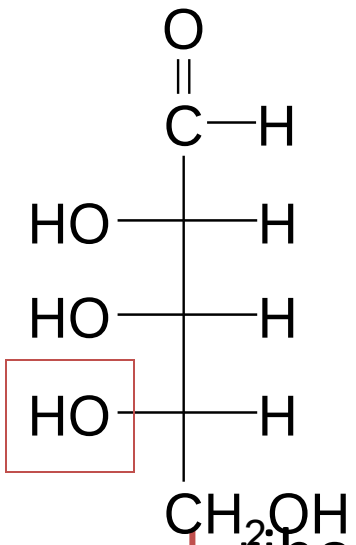
__-ribose

fructose

Solution

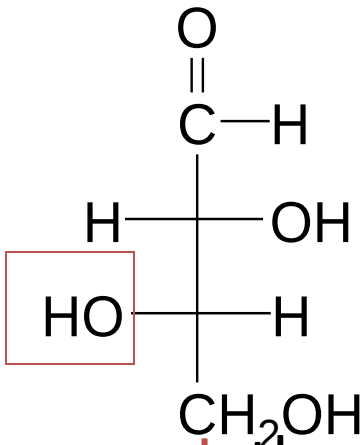
Identify each as the D or L isomer.

C.



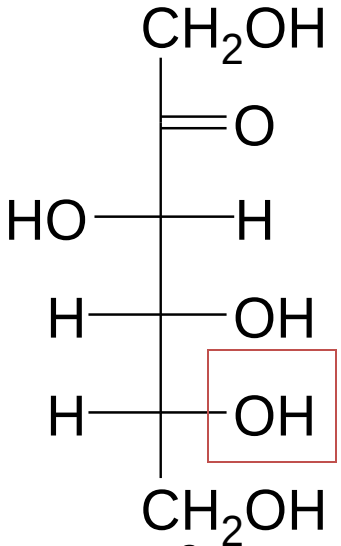
L-ribose

B.



L-threose

A.

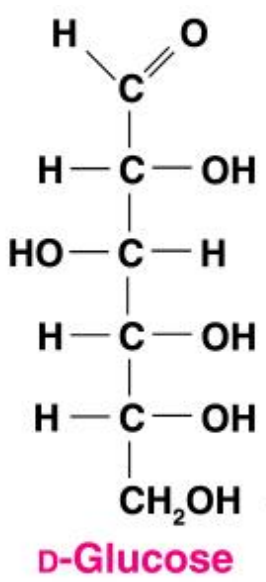


D-fructose

D-Glucose

D-glucose is

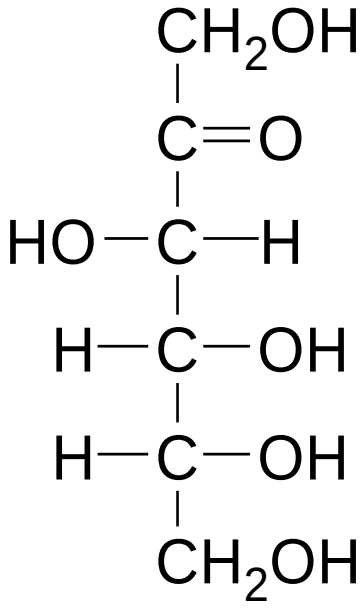
- Found in fruits, corn syrup, and honey.
- An aldohexose with the formula $C_6H_{12}O_6$.
- Known as blood sugar in the body.
- The monosaccharide in polymers of starch, cellulose, and glycogen.



D-Fructose

D-fructose

- Is a ketohexose $C_6H_{12}O_6$.
- Is the sweetest carbohydrate.
- Is found in fruit juices and honey.
- Converts to glucose in the body.

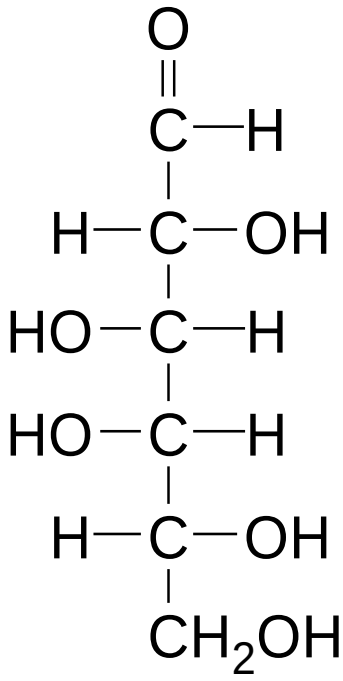


D-Fructose

D-Galactose

D-galactose is

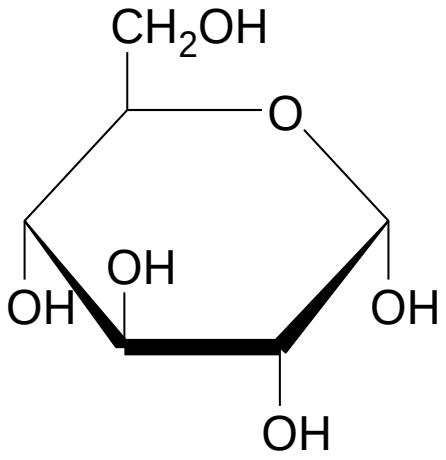
- An aldohexose $C_6H_{12}O_6$.
- Not found free in nature.
- Obtained from lactose, a disaccharide.
- A similar structure to glucose except for the –OH on C4.



D-Galactose

Carbohydrates

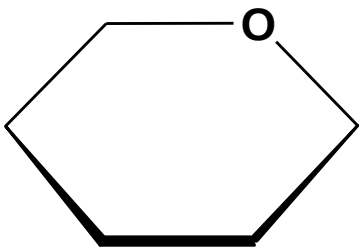
Cyclic Structures of Monosaccharides

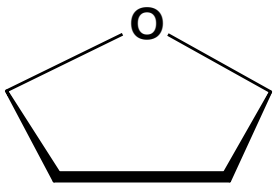


Cyclic Structures

Cyclic structures

- Are the prevalent form of monosaccharides with 5 or 6 carbon atoms.



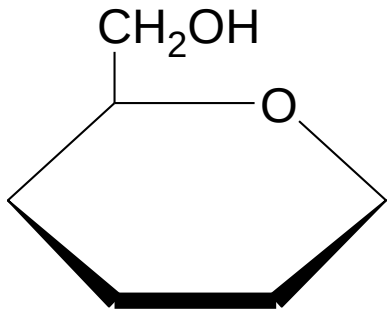


- Form when the hydroxyl group on C-5 reacts with the aldehyde group or ketone group.

Cyclic Haworth Structures

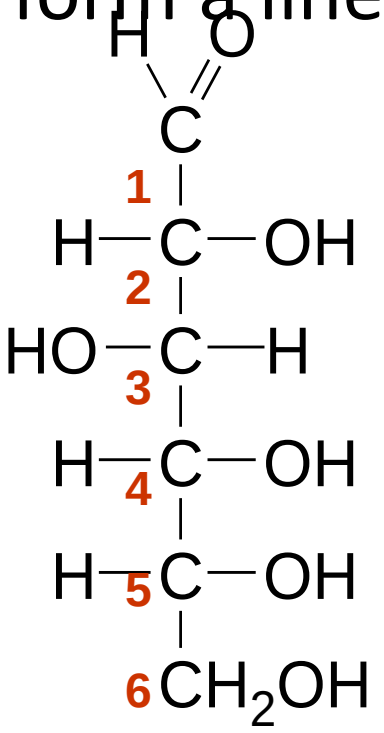
Stable cyclic hemiacetals form

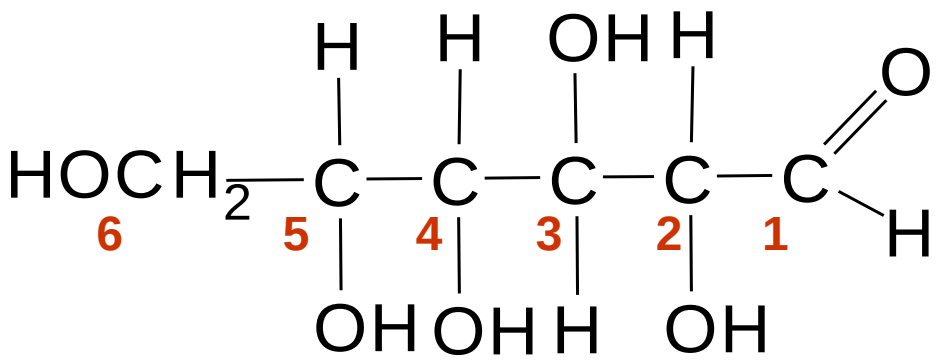
- When the C=O group and the —OH are part of the same molecule.
- For hexoses, the hydroxyl group on C-5 reacts with the aldehyde group or ketone group.
- The cyclic structure of a D-isomer has the last CH_2OH group located above the ring.



Drawing the Cyclic Structure for Glucose

STEP 1 Number the carbon chain and turn clockwise to form a linear open chain.

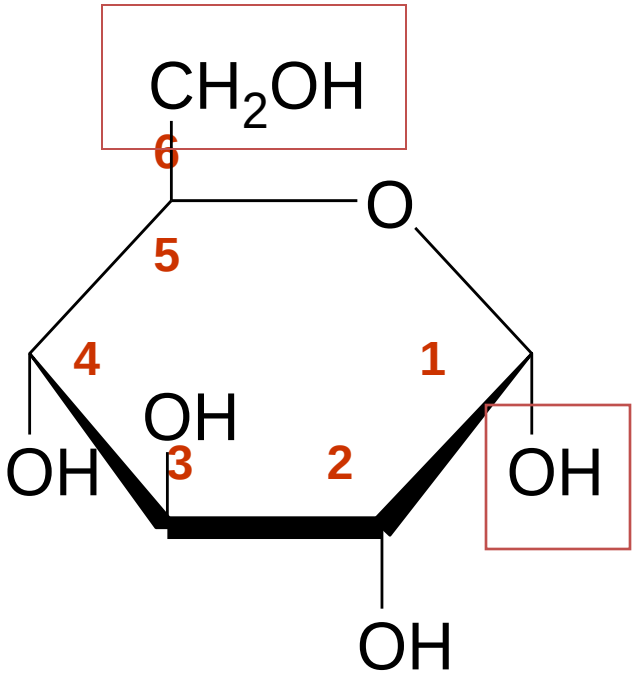




Cyclic Structure for Glucose

STEP 2 Bend the chain to make a hexagon

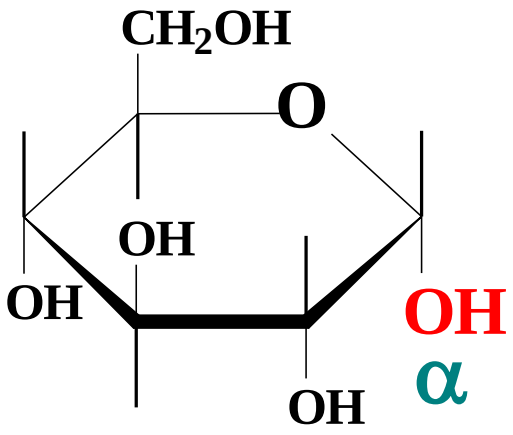
- Bond the C5 –O– to C1.
- Place the C6 group above the ring.
- Write the –OH groups on C2 and C4 below the ring.
- Write the –OH group on C3 above the ring.
- Write a new –OH on C1.



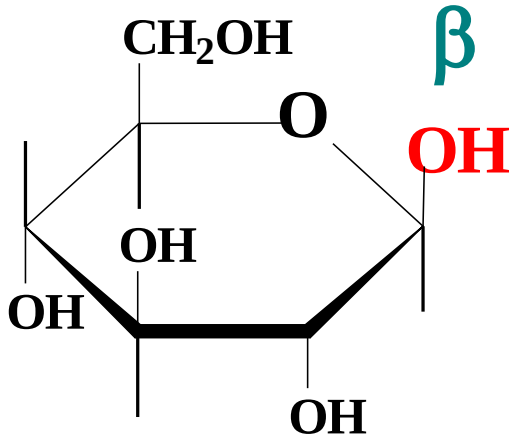
Cyclic Structure for Glucose (cont)

STEP 3 The new –OH on C1 is drawn

- Down for the α anomer.
- Up for the β anomer.

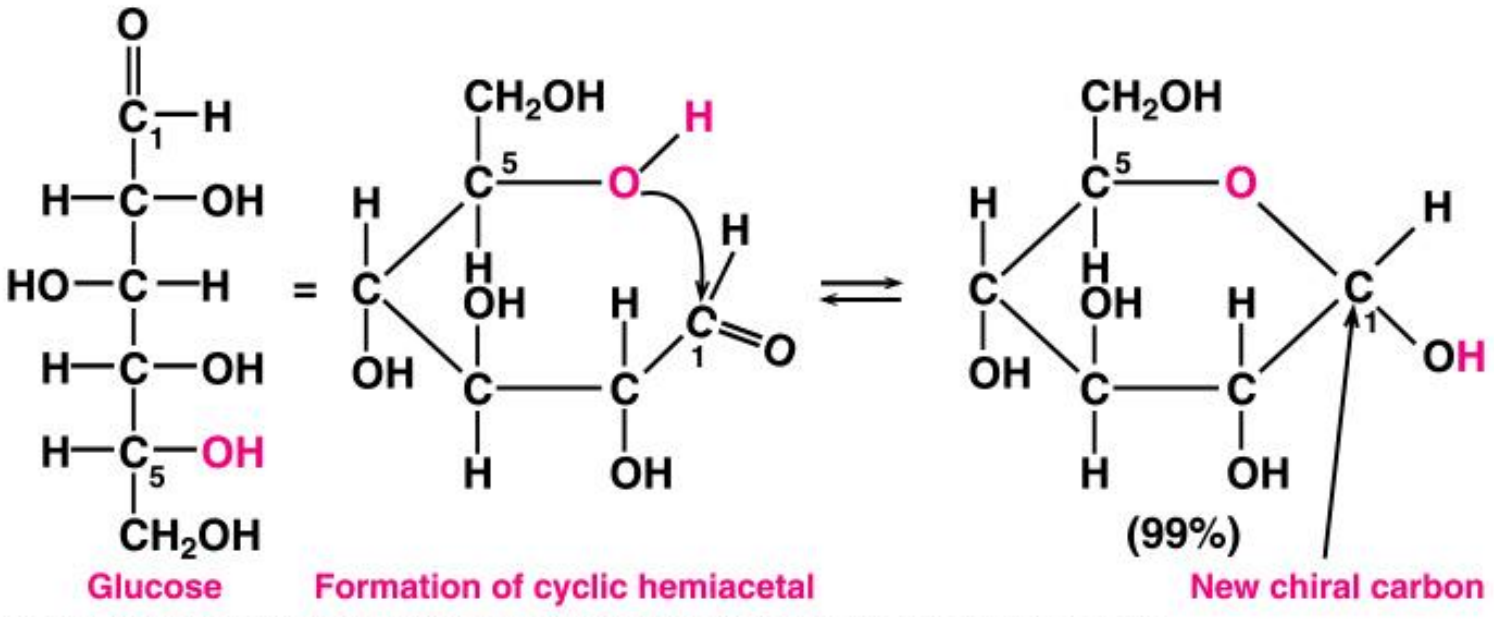


α-D-glucose



β-D-glucose

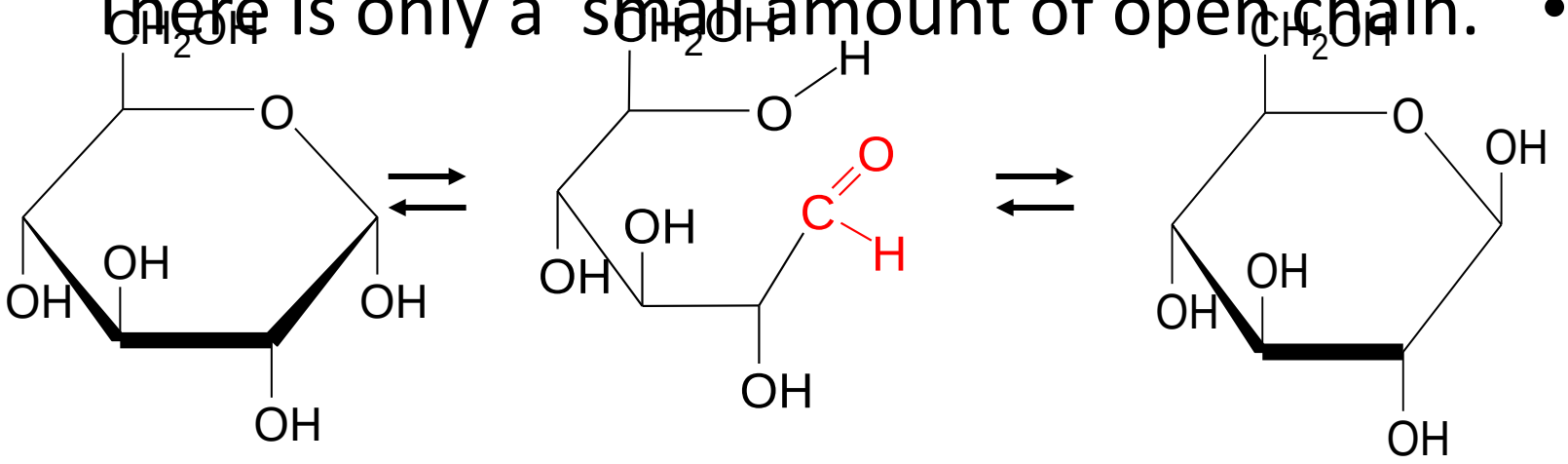
Summary of the Formation of Cyclic Glucose



α-D-Glucose and β-D-Glucose in Solution

When placed in solution,

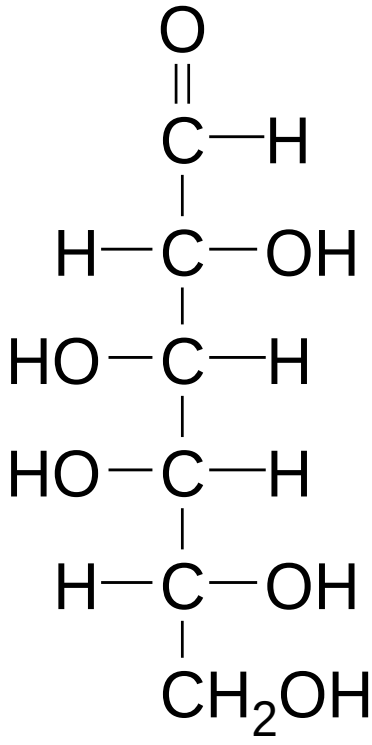
- Cyclic structures open and close.
- α-D-glucose converts to *β*-D-glucose and back.
- There is only a small amount of open chain.



α-D-glucose (64%) ⇌ D-glucose (open) (36%) ⇌ *β*-D-glucose (trace)

Learning Check

Write the cyclic form of α-D-galactose



Carbohydrates

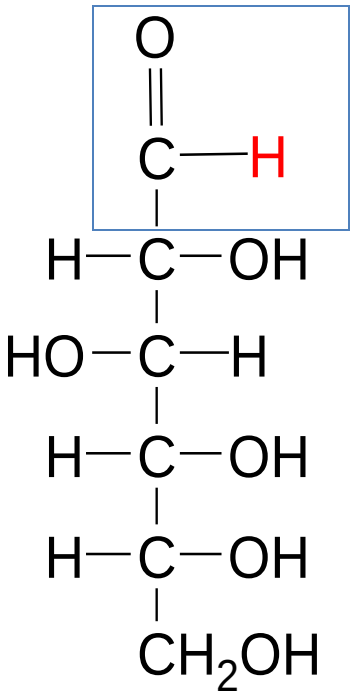
Chemical Properties of Monosaccharides

Reducing Sugars

Reducing sugars

- Are monosaccharides with a carbonyl group that oxidizes to give a carboxylic acid.
- Undergo reaction with Benedict's reagent (Cu^{2+}) to give the corresponding carboxylic acid.
- Include the monosaccharides glucose, galactose, and fructose.

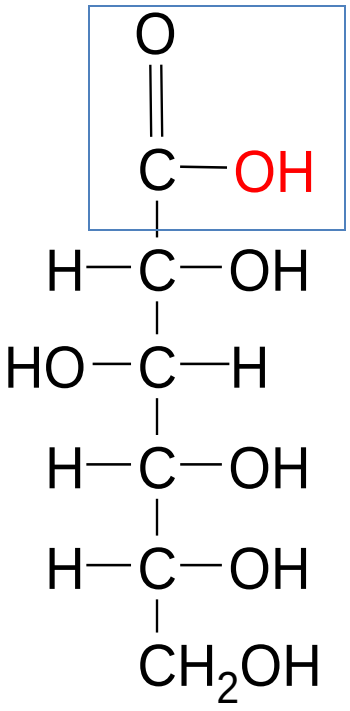
Oxidation of D-Glucose



D-glucose

Benedicts reagent

+ Cu^{2+} [O] →



D-gluconic acid

Glucose is oxidized to a carboxylic acid

+ $Cu_2O(s)$

Cu^+ (reduced form)

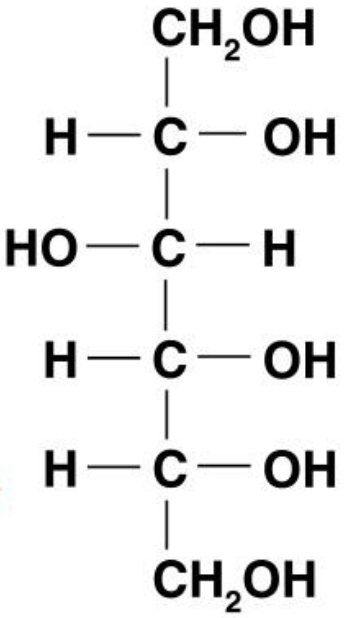
Glucose is a reducing sugar

Reduction of Monosaccharides

The reduction of monosaccharides

- Involves the carbonyl group.
- Produces sugar alcohols called *alditols.*
- Such as D-glucose gives D-glucitol also called sorbitol.

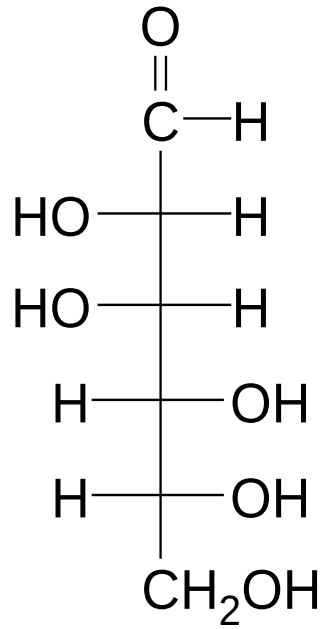
D-Glucitol



D-Sorbitol

Learning Check

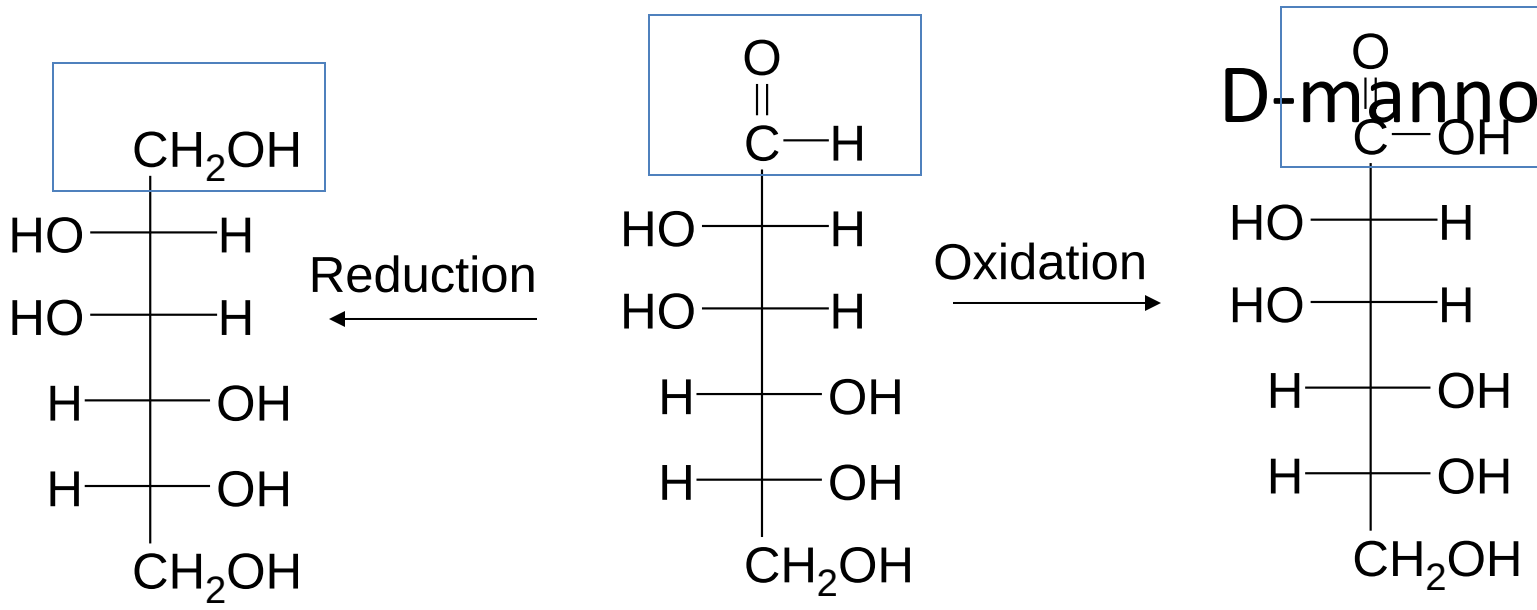
Write the products of the oxidation and reduction of D-mannose.



D-mannose

Solution

Write the products of the oxidation and reduction of D-mannose.



D-mannitol D-mannose D-mannonic acid

Carbohydrates

Disaccharides

Important Disaccharides

A disaccharide

- Consists of two monosaccharides.

Monosaccharides	Disaccharide
maltose +	Glucose + glucose
	H_2O
lactose + H_2O	Glucose + galactose
sucrose +	Glucose + fructose
	H_2O

Carbohydrates

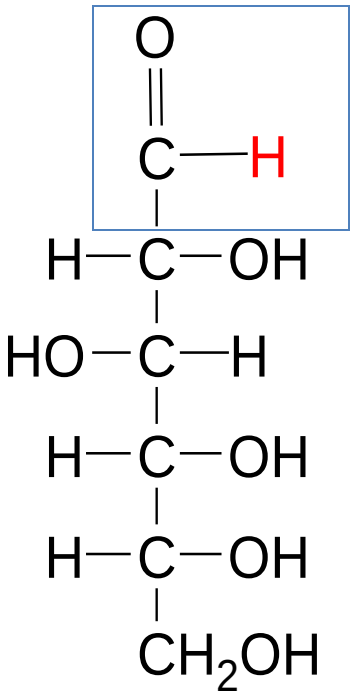
Chemical Properties of Monosaccharides

Reducing Sugars

Reducing sugars

- Are monosaccharides with a carbonyl group that oxidizes to give a carboxylic acid.
- Undergo reaction with Benedict's reagent (Cu^{2+}) to give the corresponding carboxylic acid.
- Include the monosaccharides glucose, galactose, and fructose.

Oxidation of D-Glucose

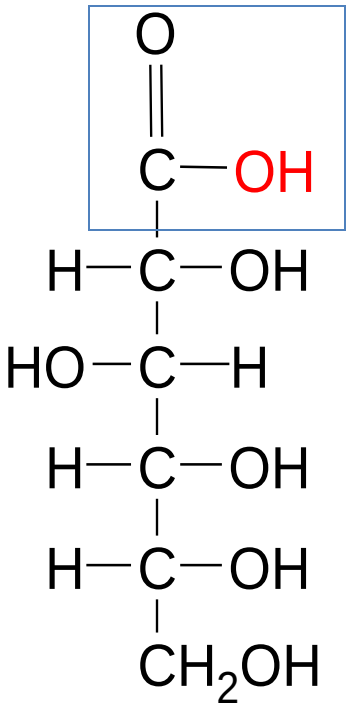


D-glucose

Benedicts reagent

+ Cu^{2+}

[O]



D-gluconic acid

Glucose is oxidized to a carboxylic acid

+ $Cu_2O(s)$

Cu^+ (reduced form)

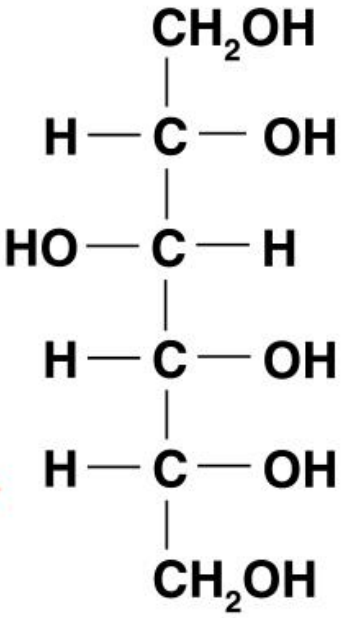
Glucose is a reducing sugar

Reduction of Monosaccharides

The reduction of monosaccharides

- Involves the carbonyl group.
- Produces sugar alcohols called *alditols.*
- Such as D-glucose gives D-glucitol also called sorbitol.

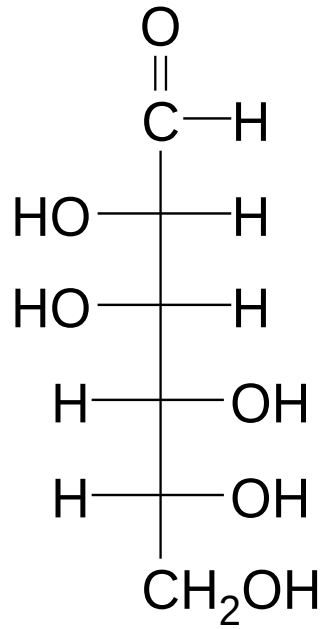
D-Glucitol



D-Sorbitol

Learning Check

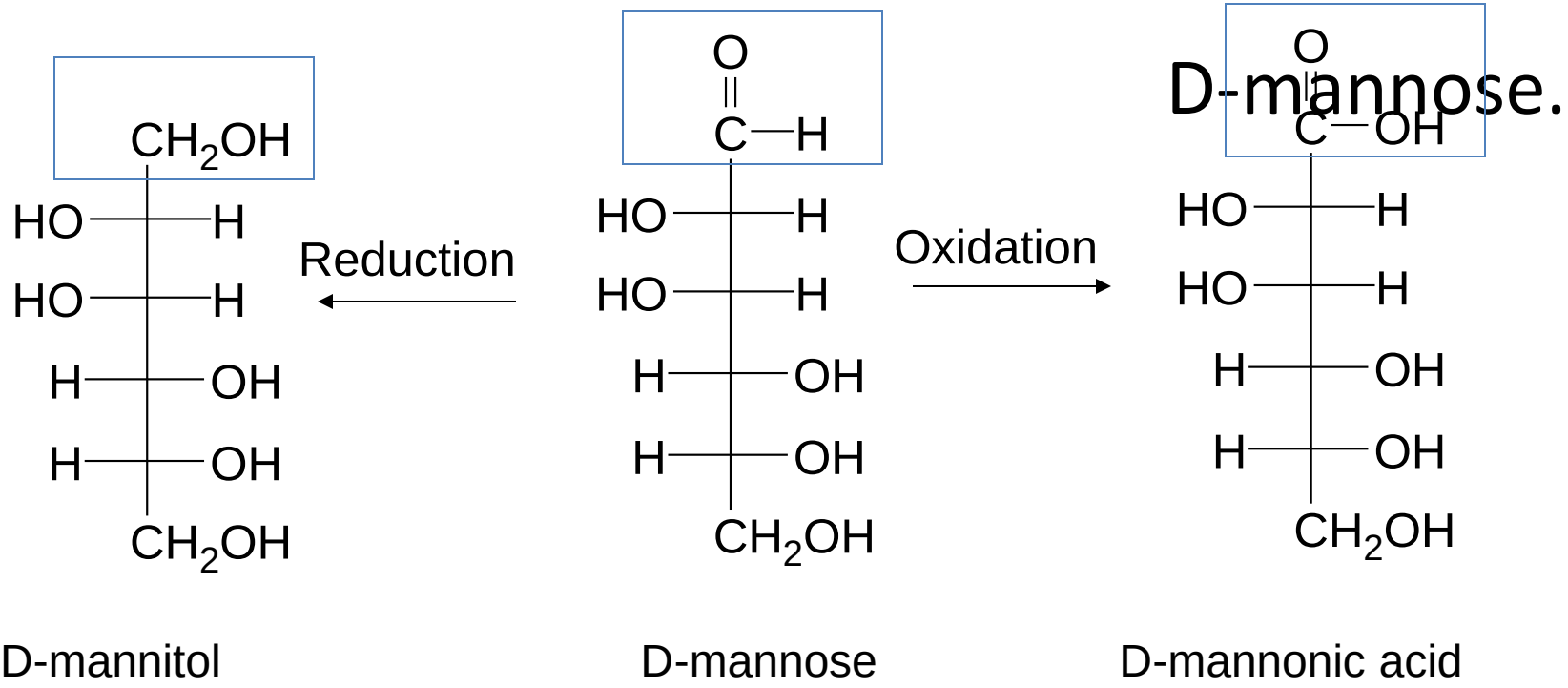
Write the products of the oxidation and reduction of D-mannose.



D-mannose

Solution

Write the products of the oxidation and reduction of D-mannose.



D-mannitol D-mannose D-mannonic acid

Carbohydrates

Disaccharides

Important Disaccharides

A disaccharide

- Consists of two monosaccharides.

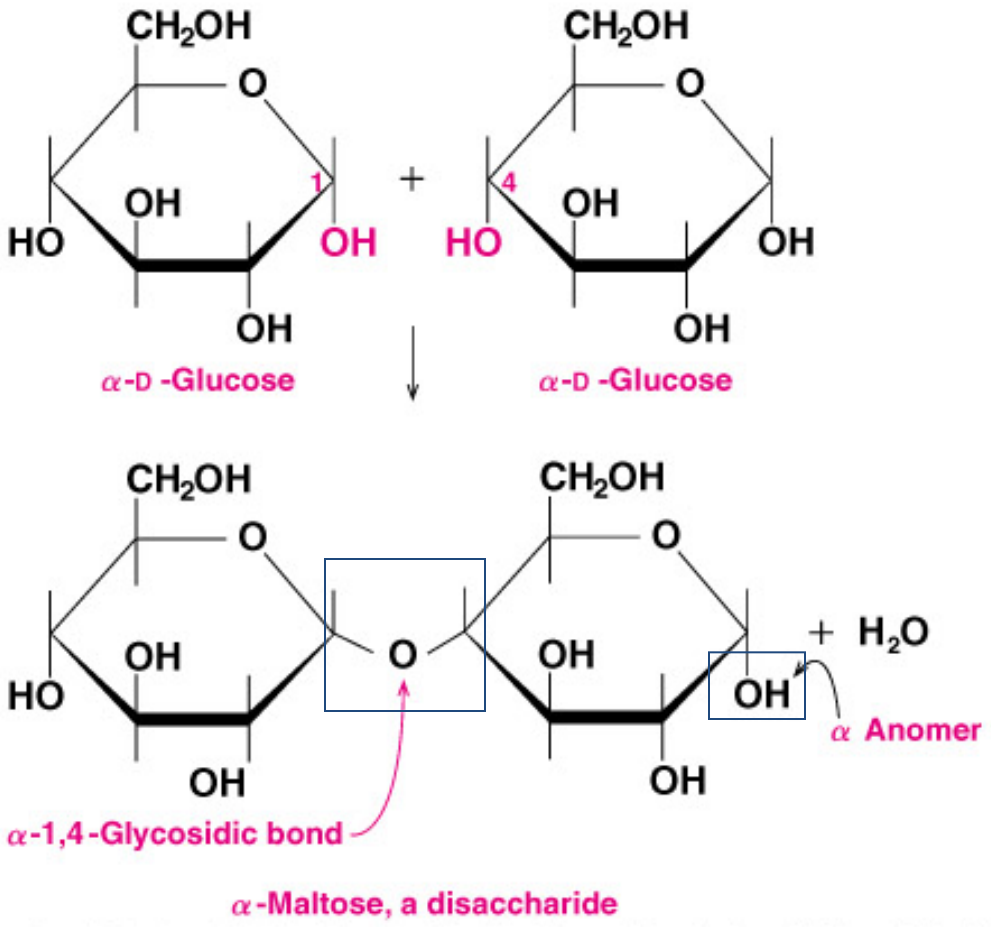
Monosaccharides	Disaccharide
maltose + H_2O	Glucose + glucose
lactose + H_2O	Glucose + galactose
sucrose + H_2O	Glucose + fructose

Maltose

Maltose is

- A disaccharide also known as *malt sugar.*
- Composed of two D-glucose molecules.
- Obtained from the hydrolysis of starch.
- Linked by an α-1,4-glycosidic bond formed from the α –OH on C1 of the first glucose and –OH on C4 of the second glucose.
- Used in cereals, candies, and brewing.
- Found in both the α- and β- forms.

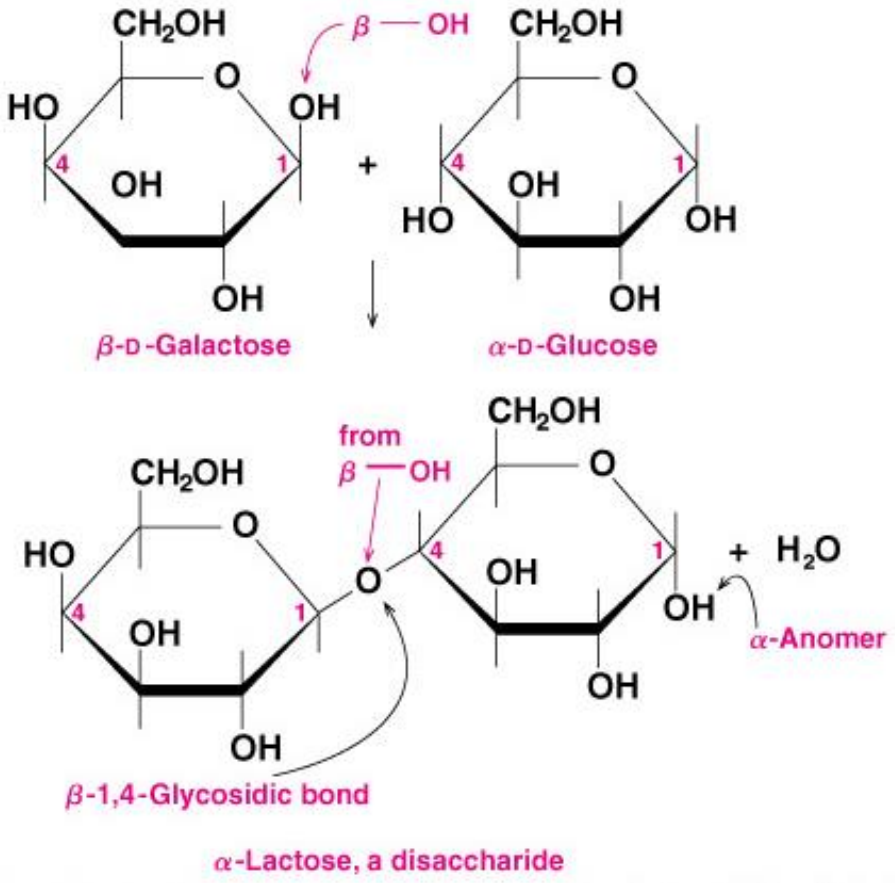
Formation of Maltose



Lactose

Lactose

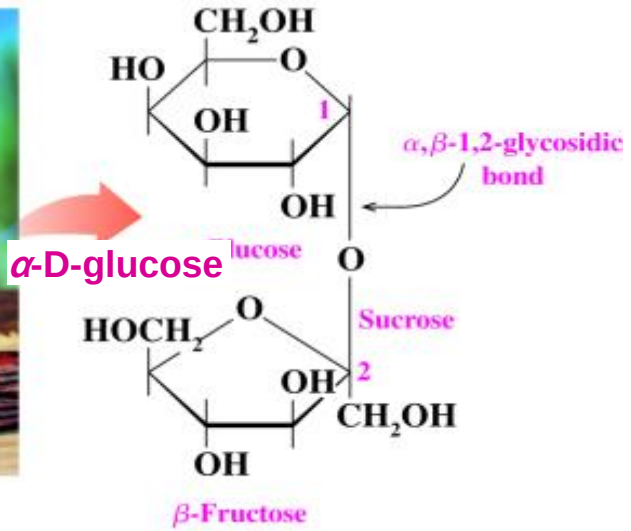
- Is a disaccharide of β-D-galactose and α- *or* β-D-glucose.
- Contains a β-1,4-glycosidic bond
- Is found in cheese and milk



Sucrose

Sucrose or *table sugar*

- Is obtained from sugar cane and sugar beets.
- Consists of α-D-glucose and β-D-fructose..
- Has an α,β-1,2-glycosidic bond.



β-D-fructose

Learning Check

Write the structures and names of the two monosaccharides that form when sucrose is hydrolyzed.

Sweeteners

Sugars and artificial sweeteners

- Differ in sweetness.
- Are compared to sucrose (table sugar), which is assigned a value of 100.

TABLE: Relative Sweetness of Sugars and Artificial Sweeteners

	Sweetness Relative to Sucrose (= 100)	
Monosaccharides		
Galactose	30	
Sorbitol	36	
Glucose	75	
Fructose	175	
Disaccharides		
Lactose	16	
Maltose	33	
Sucrose	100	← reference standard
Artificial Sweeteners (Noncarbohydrate)		
Sucralose	**60 000**	
Aspartame	18,000	
Saccharin	45,000	

Learning Check

Identify the monosaccharides in each of the following:

A. lactose

(3) β-D-galactose (2) β-D-fructose (1) α-D-glucose

B. maltose

(3) β-D-galactose (2) β-D-fructose (1) α-D-glucose

C. sucrose

(3) β-D-galactose (2) β-D-fructose (1) α-D-glucose

Solution

Identify the monosaccharides in each of the following:

A. lactose

(3) β-D-galactose

(1) α-D-glucose

B. maltose

(1) α-D-glucose

C. sucrose

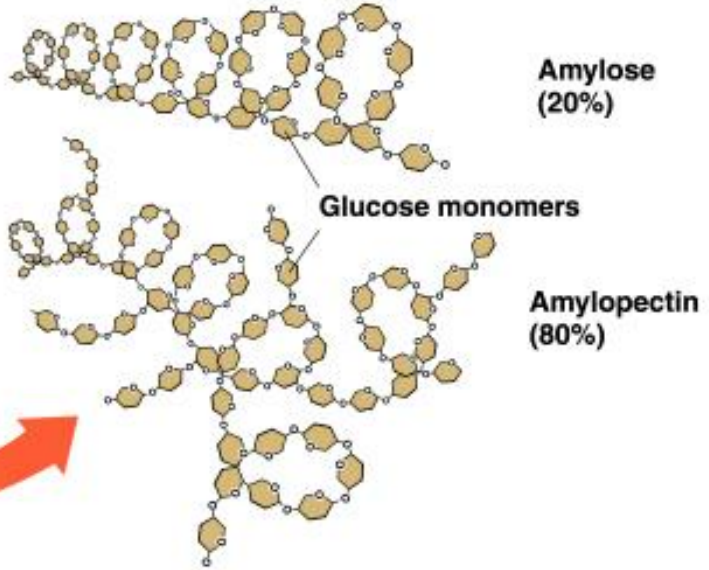
(2) β-D-fructose

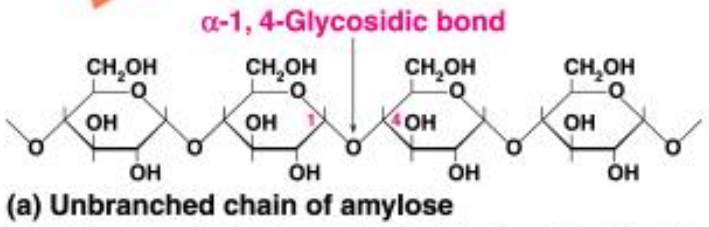
(1) α-D-glucose

Carbohydrates

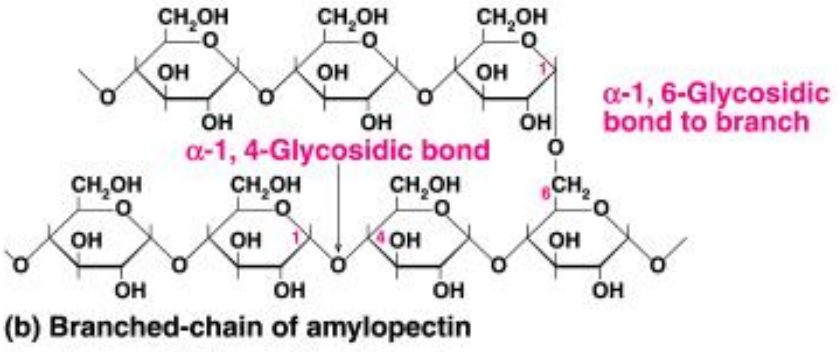
Polysaccharides

Structures of Amylose and Amylopectin





(a) Unbranched chain of amylose

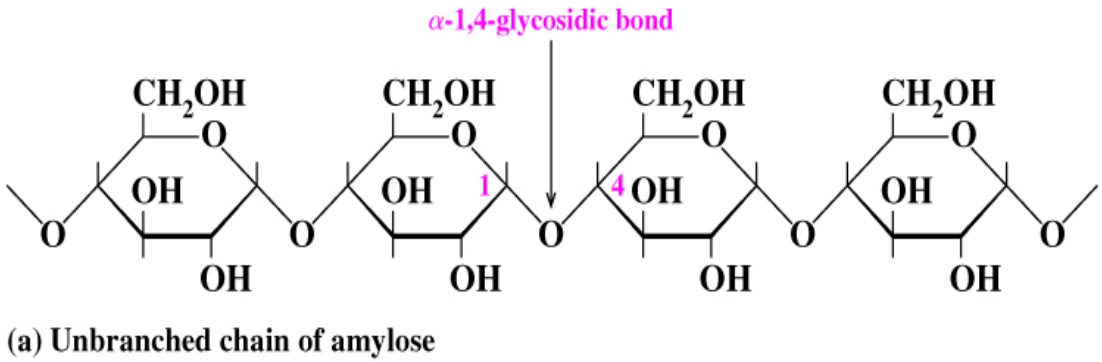


(b) Branched-chain of amylopectin

Amylose

Amylose is

- A polymer of α-D-glucose molecules.
- Linked by α-1,4 glycosidic bonds.
- A continuous (unbranched chair

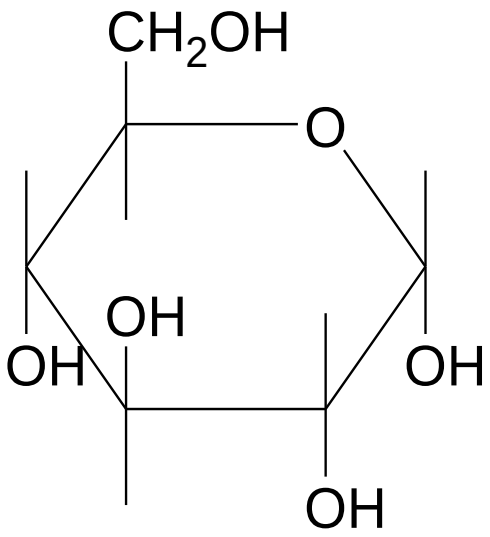


(a) Unbranched chain of amylose

Polysaccharides

Polysaccharides

- Are polymers of D-glucose.
- Include amylose and amylopectin, starches made of α-D-glucose.
- Include glycogen (animal starch in muscle), which is made of α-D-glucose.
- Include cellulose (plants and wood), which is made of *β*-D-glucose.

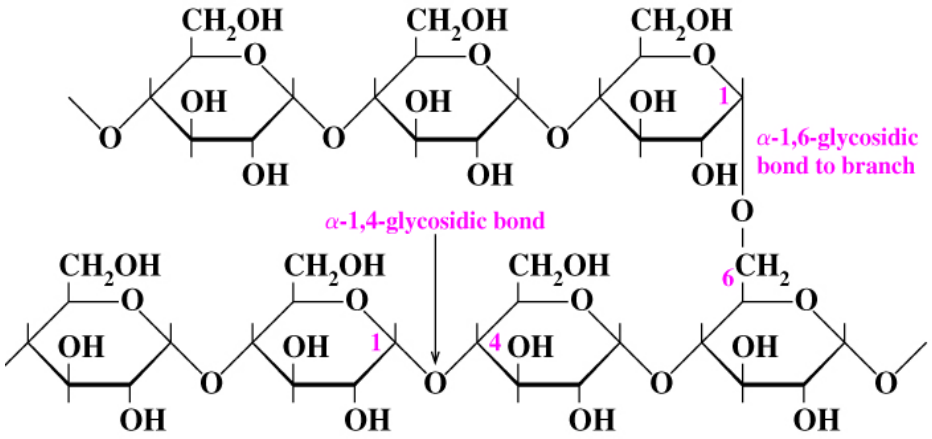


α-D-glucose

Amylopectin

Amylopectin

- Is a polymer of α-D-glucose molecules.
- Is a branched-chain polysaccharide.
- Has α-1,4-glycosidic bonds between the glucose units.
- Has α-1,6 bonds to branches.

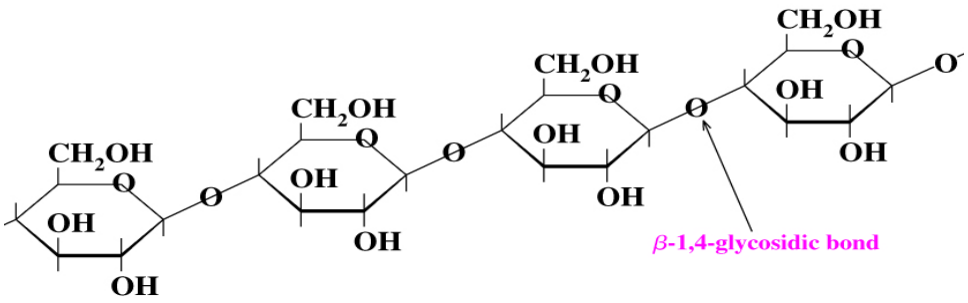


Branched chain of amylopectin

Cellulose

Cellulose

- Is a polysaccharide of glucose units in unbranched chains.
- Has β-1,4-glycosidic bonds.
- Cannot be digested by humans because humans cannot break down β-1,4-glycosidic bonds.



Solution

β-1,4-glycosidic bonds	A. Cellulose
α-1,4-glycosidic bonds	B. Amylose
α-1,4-and α-1,6-glycosidic bonds	Amylopectin
α-1,4-and α-1,6-glycosidic bonds (more branched than amylopectin)	C. Glycogen

Learning Check

Identify the polysaccharides and types of glycosidic

bonds in each of the following:

A.

Regulation of Blood Glucose

Origin of blood glucose :-

***- From carbohydrates of the dietary after digestion and absorption**

***- From hydrolyses of glycogen in the liver by glycogenolysis.**

***- From converted of amino acid(alanine) by gluconeogenesis .**

In the fasted state : the blood glucose level between 70-110 mg/dl.(3.9-6.1mMol/L)

Increase of range is called hyperglycemia .

Decrease of range is called hypoglycemia.

The regulation of blood glucose is the result of interplay of hormones.

1-Insulin :- it is peptide hormone that contains 51 amino acids and consists of two chains A-chain having 21 amino acids and B-chain with 30 amino acids linked by three disulphide bridges.

Insulin promotes the glucose to conversion to glycogen or fatty acids or non-essential amino acids which reduce the blood glucose level.

2-Glucagon :- It is synthesized in the α-cells of islets of Langerhans of the pancreas , secretion is stimulated by Hypo glycaemia, it promotes glycogenolysis and gluconeogenesis raising blood glucose concentration

3-Somatostatin it is produced in Ɣ -cells of Langerhans of the pancreatic islets ,it is poly peptide it inhibits secretion of insulin and glucagon .

4-Adrenaline :- In hypo glycaemia

A- it promotes the glycogenolysis (production of glucose from glycogen)

B- it inhibits insulin secretion thus raising blood glucose concentrations.

C- adrenaline stimulates adipose tissue lipolysis increasing (NEFA) production.

5- Thyroxin :- It is secreted by the thyroid gland, it stimulates glycogenolysis and increase the rate of both gastric emptying and intestinal glucose absorption.

6- Growth hormone :- it is a poly peptide secreted by the anterior pituitary gland,

it is stimulated by hypo glycaemia ,and his actions include glucose production and reduced up tack by some tissues ,

It increased the lipolysis raising plasma level which are utilized by some tissues as energy source in preference to glucose.

7- Cortisol:- secreted by the adrenal cortex, it stimulates gluconeogenesis and increase the breaker down of proteins and fats.

Normally after each meal a postprandial hyper glycaemia an increased blood glucose level. The β –cells of the islets of Langerhans increased the secretion of insulin , the liver takes priority over other organs in its utilization of the hormone which is suppression the blood glucose level in a number of ways as :-

1-stimulating protein synthesis. (glucose ~~amino acids~~)

2-stimulating lipogenesis. (glucose ~~fatty acids~~)

3-stimulating glycogenesis (glucose ~~glycogen~~)

4-stimulating glycolysis (glucose ~~acetyl CoA~~)

5- inhibiting lipolysis (fatty acids ~~glucose~~)

6- inhibiting gluconeogenesis (amino acids ~~glucose~~)

The glucose homeostasis is dependent on the ratio of Insulin to Glucagon (I/G Ratio).

Thus hypo glycaemia (I/G ratio) is high : the increase secretion of glucagon is needing to mobilize glucose (glycogenolysis) and the insulin level is suppressed.

In hyper glycaemia the (I/G ratio) is lower : the insulin secretion must increase to promote to use and storage of glucose in to the tissues and glucagon level is suppressed.

Diabetes Mellitus

Definition: D.M. It is a group of metabolic disorders carbohydrate metabolism in which glucose is underutilized producing hyper glycaemia.

It is a state of diminished insulin action due to its decreased availability or effectiveness.

Classification of diabetes :

Type 1 :-

Insulin Dependent Diabetes Mellitus

(IDDM)

patient usually are feeling polyuria , polydipsia and rapid weight loss.

Patients have a deficiency of insulin production, and are dependent on insulin to sustain life and prevent ketosis.

In this type (IDDM) the insulin secretion is absent or reduced as a result of immunological destruction of β-cells in the islets of Langerhans

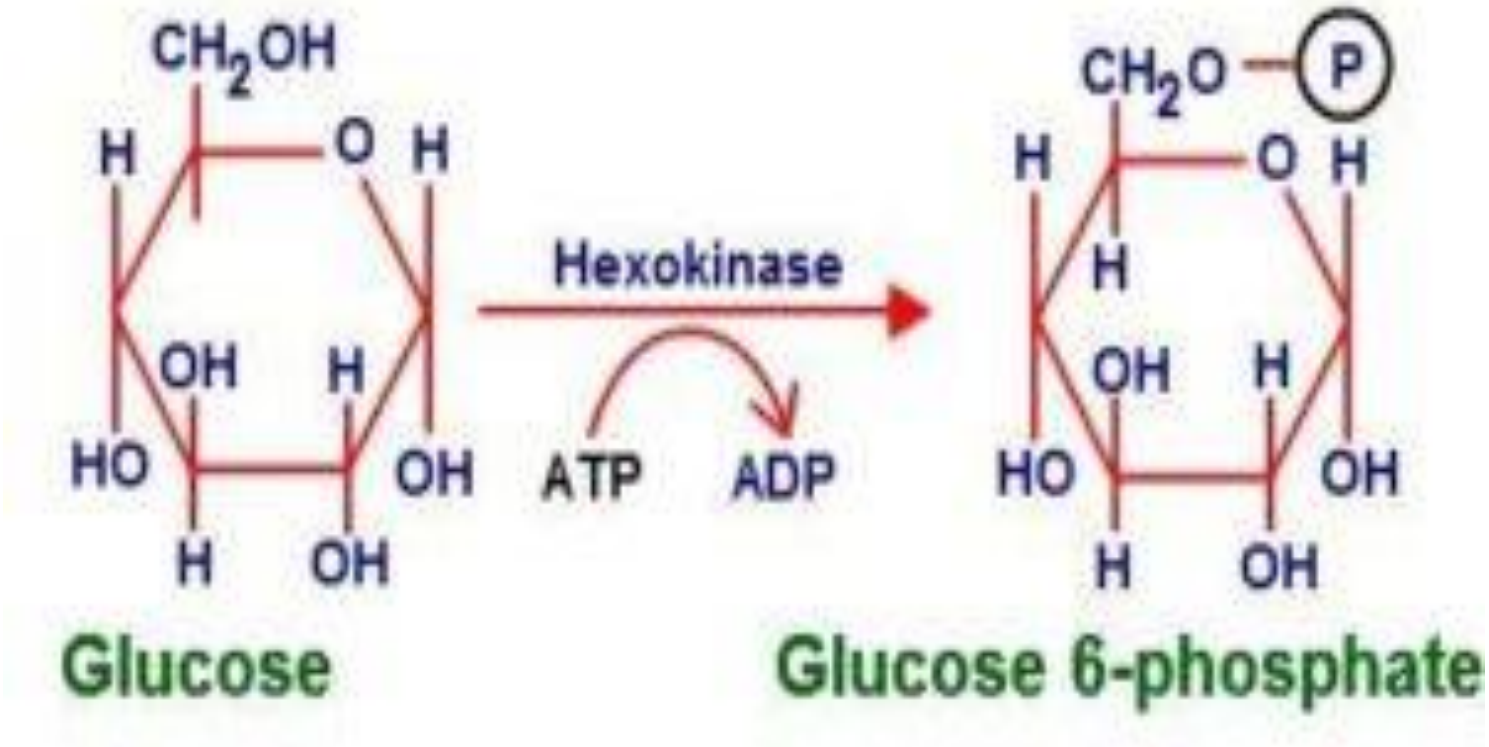
Type 2 :-

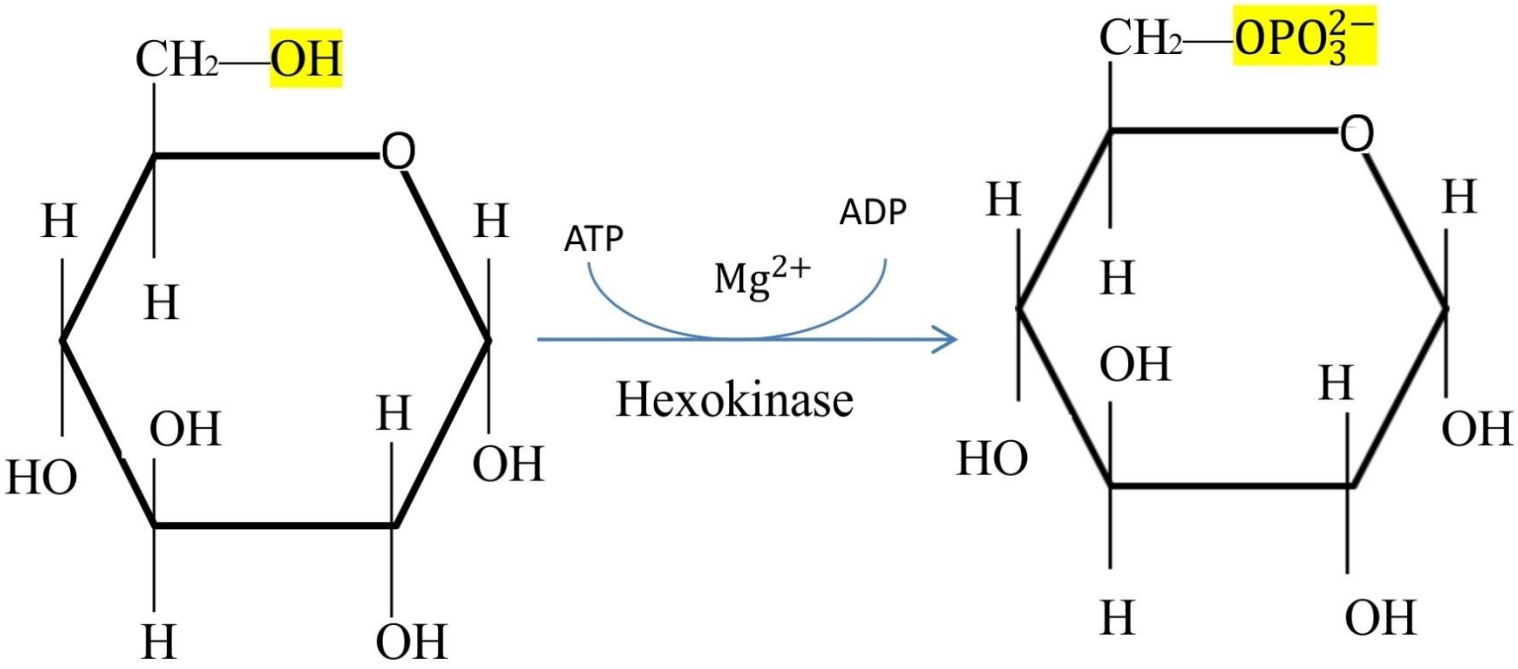
Non Insulin Dependent Diabetes Mellitus (NIDDM)

This group comprises approximately 90% of all cases of diabetes , patients have minimal symptoms are not prone to ketosis

glycolysis

Assist prof. dr majid m.a.ali

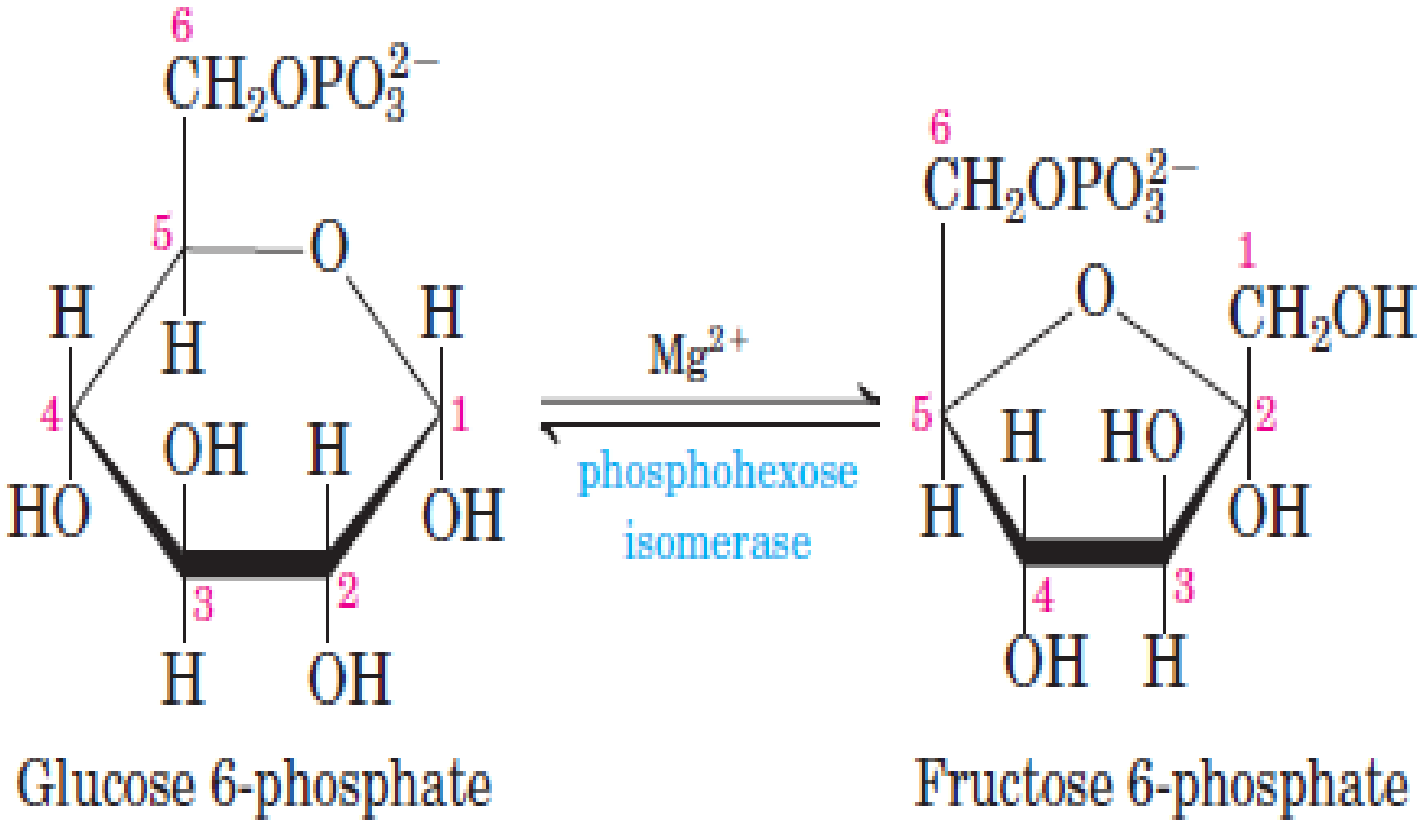

CH2OH
H
O
H
OH
H
HO
OH
H
OH
Hexokinase
ATP
ADP
CH2O
P
H
O
H
H
OH
H
HO
OH
H
OH
Glucose
Glucose 6-phosphate



Glucose

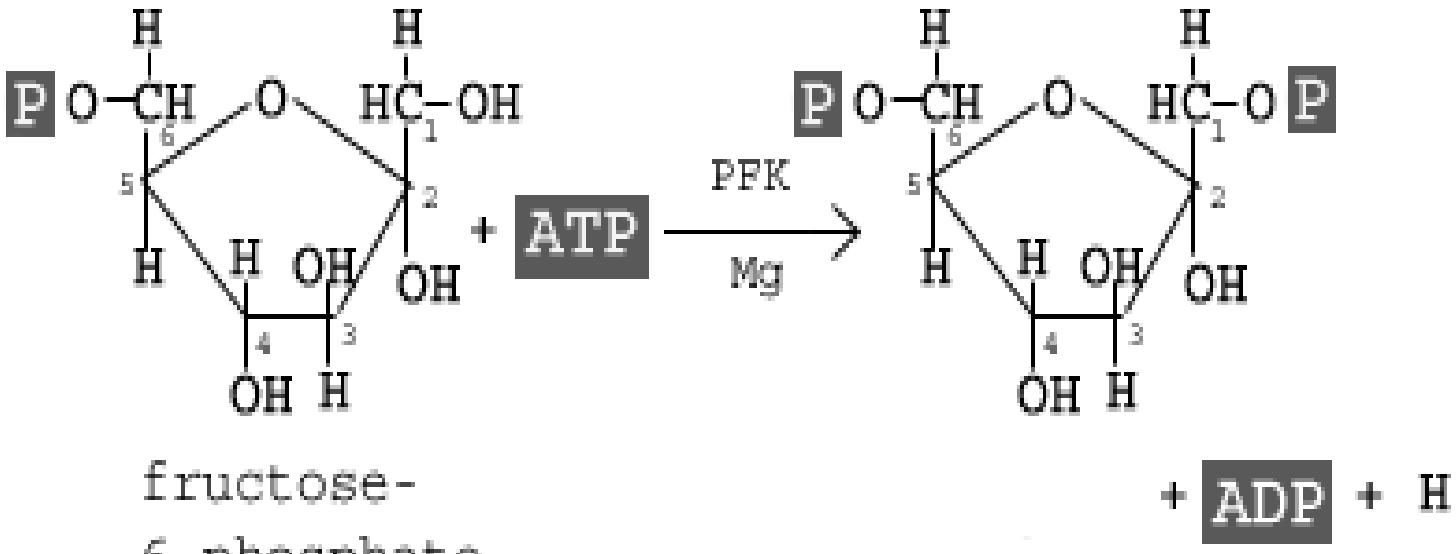
Glucose6 phosphate

$\Delta G^{o} = -16.7$ kJ/mol



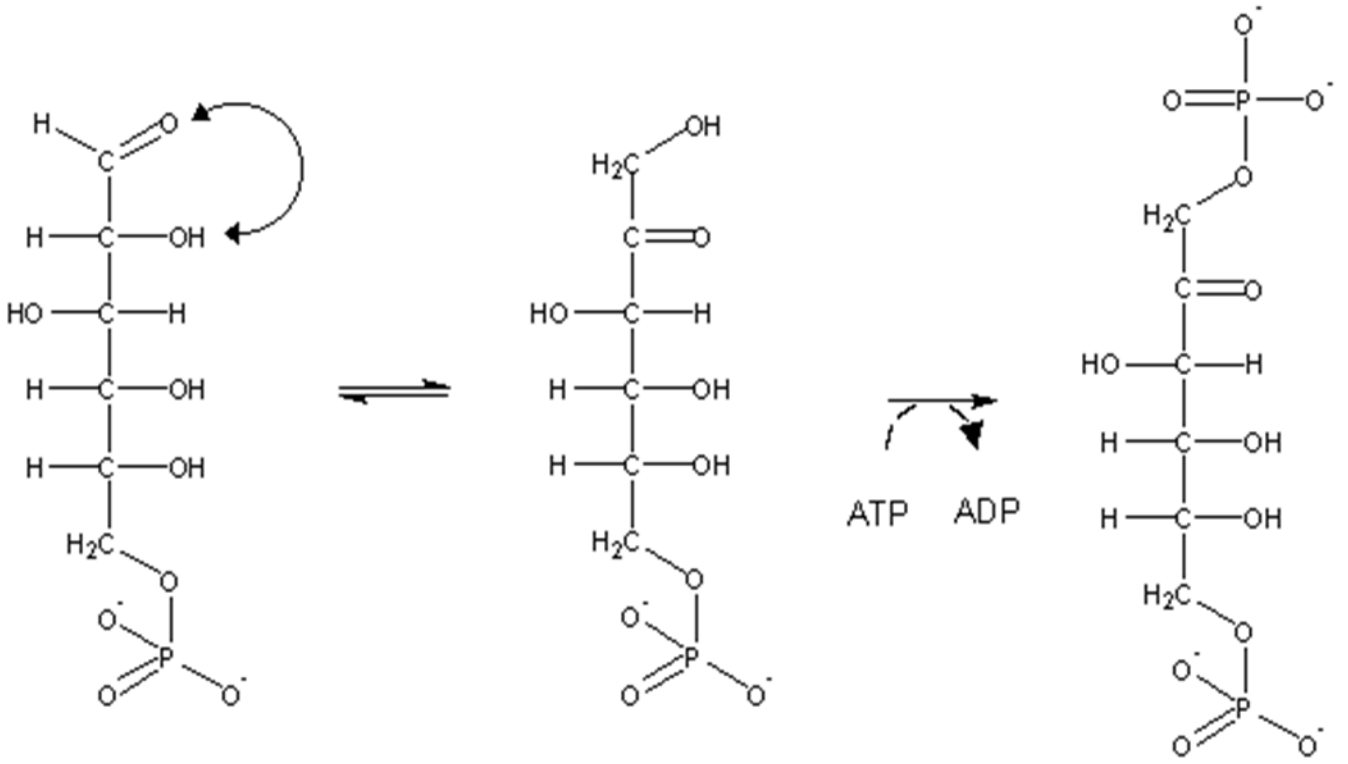
Glucose 6-phosphate

Fructose 6-phosphate

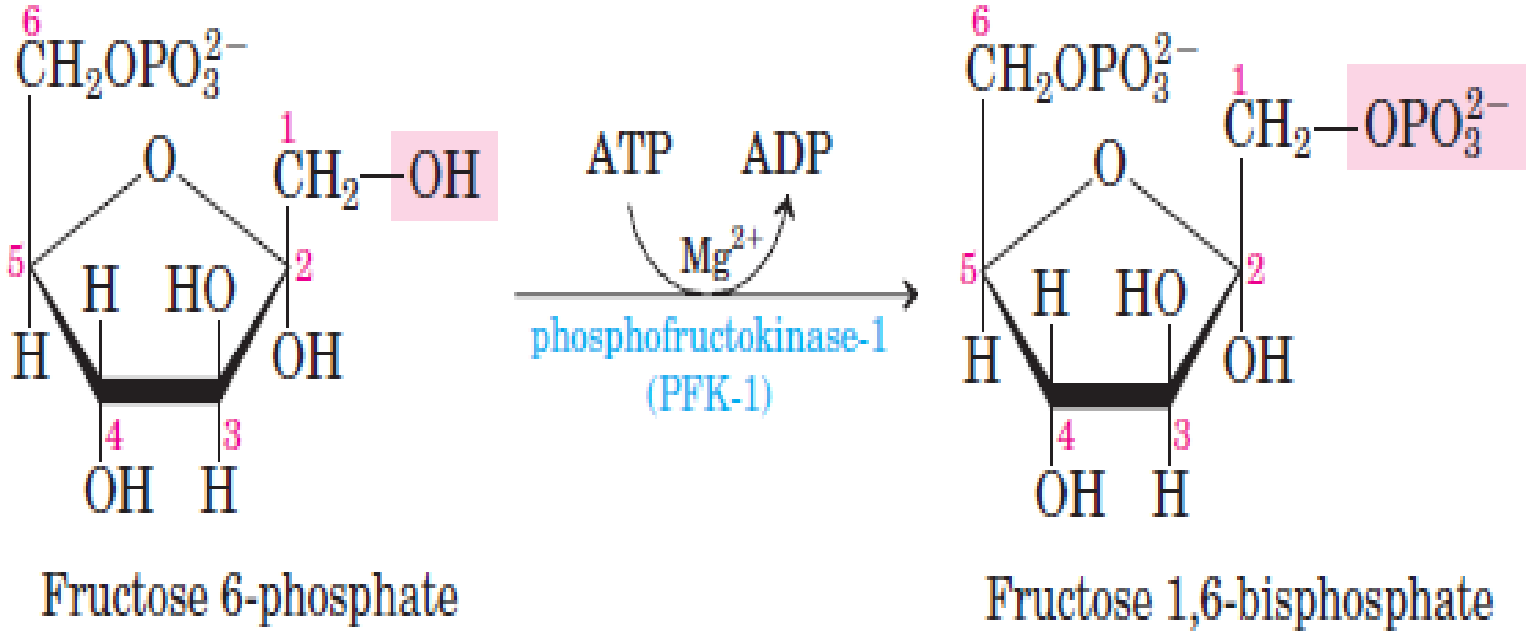


fructose-
6-phosphate

fructose-
1,6-bisphosphate

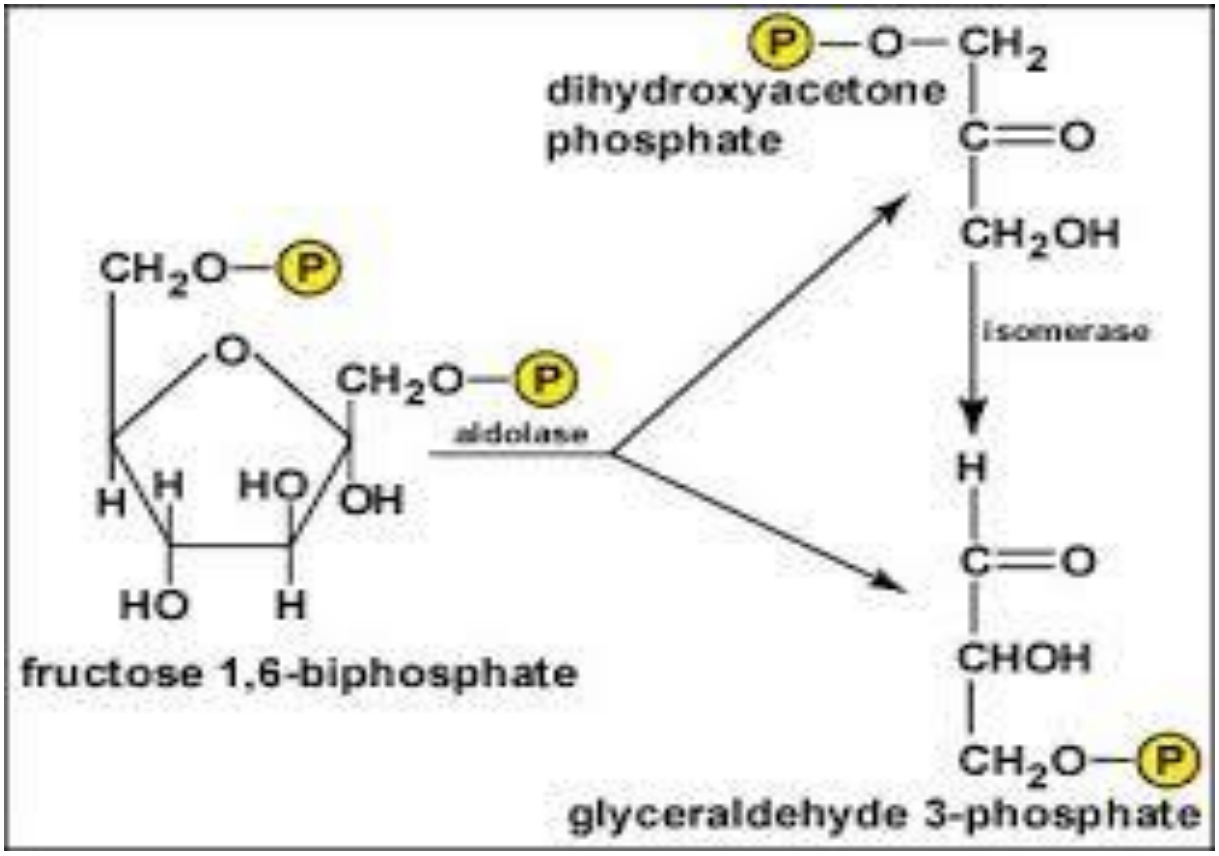


Glucose-6-P **Frutose-6-P** **Frutose-1,6-BP**



Fructose 6-phosphate

Fructose 1,6-bisphosphate

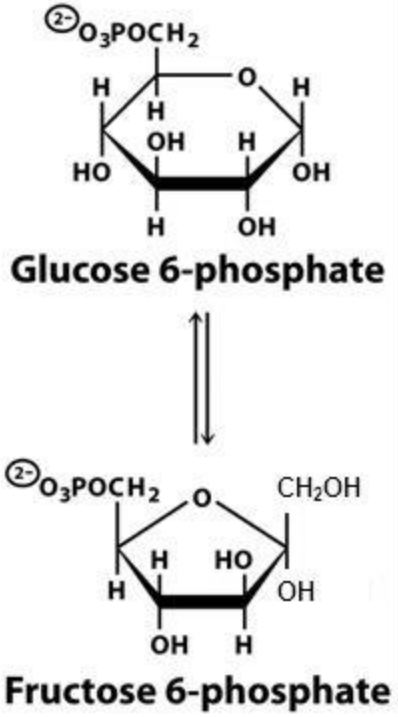

dihydroxyacetone phosphate
isomerase
aldolase
fructose 1,6-biphosphate
glyceraldehyde 3-phosphate

Glycolysis: Steps 2 and 3

Isomerization

Opens the chain during the rxn

(2) Glucose 6-phosphate isomerase



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Transfer of a second phosphoryl group from ATP to fructose 6-phosphate

PFK-1

(3) Phofructokinase-1

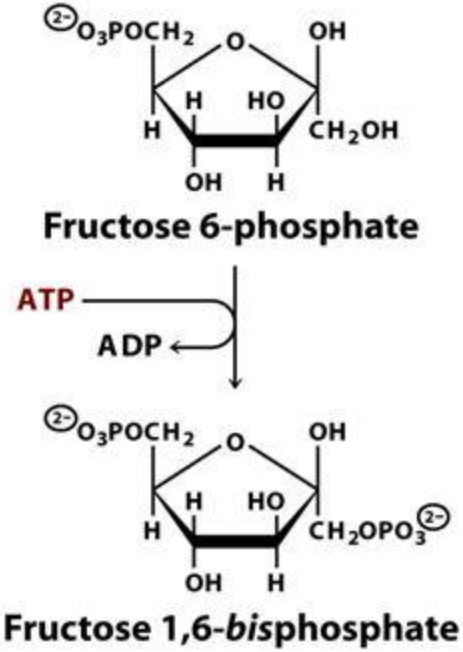

Figure 11-2 part 3 Principles of Biochemistry, 4/e
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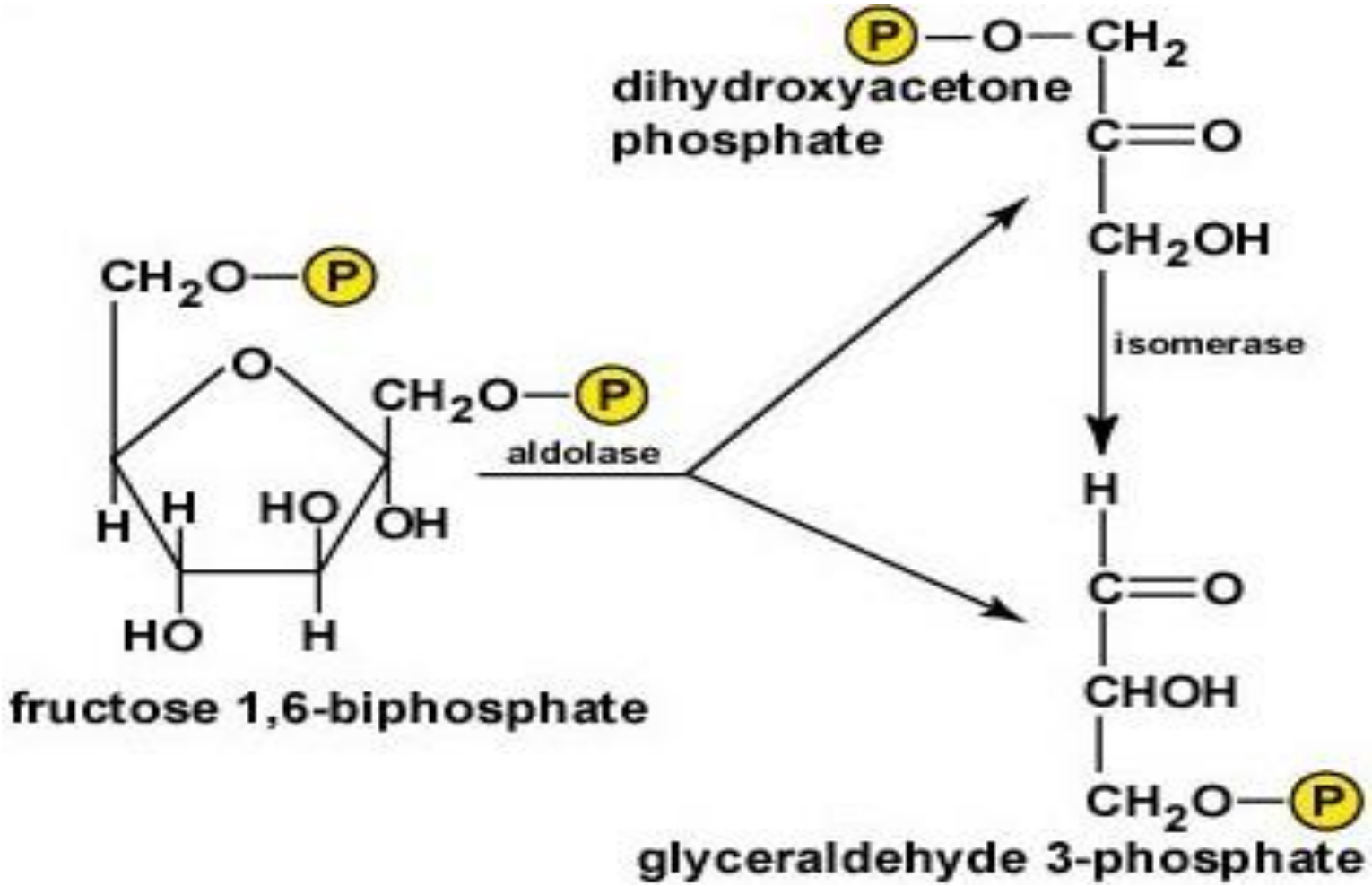
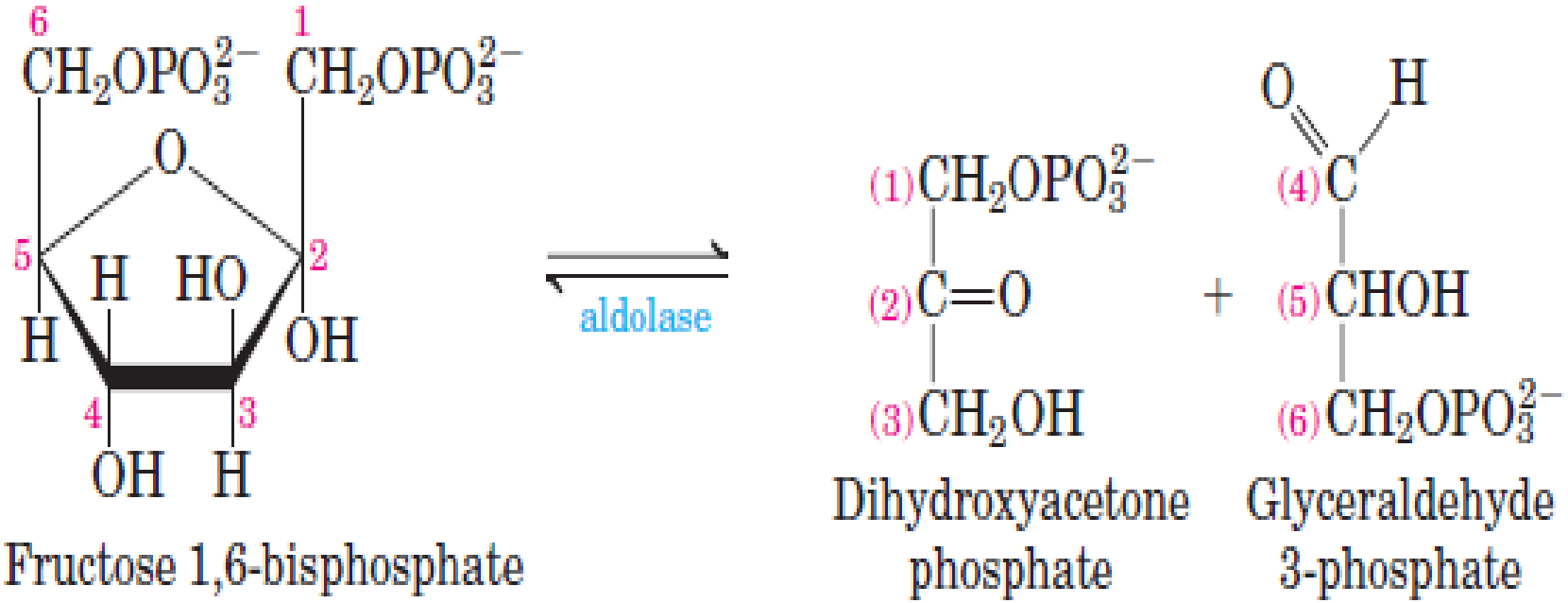
Stereospecific: uses α-Glc; produces 100% α-D-fructose-6-phosphate

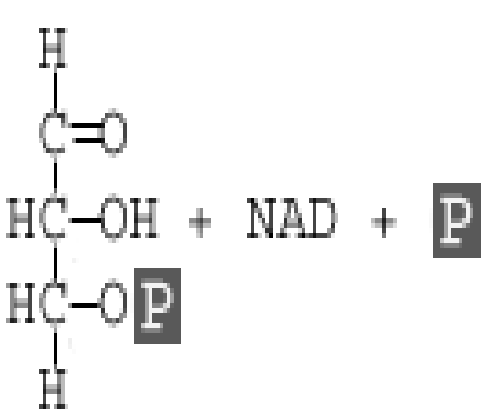
utilizes 100% β-anomer

36% α-fructose ⇌ 64% β-fructose

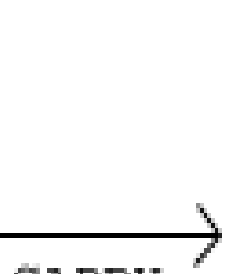

dihydroxyacetone phosphate
isomerase
aldolase
fructose 1,6-biphosphate
glyceraldehyde 3-phosphate


6
1
$CH_2OPO_3^{2-}$
$CH_2OPO_3^{2-}$
O
5
2
H
HO
H
OH
4
3
OH
H
aldolase
(1)$CH_2OPO_3^{2-}$
(2)C=O
(3)CH_2OH
+
O
H
(4)C
(5)CHOH
(6)$CH_2OPO_3^{2-}$
Fructose 1,6-bisphosphate
Dihydroxyacetone phosphate
Glyceraldehyde 3-phosphate

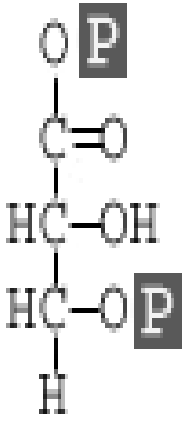
Glyceraldehyde-
3-phosphate (GAP)



+ NAD + P

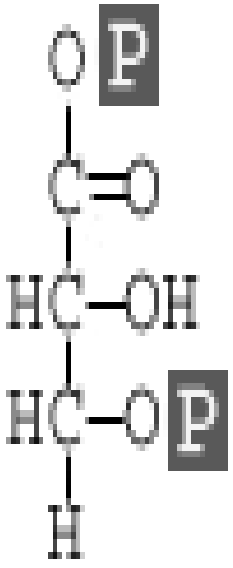


1,3-bisphoglycerate



+ NADH + H

1,3-bisphoglycerate

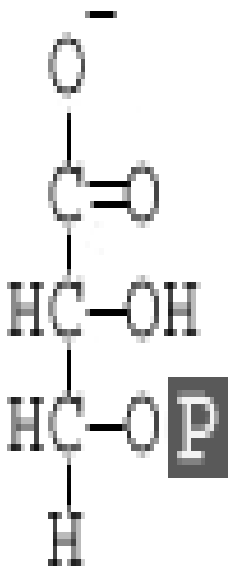


+ ADP

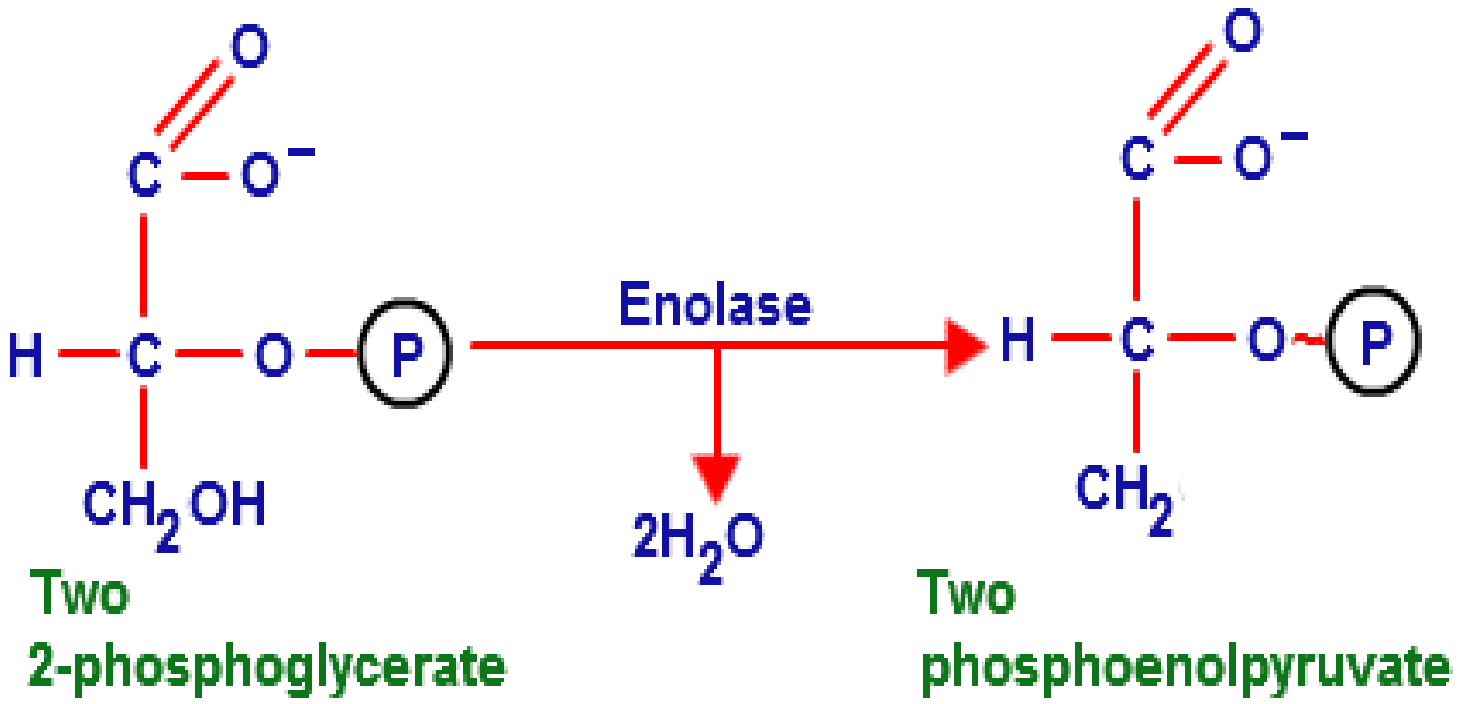
PGK

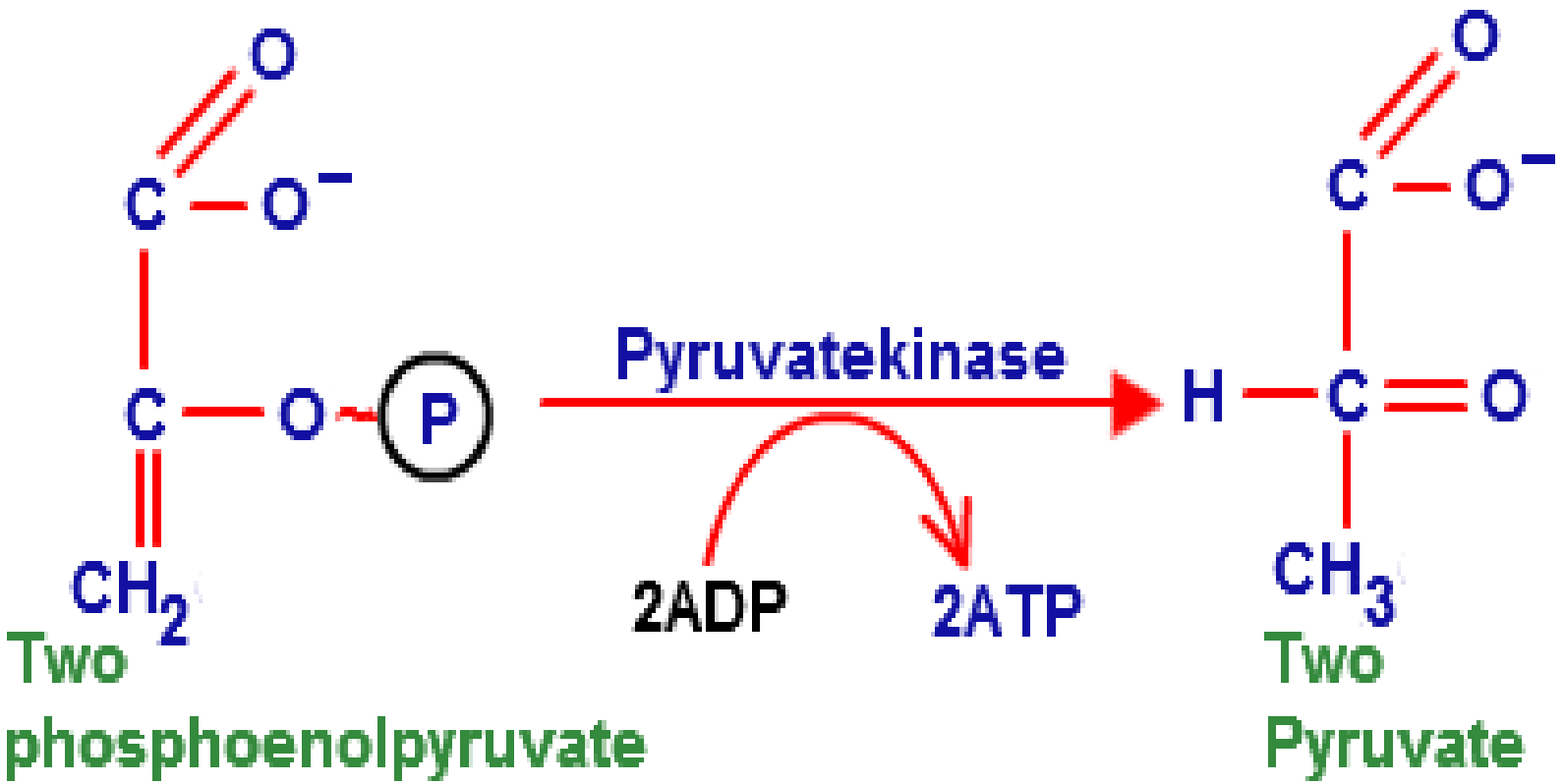
Mg

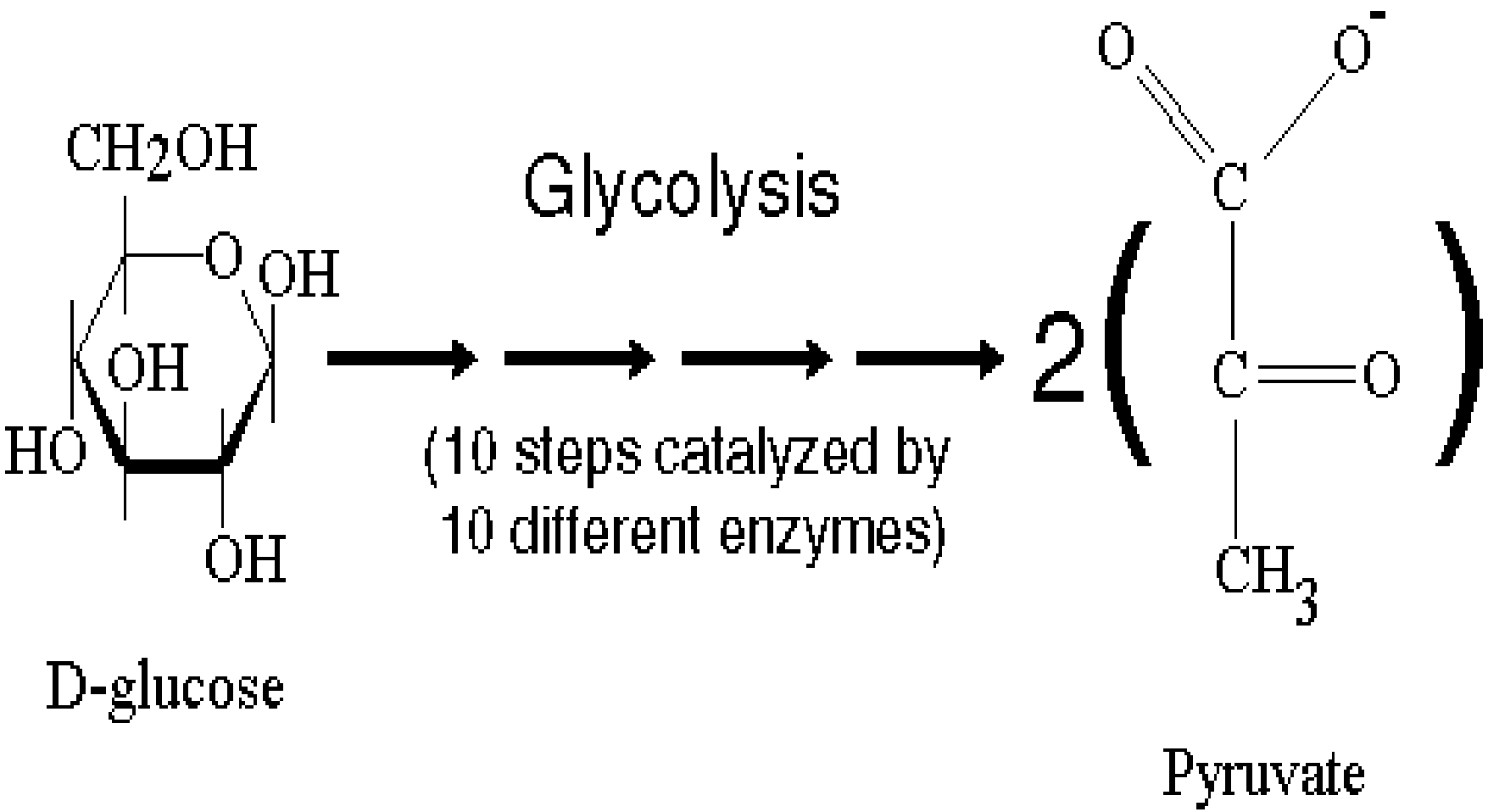
3 phosphoglycerate

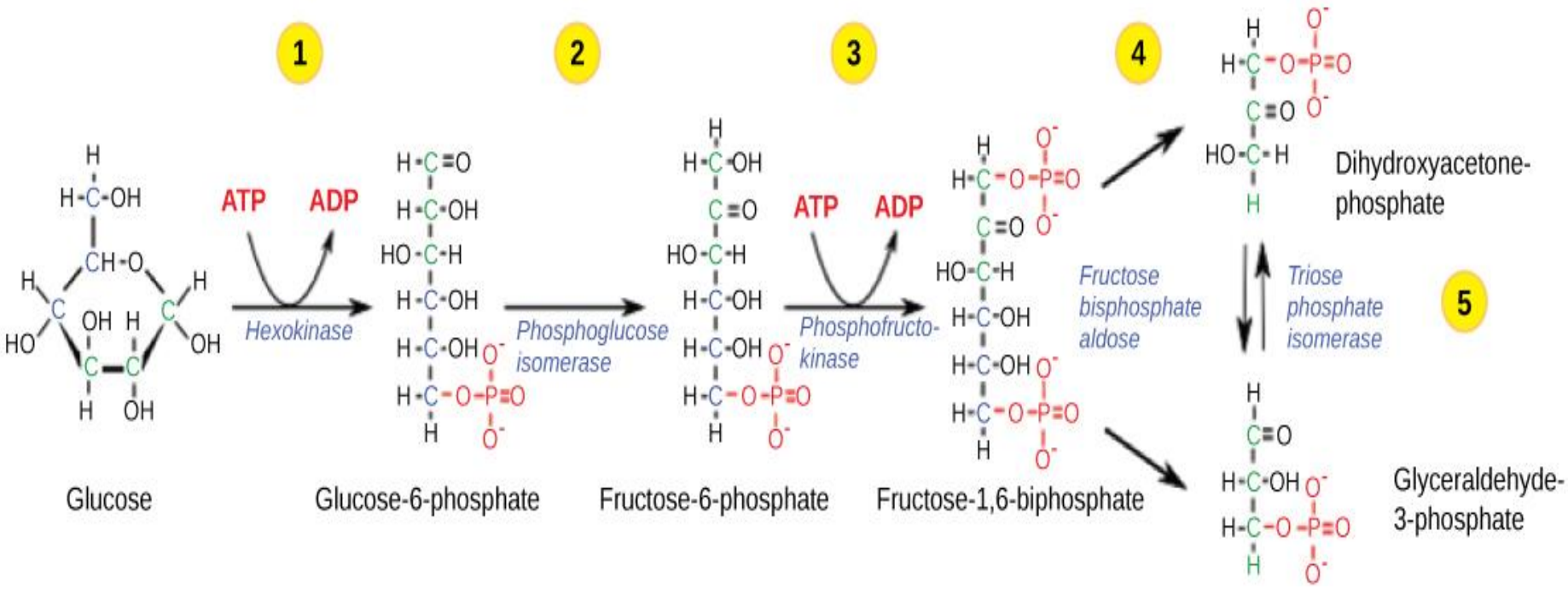


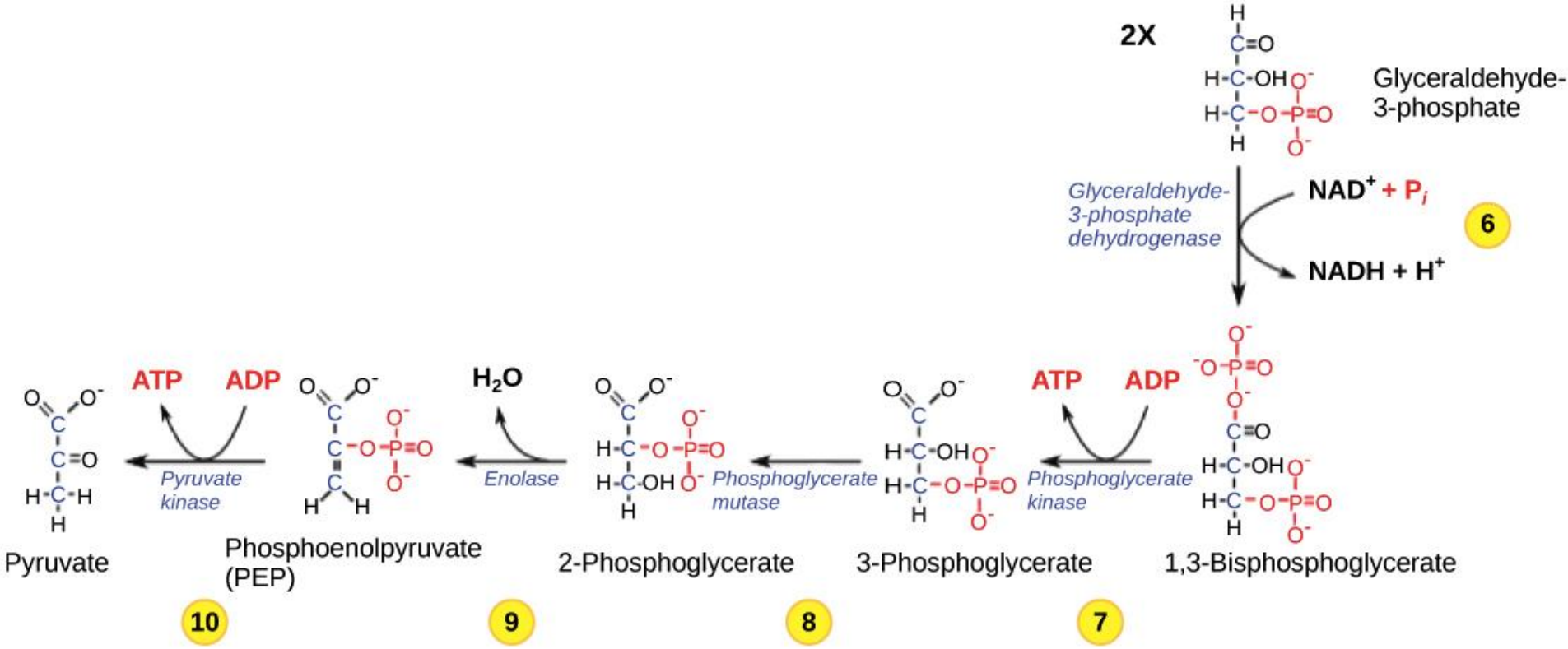
+ ATP

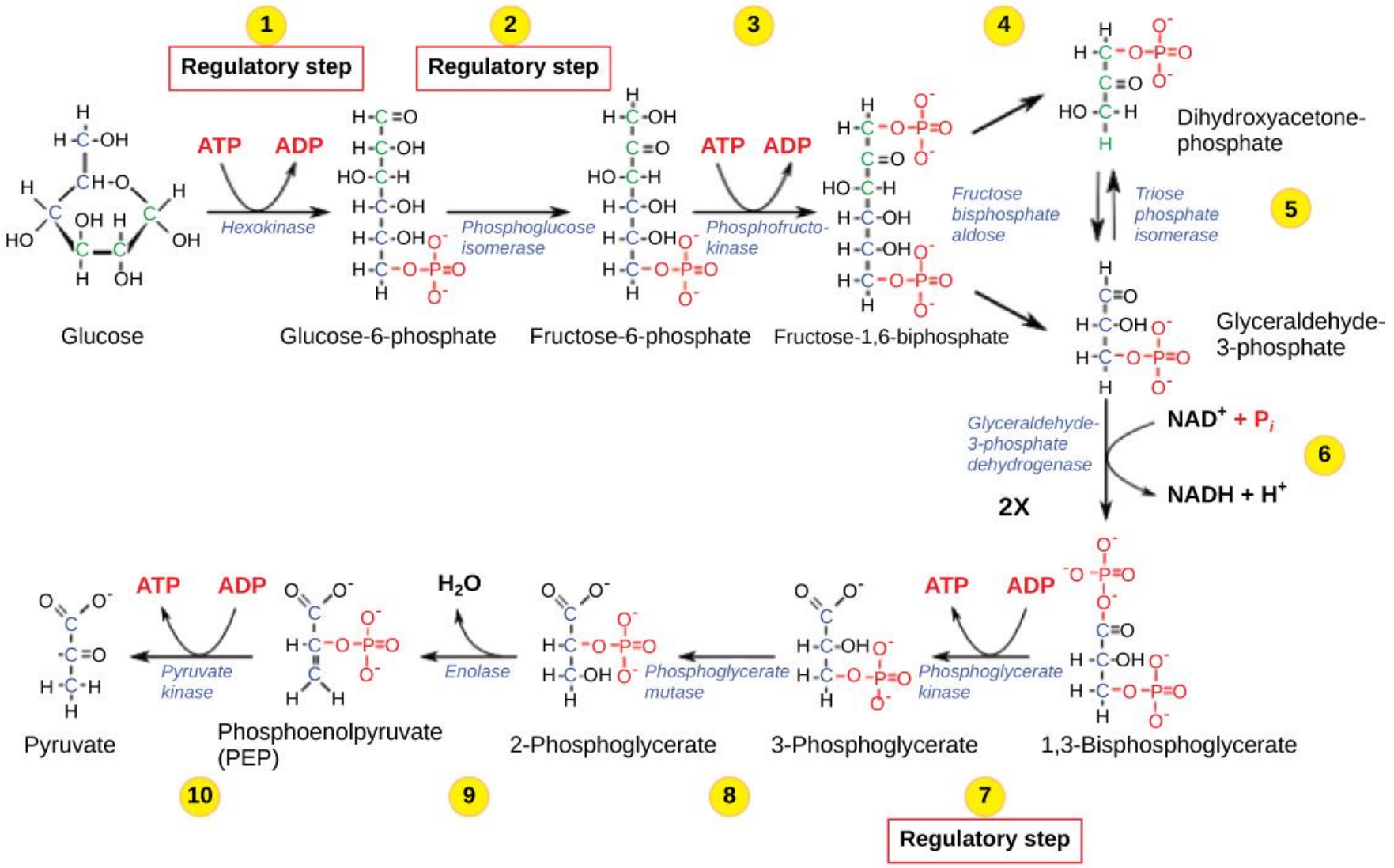

O
C
O⁻
H
C
O
P
CH2OH
Enolase
2H2O
O
C
O⁻
H
C
O
P
CH2
Two
2-phosphoglycerate
Two
phosphoenolpyruvate

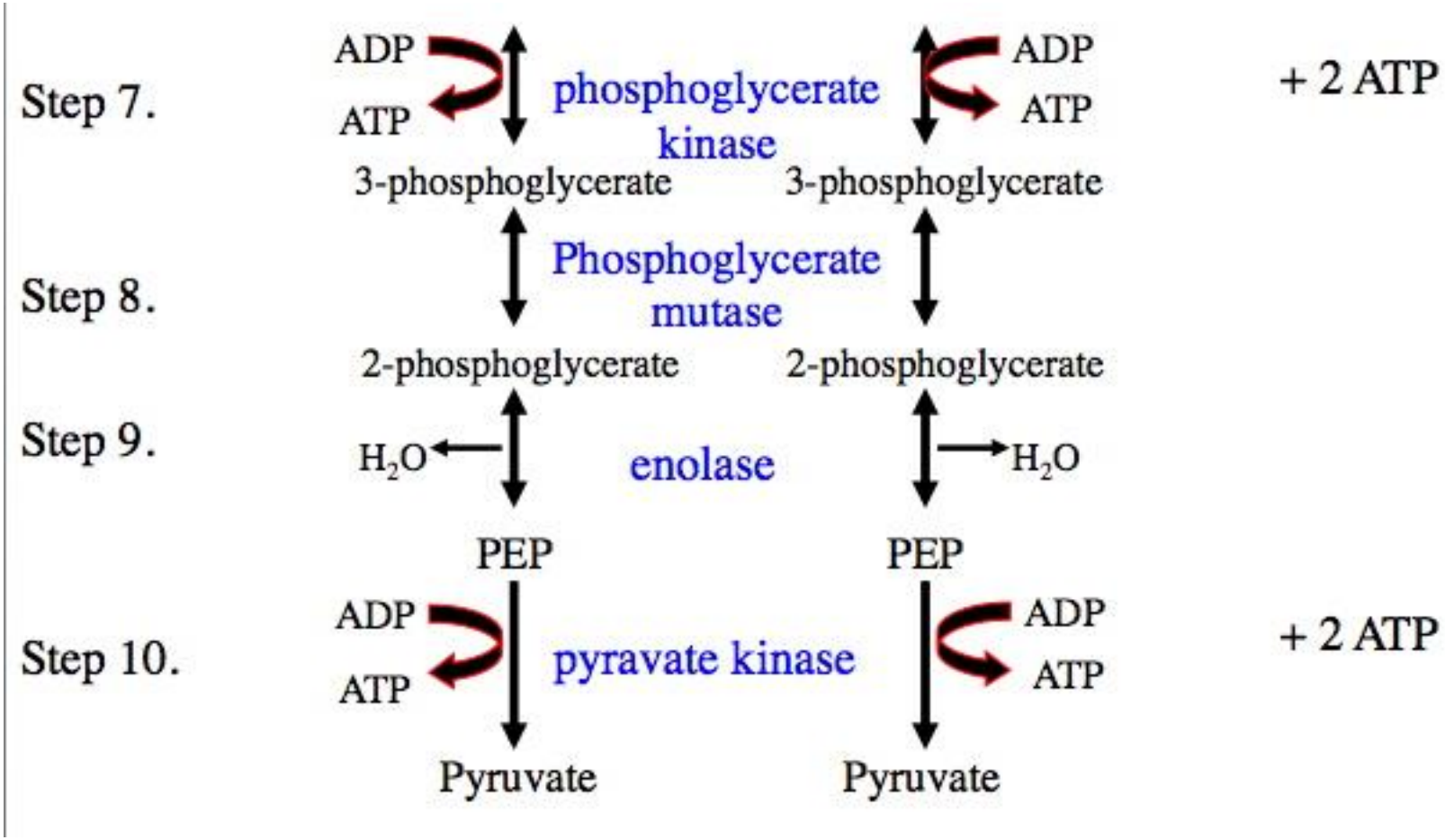

O
C
O⁻
C
O
P
CH2
Pyruvatekinase
2ADP
2ATP
H
C
O
O
C
O⁻
CH3
Two
phosphoenolpyruvate
Two
Pyruvate

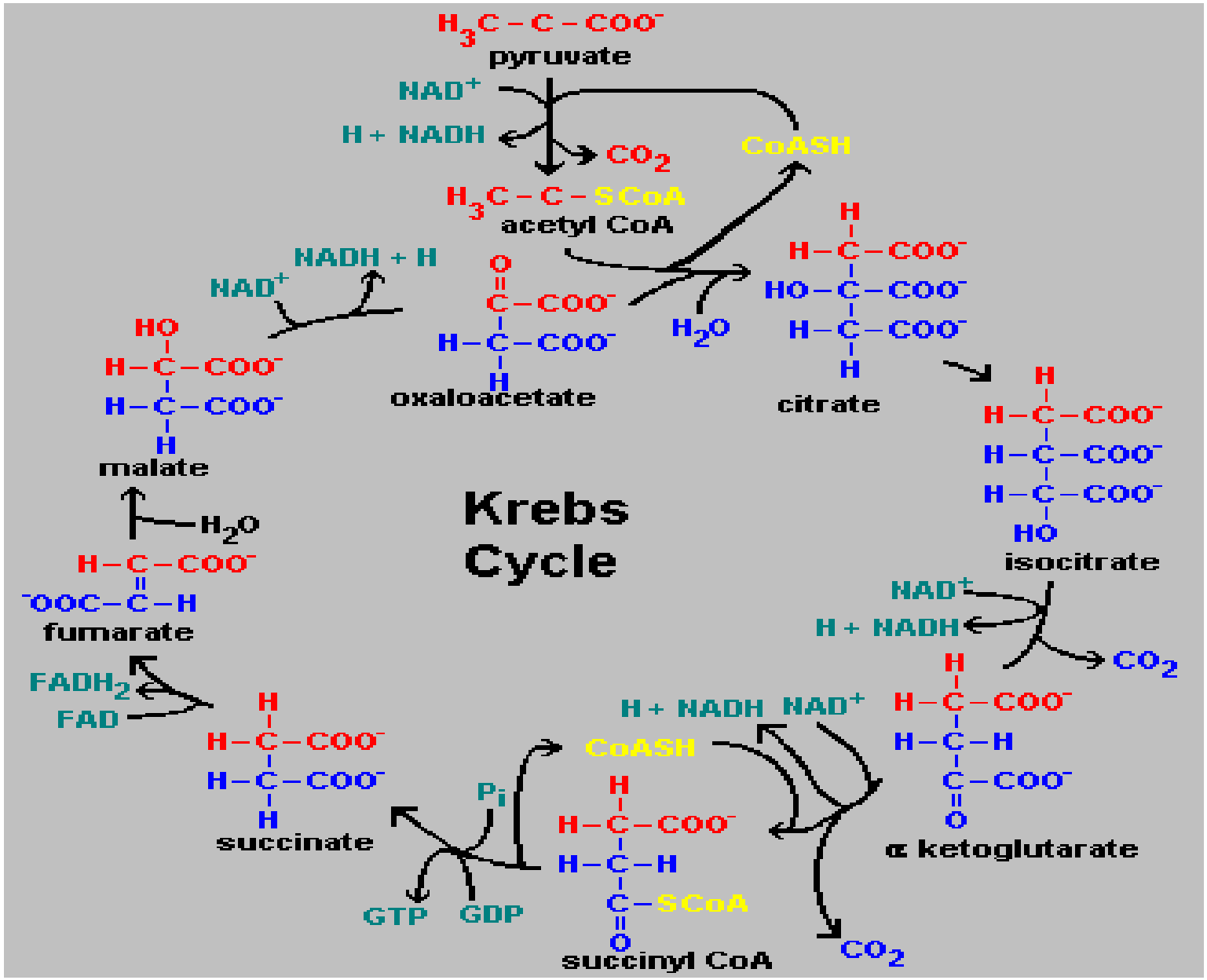

CH2OH
O
OH
OH
HO
OH
D-glucose
Glycolysis
(10 steps catalyzed by
10 different enzymes)
2
O
O-
C
C
O
CH3
Pyruvate


1
2
3
4
5
ATP
ADP
Hexokinase
Phosphoglucose isomerase
ATP
ADP
Phosphofructo-kinase
Fructose bisphosphate aldose
Triose phosphate isomerase
Dihydroxyacetone-phosphate
Glyceraldehyde-3-phosphate
Glucose
Glucose-6-phosphate
Fructose-6-phosphate
Fructose-1,6-biphosphate


2X
Glyceraldehyde-3-phosphate
Glyceraldehyde-3-phosphate dehydrogenase
NAD+ + Pi
NADH + H+
6
1,3-Bisphosphoglycerate
ATP
ADP
Phosphoglycerate kinase
7
3-Phosphoglycerate
Phosphoglycerate mutase
8
2-Phosphoglycerate
H2O
Enolase
9
Phosphoenolpyruvate (PEP)
ATP
ADP
Pyruvate kinase
10
Pyruvate


1
Regulatory step
2
Regulatory step
3
4
5
6
7
Regulatory step
8
9
10
ATP
ADP
Hexokinase
Phosphoglucose isomerase
Phosphofructo-kinase
Fructose bisphosphate aldose
Triose phosphate isomerase
Glyceraldehyde-3-phosphate dehydrogenase
2X
NAD+ + Pi
NADH + H+
Phosphoglycerate kinase
Phosphoglycerate mutase
Enolase
H2O
Pyruvate kinase
Glucose
Glucose-6-phosphate
Fructose-6-phosphate
Fructose-1,6-biphosphate
Dihydroxyacetone-phosphate
Glyceraldehyde-3-phosphate
1,3-Bisphosphoglycerate
3-Phosphoglycerate
2-Phosphoglycerate
Phosphoenolpyruvate (PEP)
Pyruvate


Step 7.
ADP
ATP
phosphoglycerate kinase
ADP
ATP
+ 2 ATP
3-phosphoglycerate
3-phosphoglycerate
Step 8.
Phosphoglycerate mutase
2-phosphoglycerate
2-phosphoglycerate
Step 9.
H_2O
enolase
H_2O
PEP
PEP
Step 10.
ADP
ATP
pyravate kinase
ADP
ATP
+ 2 ATP
Pyruvate
Pyruvate


pyruvate
NAD+
H + NADH
CO2
CoASH
acetyl CoA
NADH + H
NAD+
oxaloacetate
H2O
citrate
malate
H2O
Krebs
Cycle
isocitrate
fumarate
NAD+
H + NADH
CO2
FADH2
FAD
succinate
H + NADH
NAD+
CoASH
Pi
α ketoglutarate
GTP
GDP
succinyl CoA
CO2

TOTAL ATP Production from one Glucose molecule

Glycolysis: (Net yields)

Stage I.

ATP	**2 ATP**
2 NADH+H$^+$ → 2 FADH$_2$ (to ETC)	**3 ATP**

Stage II. **Conversion of pyruvate to ACoA**

2 NADH + H$^+$ (to ETC)	**5 ATP**

Stage III. **TCA cycle**

ATP (at one site)	**2 ATP**
NADH+H$^+$ at three steps (to ETC)	**15 ATP**
FADH$_2$ at one step (to ETC)	**3 ATP**

Total ATP from one molecule of glucose = 30 ATP

Amino Acids, Peptides, and Proteins.

Assistant Prof.Dr. MAJID M. A.ALI

12-15	PROTEIN METABOLISM - Fate of Ammonia - Urea: (normal values, uremia) - Amino acids as buffers - Serum protein components - Insulin structure - Selected inborn errors of amino acid metabolism

Objectives

1. The nature of the amino acids,.
2. Diseases related to the functioning of the amino acids
3. General techniques used in the work of the proteins.

Specific objective

At the end of the school year, the student will be able to understand and realize

1. Defining immunology and its relationship to other sciences and its importance to the student of amino acids and protein.
2. The components, types of proteins, which include theproteins cells and organs that are related to the formation of the human body.
3. The concept of natural and acquired amino acids, humoral and cellular factors.
4. The relationship between humoral components, cellular factors and the biology.
5. proteins and its types of and its metabolic,
6. Mechanisms of laboratory diagnosis and identification of some derives proteins compounds that depend on differents laboratory diagnosis

What Are Proteins?

- **Large molecules**
- **Made up of chains of amino acids**
- **Are found in every cell in the body**
- **Are involved in most of the body’s functions and life Processes.**
- **The sequence of amino acids is determined by DNA**

Structure of Proteins

- **Made up of chains of amino acids; classified by number of amino acids in a chain.**

• Peptides: fewer than 50 amino acids

- Dipeptides: 2 amino acids

- Tripeptides: 3 amino acids

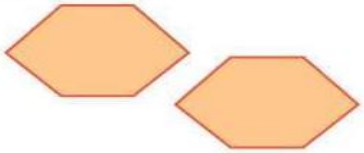
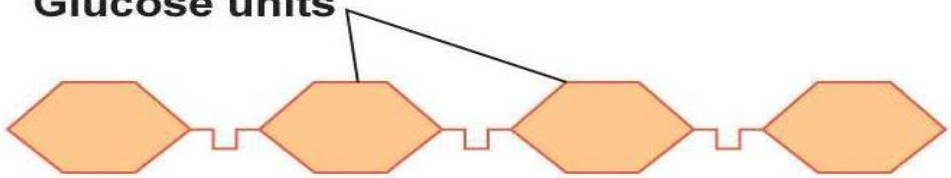
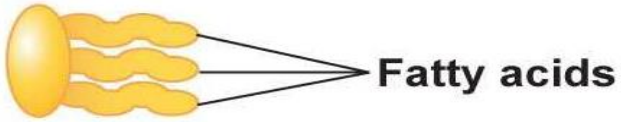
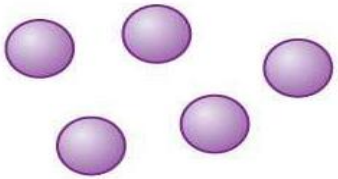
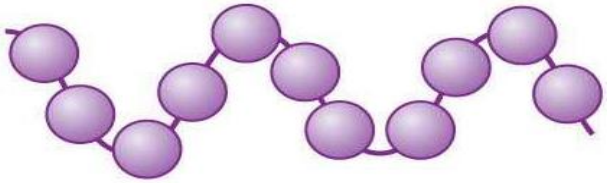
- Polypeptides: more than 10 amino acids

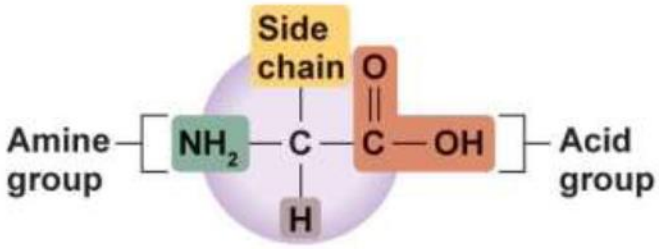
• Proteins: more than 50 amino acids

- Typically 100 to 10,000 amino acids linked together

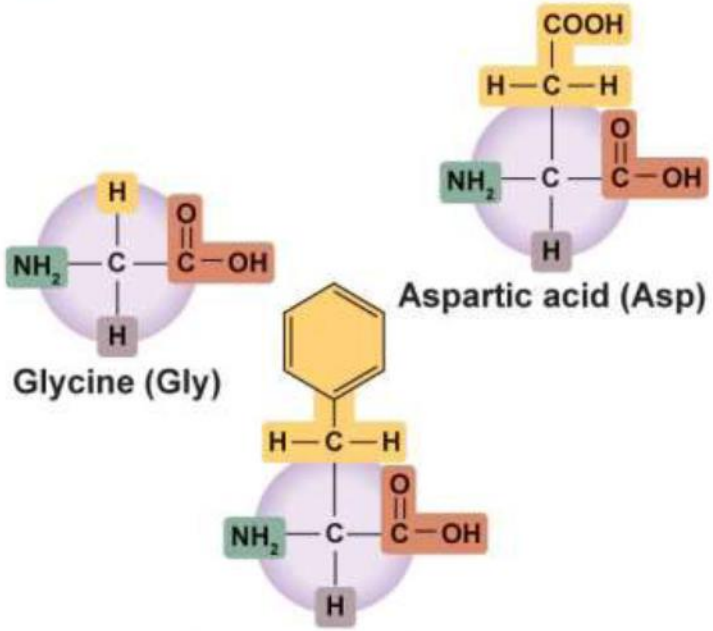
Chains are synthesizes based on specific bodily DNA

Amino acids are composed of carbon, hydrogen, oxygen, and nitrogen

Macronutrients	Chains of	Example
Carbohydrates	Glucose 	Glucose units 
Lipids	Fatty acids 	Triglyceride 
Proteins	Amino acids 	Amino acids 



a Amino acid structure



b Different amino acids, showing their unique side chains

Classification of Amino Acids

There are different ways of classifying the amino acids; the most common are chemical, nutritional, and metabolic classification.

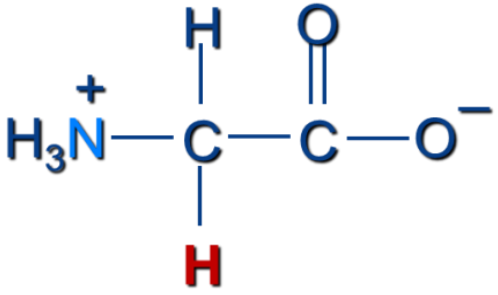
1- Neutral amino acids : there are 15 amino acids which have o

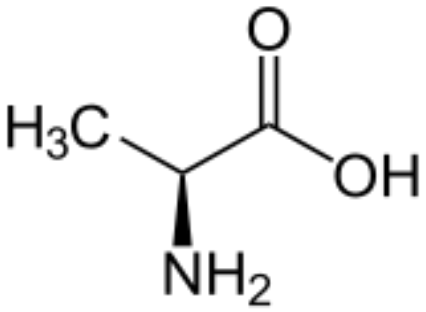
charge positive NH_3^+ and one charge negative COO^-

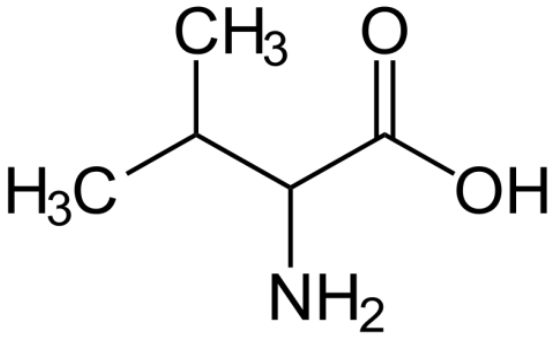
Glycine : Glycine is the simplest amino acid. *

Alanine : R = CH_3

VALINE : R = $(CH_3)_2$

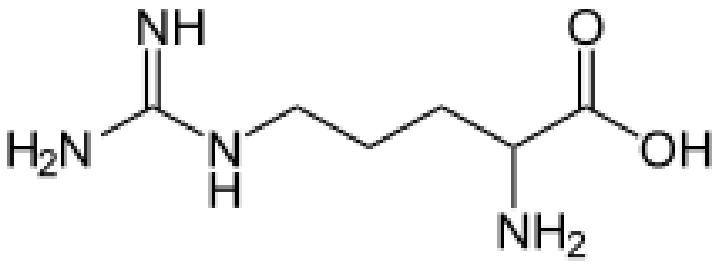




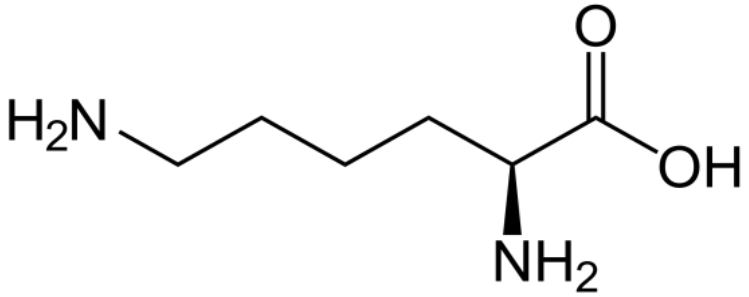


3- Basic amino acids: there are 3 amino acids , they have two or more positive charge NH_3^+ and one negative charge COO^- .

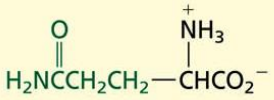
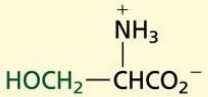
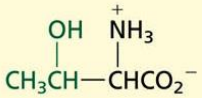
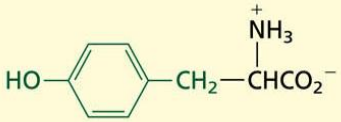
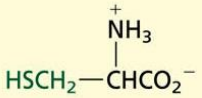
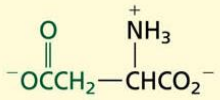
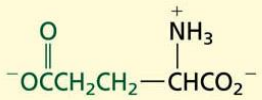
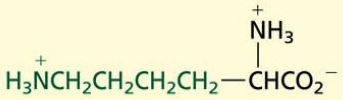
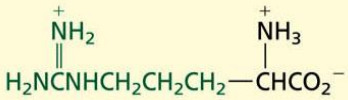
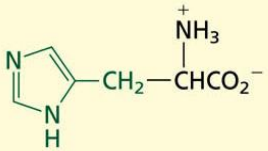
Lysine , Arginine , and Histden



Arginine

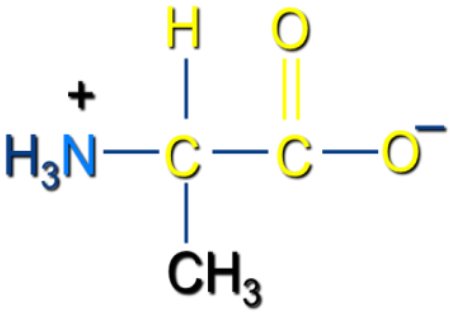


Lysine

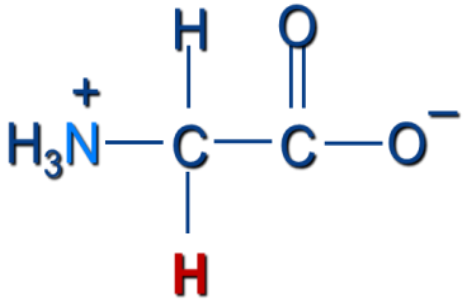
Name	Abbreviation	Structural formula*
Amino acids with polar but nonionized side chains		
Glutamine	Gln (Q)	
Serine	Ser (S)	
Threonine†	Thr (T)	
Tyrosine	Tyr (Y)	
Cysteine	Cys (C)	
Amino acids with acidic side chains		
Aspartic acid	Asp (D)	
Glutamic acid	Glu (E)	
Amino acids with basic side chains		
Lysine†	Lys (K)	
Arginine†	Arg (R)	
Histidine†	His (H)	

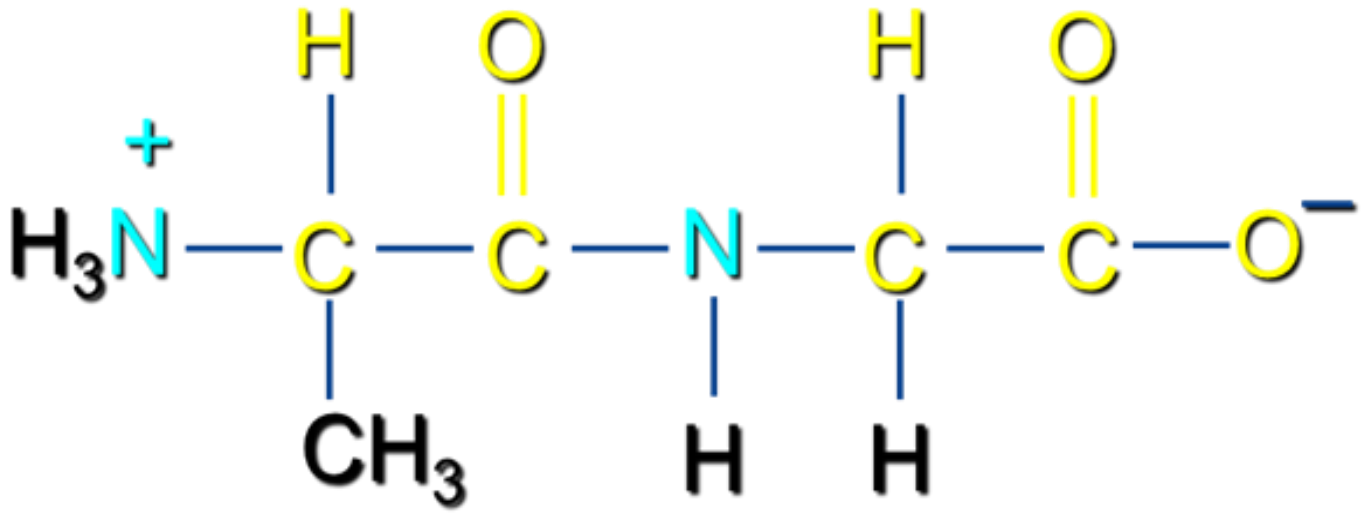
Peptides are compounds in which an amide bond links the amino group of one α-amino acid and the carboxyl group of another. An amide bond of this type is often referred to as a peptide bond.

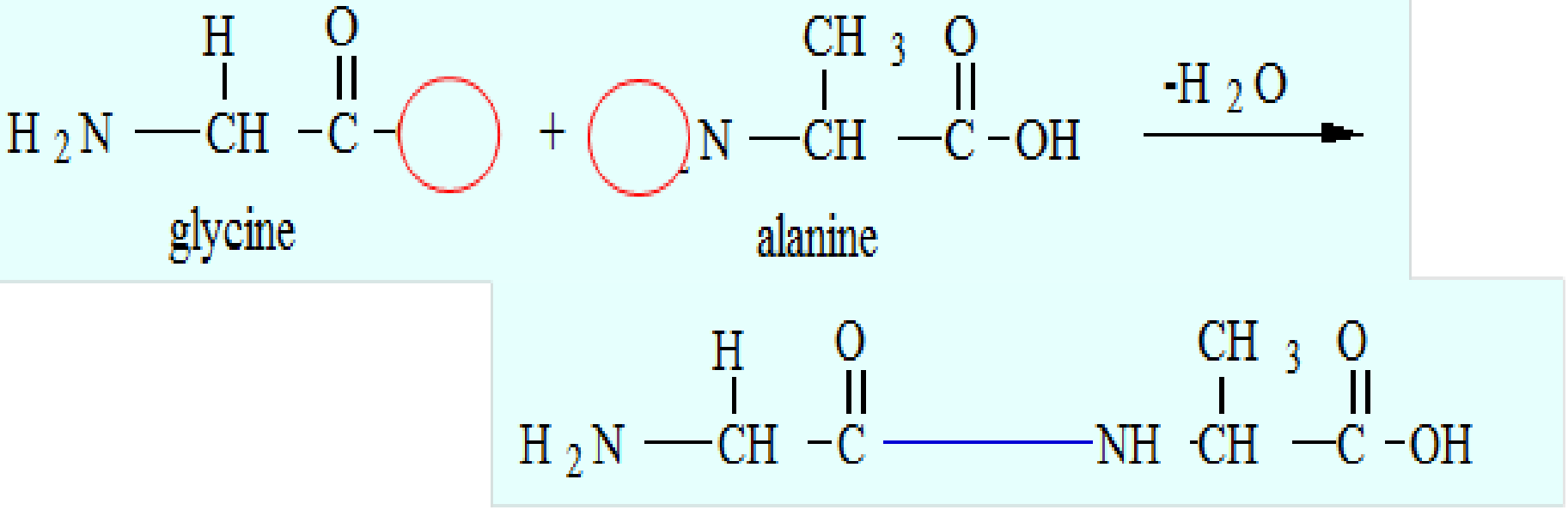
Alanine



Glycine



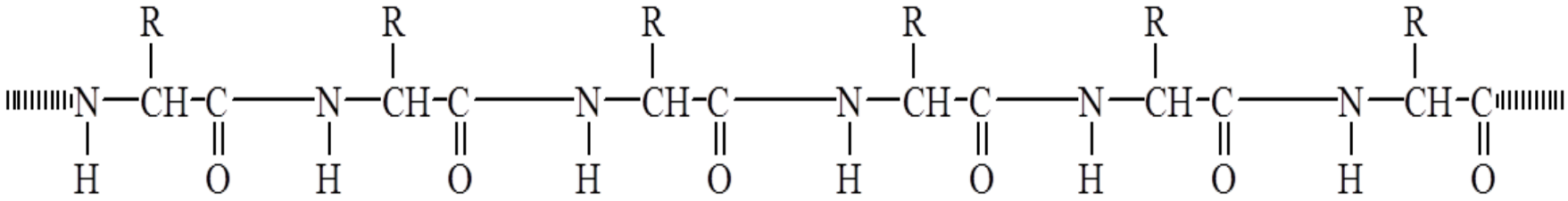

H
O
H
O
+
H3N
C
C
N
C
C
O
−
CH3
H
H


H2N—CH—C
O
H
glycine
+
N—CH—C—OH
CH3
O
alanine
-H2O
H2N—CH—C—NH—CH—C—OH
H
O
CH3
O

Peptides are classified according to the number of amino acids
ıked together.

dipeptides, Tripeptides, tetra peptides, etc.

Leucine enkephalin is an example of a pentapeptide.


R
N—CH—C——N—CH—C——N—CH—C——N—CH—C——N—CH—C——N—CH—C
H
O

Proteins are Natural Polymers

- **Proteins are constructed in the body from many repeating units call amino acids**
- **Just like other polymers the amino acids (monomers) are joined together to make long chains (polymers) – but we call them proteins instead**
- **All of the polymer information applies to proteins – cross linking, rings, polarity etc.**

Proteins are Natural Polymers

- **Proteins are constructed in the body from many repeating units call amino acids**
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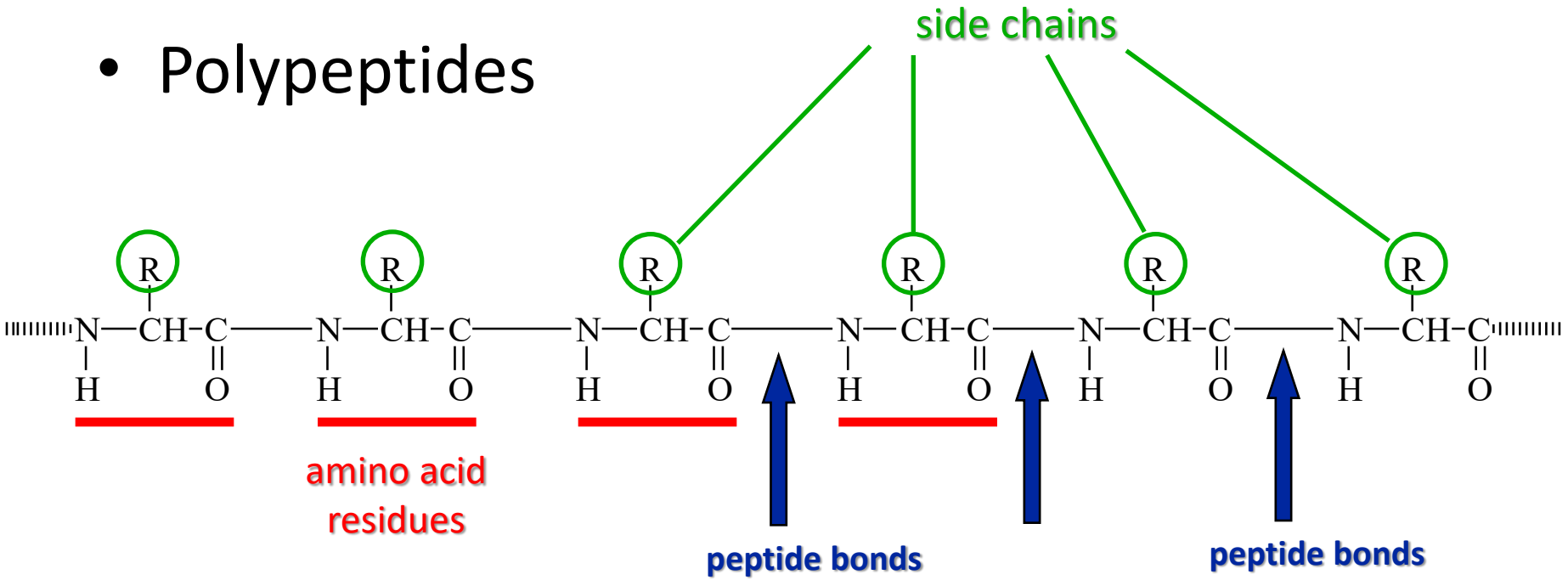
Polypeptides

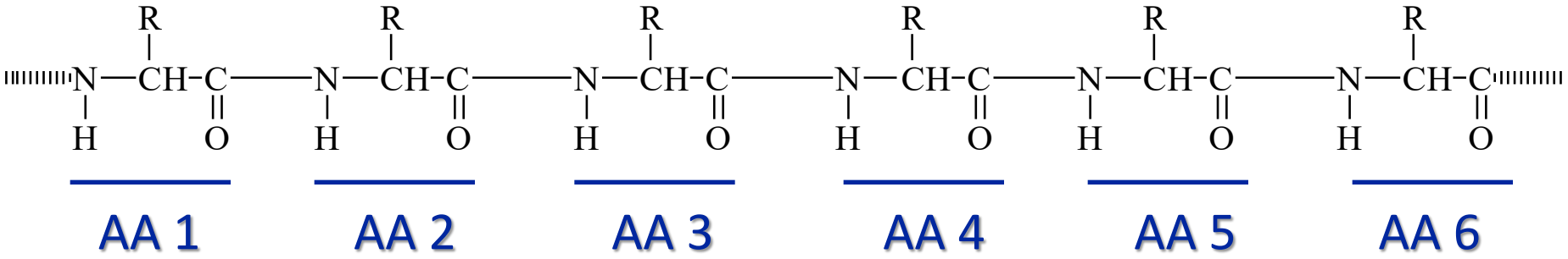
- Polypeptides



AA's

Protein Structure

- Primary Structure 1°
  - Linear sequence of AA

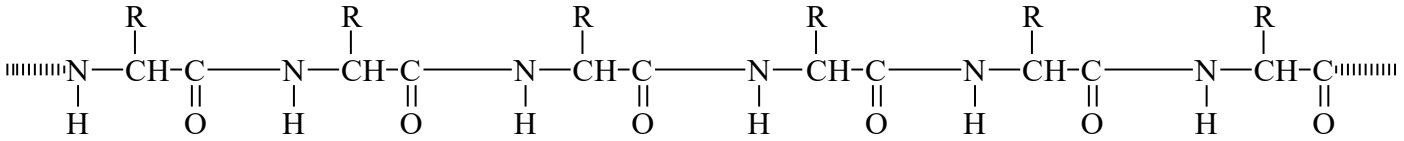


With any 6 AA residues,
the number of possible combinations is
6 x 6 x 6 x 6 x 6 x 6 = 46656

AA's

Protein Structure

- Primary Structure

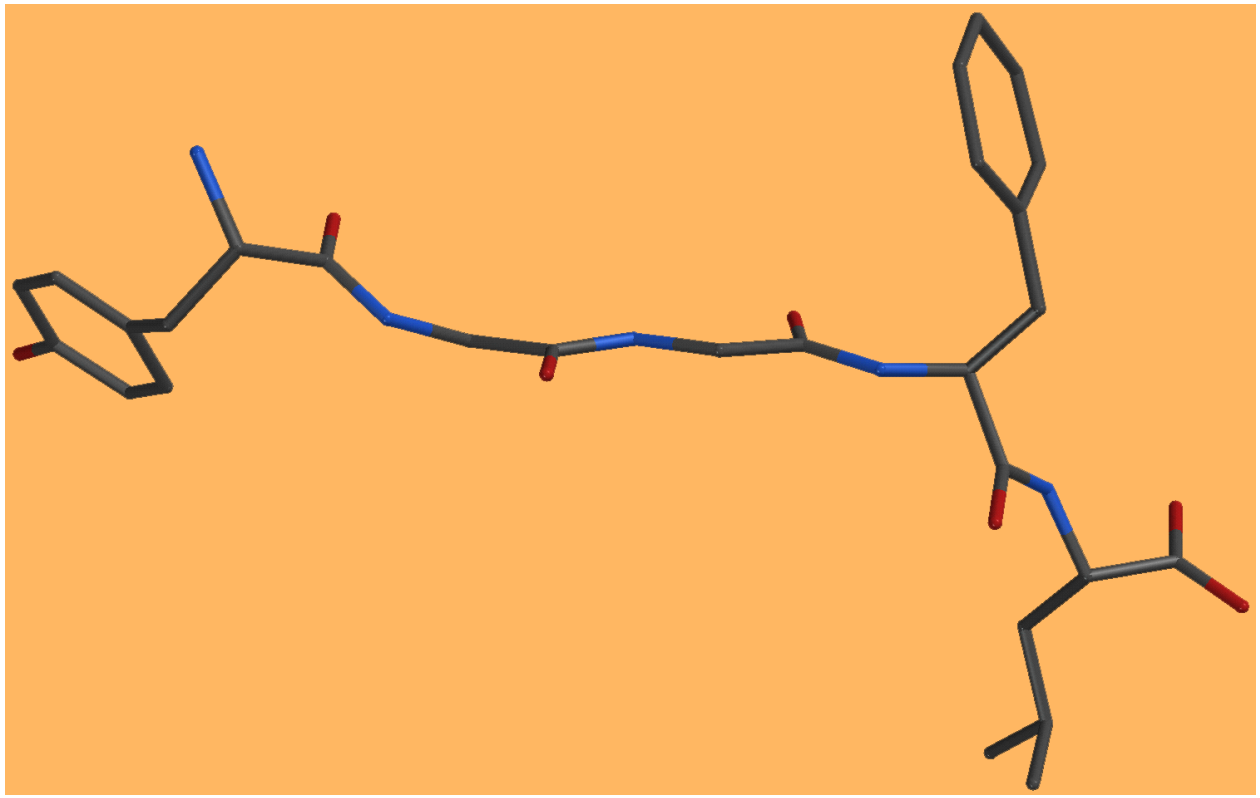


AA 1 AA 2 AA 3 AA 4 AA 5 AA 6

With any 6 of the 20 common AA residues,
the number of possible combinations is
20 x 20 x 20 x 20 x 20 x 20 = 64,000,000

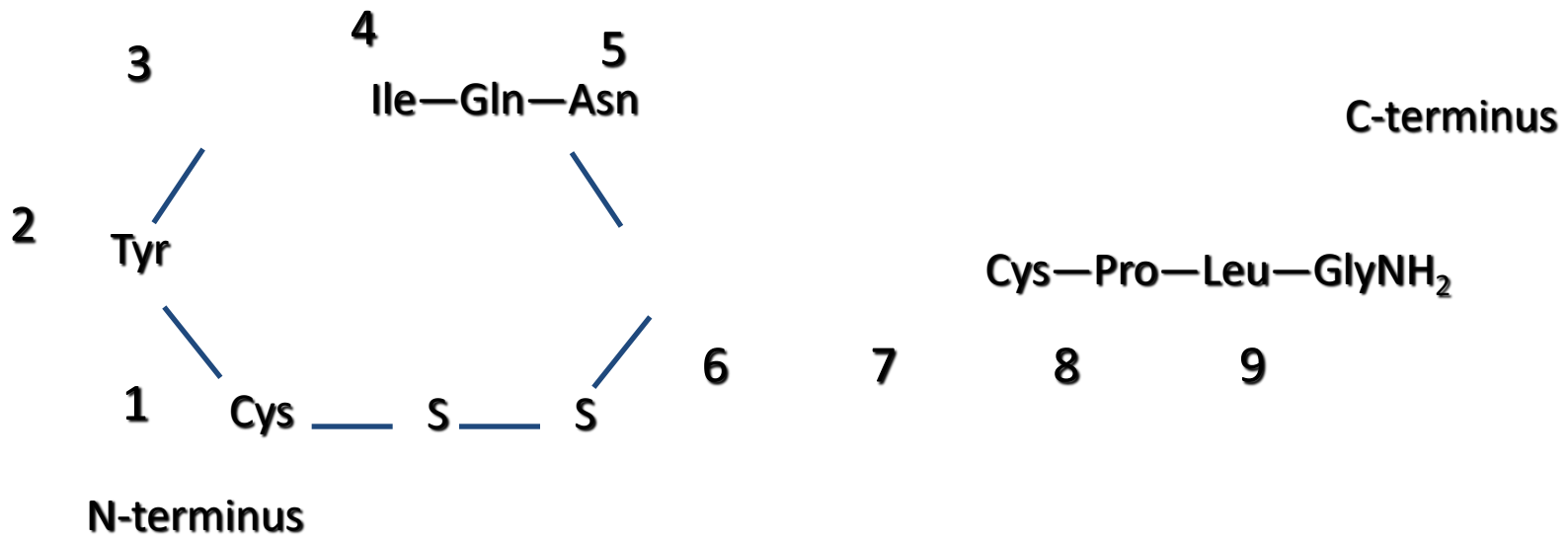
AA's

Leucine Enkephalin



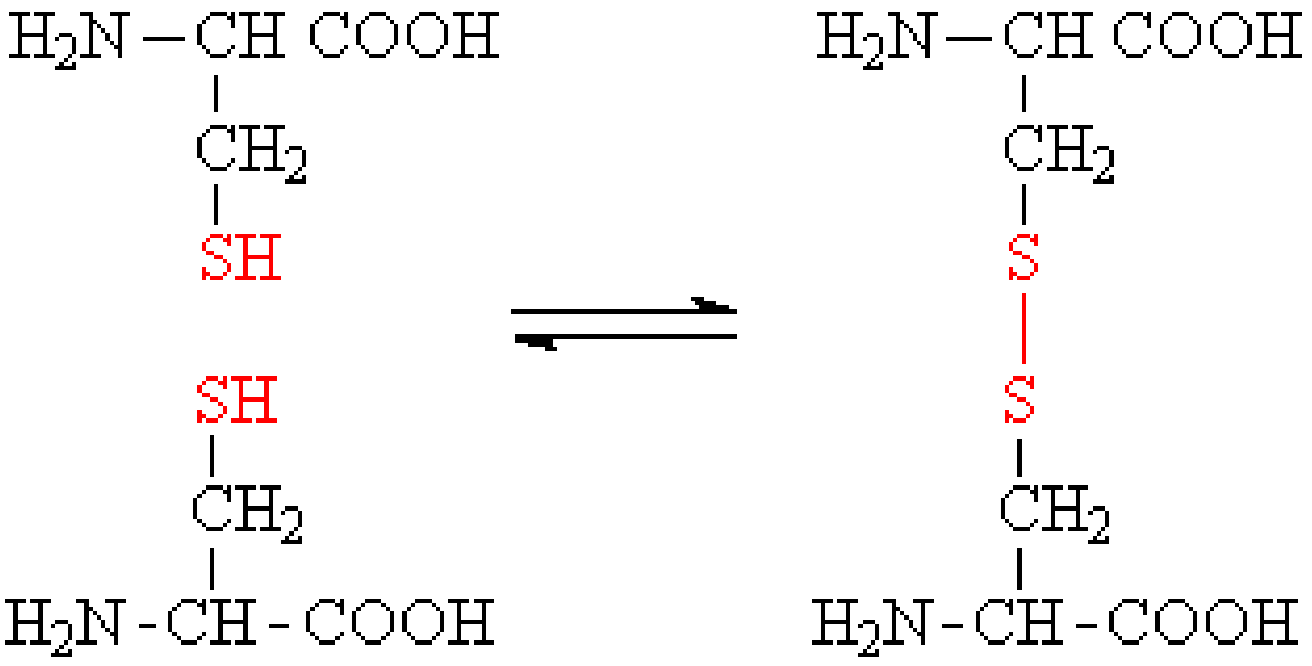
Tyr—Gly—Gly—Phe—Leu

Oxytocin

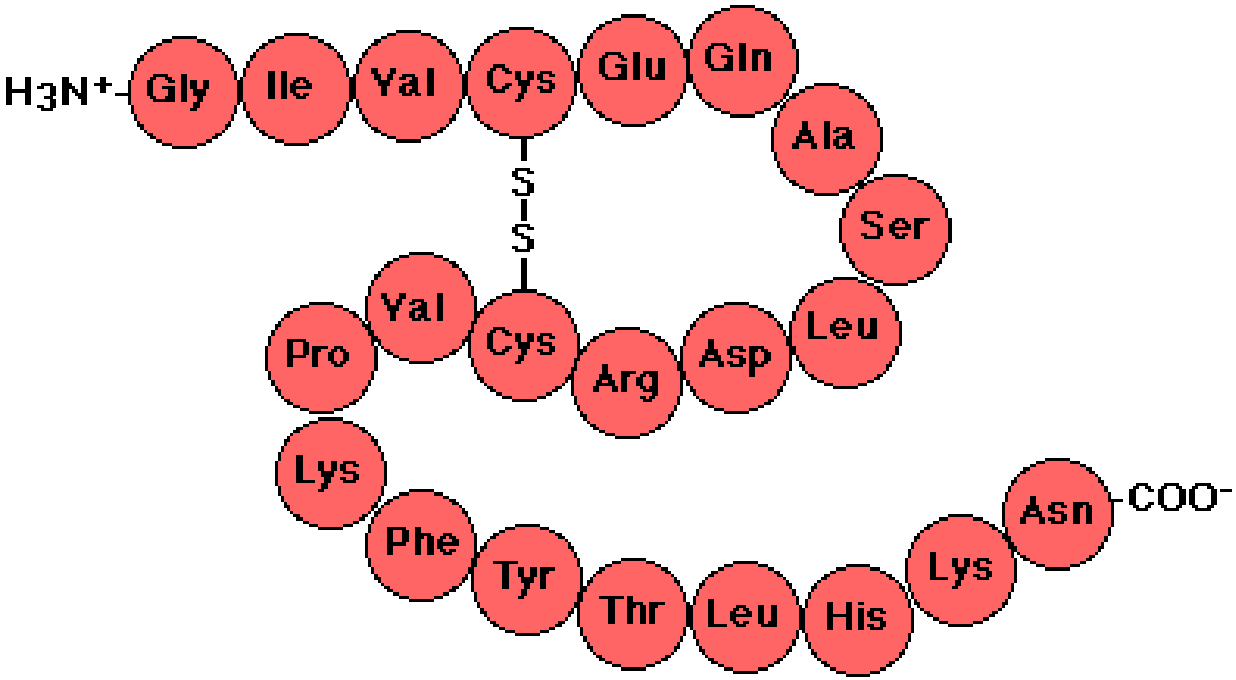


- **Oxytocin is a cyclic Nona peptide.**
- **Instead of having its amino acids linked in an extended chain, two cysteine residues are joined by an S—S bond.**

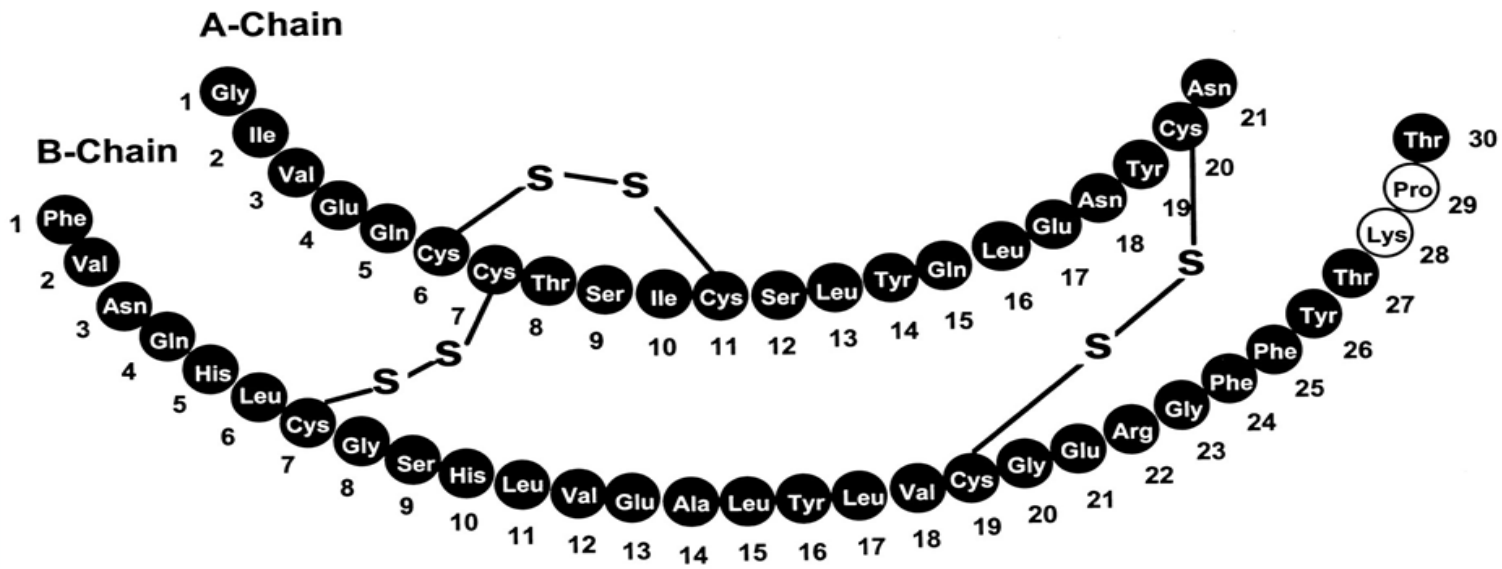
Disulfide Bridge



Disulfide Bridge – Linking Distant Amino Acids



Structure of Insulin



Protein Digestion:

1-In the mouth: no action.

2- In the stomach: the act of proteiolytic enzyme (pepsin) with PH 1.5-2.0 of gastric juice break down the proteins to peptone (small chains of amino acids).

Role of gastric juice HCl

1- It causes denaturation of proteins.

2-Converts proteins to metaproteins, which are easily digested.

3-Activate pepsinogen to pepsin.

3-In the small intestine: the act of pancreatic juice which contains of proteiolytic enzymes (Trypsin, chymotrypsin, Carboxypeptidases, and amino acid peptidase) will broke down all the small chains of peptone to amino acids, which are absorbed in to the blood and transported to liver for the functions:

Functions of proteins

1- Build new tissues in children.

2-Report worn out body tissues in adult human(muscle, skin, bone)

a-there are 30 trillion erythrocytes in circulating blood.

b-there are 3 million of erythrocytes are destroyed every second .

c-there are 300 million molecules of hemoglobin in each erythrocyte

d-we may synthesize some of 900 trillion molecules of hemoglobin each second.

e-the biosynthetic of hemoglobin is formed from 4 chains of amino a with molecule of heme.

f-we need about 8 gm. of amino acids per day to biosynthesis this amount(about 14%of total amino acids daily protein intake).

g-the synthesis of hemoglobin and erythrocytes in the bone-marrow.

3-provide sources of energy and heat.

4-provide body secretions and fluid(enzymes, hormones, milk, mucus, etc.).

5-maintain osmotic balance.

6-trasport fat, iron, calcium in the blood.

7-Produce antibodies.

Pathway of protein metabolism:

1-Anabolism : synthesis of :

a- Tissue proteins, blood protein, enzymes, and hormones.

Like Creatinine, **b-Synthesis of non-protein nitrogen compounds**

Urea , Purine , and Pyrimidine.

2-Catabolism: break down:

Proteins from diet and tissue are break down in to amino acids

Amino acids → Keto acids + NH_3

NH_3 → **Urea, Creatinine, Uric acid**

New non – essential AA

Keto acids → glucose (glycogenesis)

→ Acetyl CoA

→ Citric acid cycle

Deamination : Removal of amino group from the amino acids to for keto acid and ammonia (NH_3).

Alanine (amino acid) **Pyruvic acid (keto acid).**

Decarboxylation: Removal of carboxyl group from the amino acids give rise to some of biological active amines. As

Histidine → Histamine (powerful vasodilator)

Tyrosine → Tyramine (increase blood pressure)

Glutamic acid → Amino butyric acid (stimulates neuronal activity

Blood proteins : Albumin , Globulin , Fibrinogen

Hyperproteinemia : increase level of plasma protein .

(increase both Albumin and Globulin.)in multiple myeloma.

Hypoproteinemia decrease level of plasma protein from their normal value (decrease both Albumin and Globulin) It is shown in Malnutrition , Malabsorption , Hemorrhage, kidney disorder and liver diseases.

Normal value :

Albumin 3.5- 5.0 mg/dl.

Globulin 2.3- 3.5 mg/dl

Lipids

Assistant professor .Dr – majid m.a/ali

16-30	LIPID METABOLISM - Oxidation of Fatty acids - Ketone bodies - Cholestrol metabolism - Lipoprotein metabolism - Atherosclerosis

Lipids

Lipids are

* Biomolecules that contain fatty acids or a steroid nucleus.

*Soluble in organic solvents but not in water.

*Named for the Greek word *lipids*, which means "fat."

*Extracted from cells using organic solvents

Fats are solid at room temperature , while, oils are liquid at room temperature.

*The lipids are insoluble in water but soluble in organic solvents as ether, chloroform, benzene.

* Have low specific gravity less than 1.0 hence float on water.

* Solid fats have high melting point. while oils have low melting point.

Function of lipids :

1-source of energy 1gm. give 9 Kcal.

2-they are used by the body to store surplus energy for times of need.

3- fat are done cushion the vital organs and act as an insulating layer for the body thus helping to maintain body temperature.

4-they act as carriers of the fat soluble vitamins, and aid in there absorption.

5- un saturated fatty acid as linoleic, linolenic and Arachidonic acids are essential for health and life.

6-Unsaturated fatty acids are compounds in the prostaglandins which act the regulation of blood pressure, heart rate, and the central nervous system.

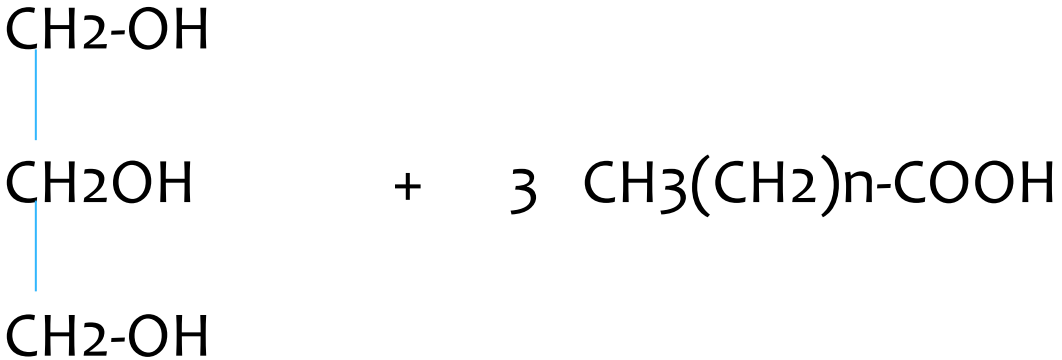
7-Cholesterol has vital function in the body , it is an essential part of production of other important steroids like the bile acids, the sex hormones , and the adrenocortical hormones.

8-Activators of enzymes.

1-simple lipids:

A- fats and oils : They are contain fatty acids linked to glycerol .

Triglyceride is an ester derived from glycerol and three fatty acids. Triglycerides are the main constituents of body fat in humans and other animals, as well as vegetable fat. They are also present in the blood ., and are a major component of human skin oils.



GLYCEROL Fatty acids

B- waxes: they are solid lipids ester of fatty acids with monohydroxy alcohols other than glycerol. As bees wax : palmitic acid ester of myricyl alcohol.

Waxes

Waxes are

* Esters of saturated fatty acids and long-chain alcohols.
* Coatings that prevent loss of water by leaves of plants.

TABLE Some Typical Waxes

Type	Structural Formula	Source	Uses
Beeswax	$CH_3(CH_2)_{14}-\overset{\overset{O}{\|}}{C}-O-(CH_2)_{29}CH_3$	Honeycomb	Candles, shoe polish, wax paper
Carnauba wax	$CH_3(CH_2)_{24}-\overset{\overset{O}{\|}}{C}-O-(CH_2)_{29}CH_3$	Brazilian palm tree	Waxes for furniture, cars, floors, shoes
Jojoba wax	$CH_3(CH_2)_{18}-\overset{\overset{O}{\|}}{C}-O-(CH_2)_{19}CH_3$	Jojoba	Candles, soaps, cosmetics

Fatty Acids

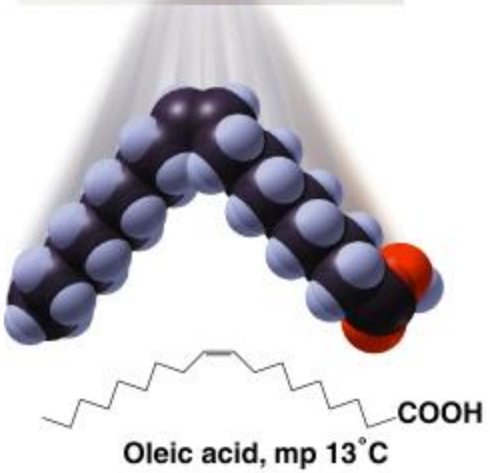
Fatty acids

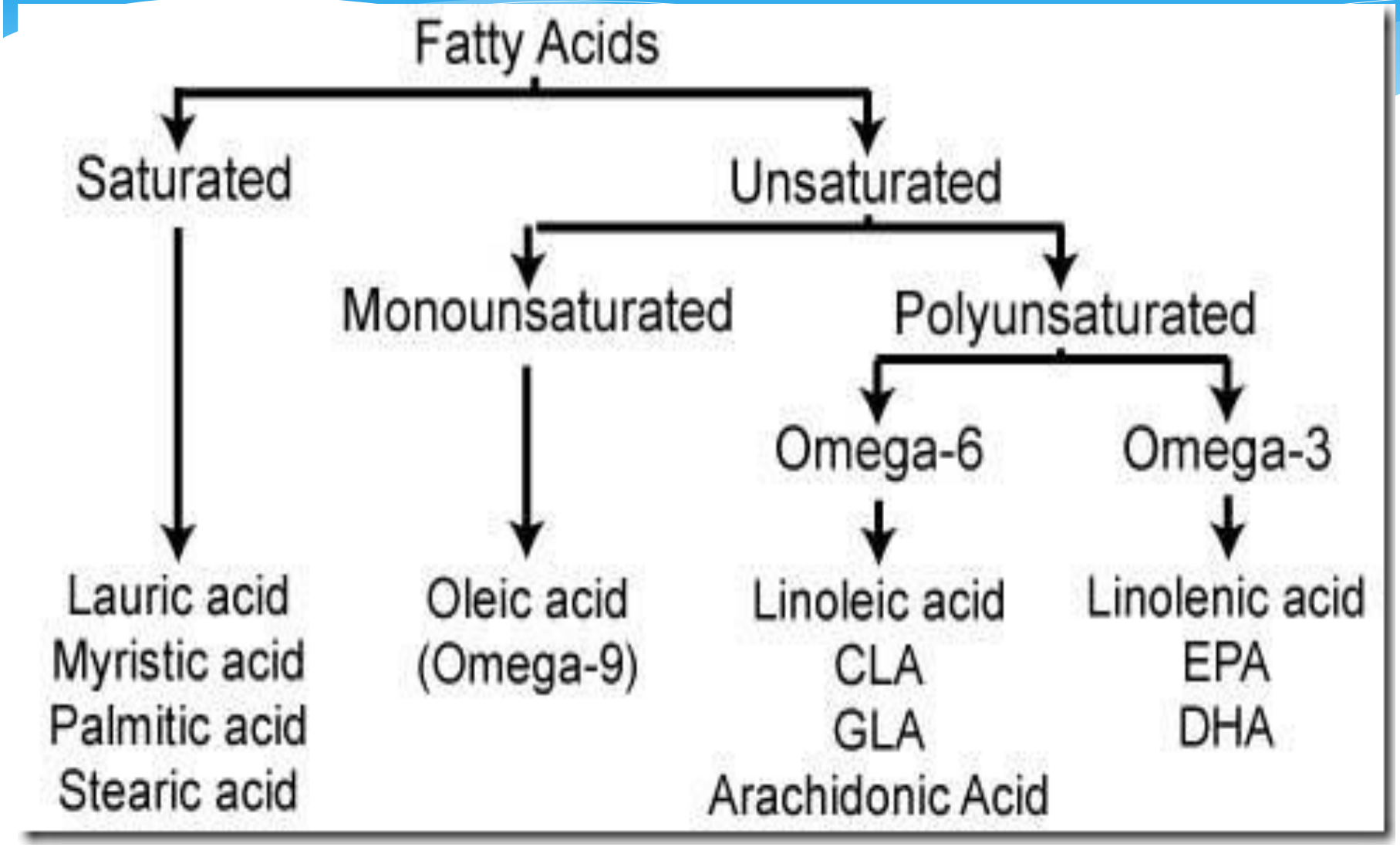
Are long-chain carboxylic acids. *

Typically contain 4 -18 carbon atoms. *

Are insoluble in water. *

Can be saturated or unsaturated. *




Fatty Acids
Saturated
Unsaturated
Monounsaturated
Polyunsaturated
Omega-6
Omega-3
Lauric acid
Myristic acid
Palmitic acid
Stearic acid
Oleic acid
(Omega-9)
Linoleic acid
CLA
GLA
Arachidonic Acid
Linolenic acid
EPA
DHA

Fatty Acid Formulas

The formulas for fatty acids are written as

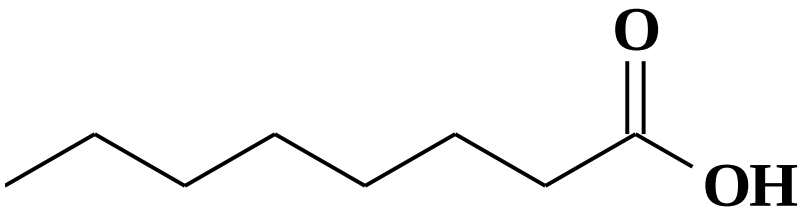
Condensed formulas. *

Line-bond formulas. *

For example caprylic acid with 8 carbon atoms. *

$CH_3—(CH_2)_6—COOH$

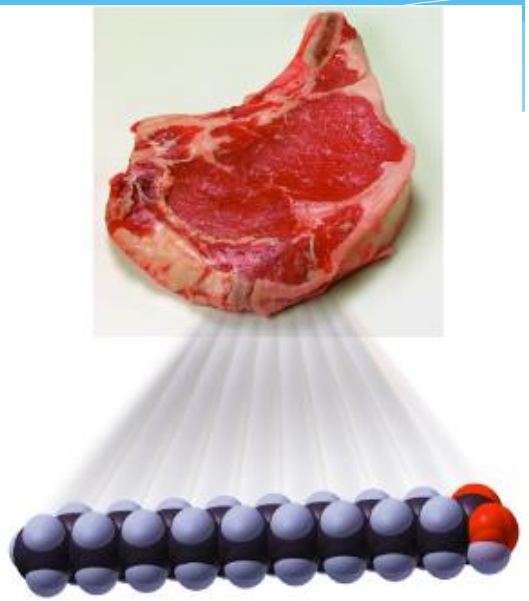
$CH_3—CH_2—CH_2—CH_2—CH_2—CH_2—CH_2—COOH$



Saturated Fatty Acids

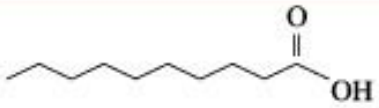
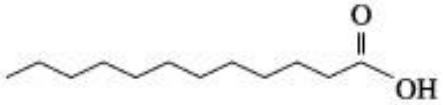
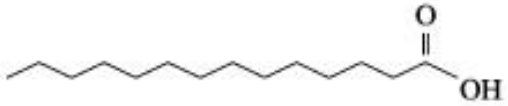
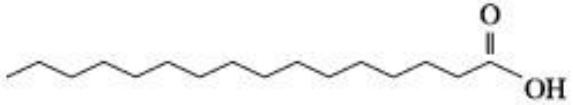
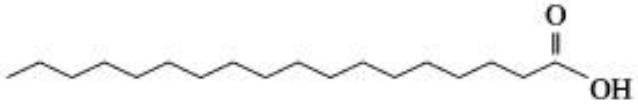
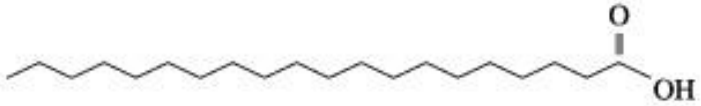
Saturated fatty acids have

Single C–C bonds.Molecules that fit closely together in a regular pattern.Strong attractions between fatty acid chains.High melting points that make them solids at room temperature



Some Saturated Fatty Acids

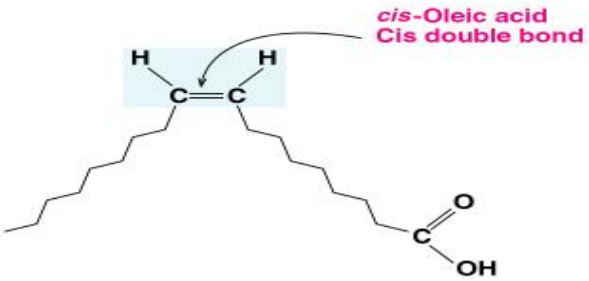
Table 18.1 Structures and Melting Points of Common Fatty Acids

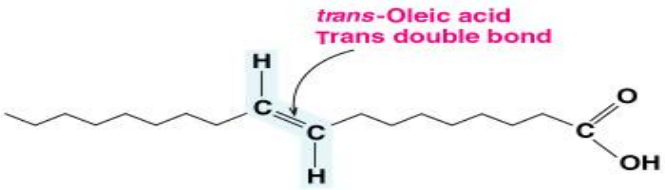
Name	Carbon Atoms	Structure	Melting Point (°C)	Source
Saturated Fatty Acids				
Capric acid	10		32	Saw palmetto
Lauric acid	12		43	Coconut
Myristic acid	14		54	Nutmeg
Palmitic acid	16		62	Palm
Stearic acid	18		69	Animal fat
Arachidic acid	20		76	Peanut oil, vegetable and fish oils

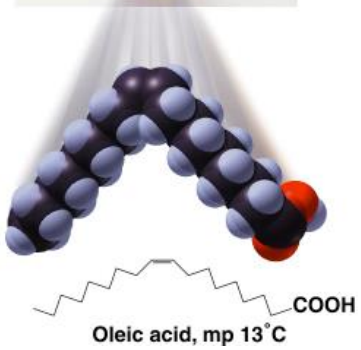
Unsaturated Fatty Acids

Unsaturated fatty acids

* Have one or more double C=C bond
* Typically contain *cis* double bonds.





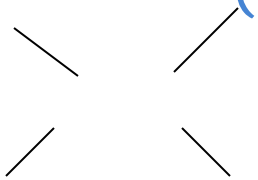


Cis and *Trans* Fatty Acids

Unsaturated fatty acids can be

Cis with bulky groups on *same side* of C=C. *

$(CH_2)_7—COOH$ *cis* $CH_3—(CH_2)_5$

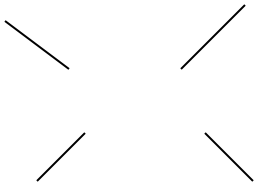


C=C

H H

Trans have bulky groups on *opposite sides* of C=C. *

H $CH_3—(CH_2)_5$

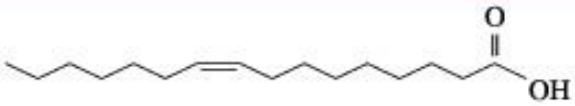
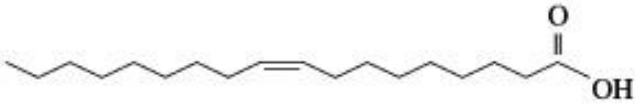
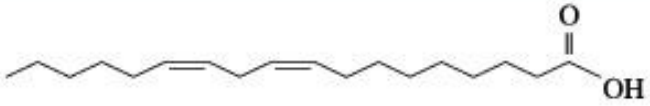
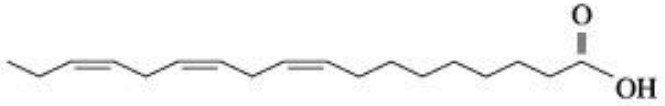
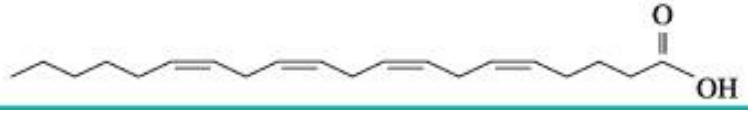


C=C *trans*

H $(CH_2)_7—COOH$

Unsaturated Fatty Acids

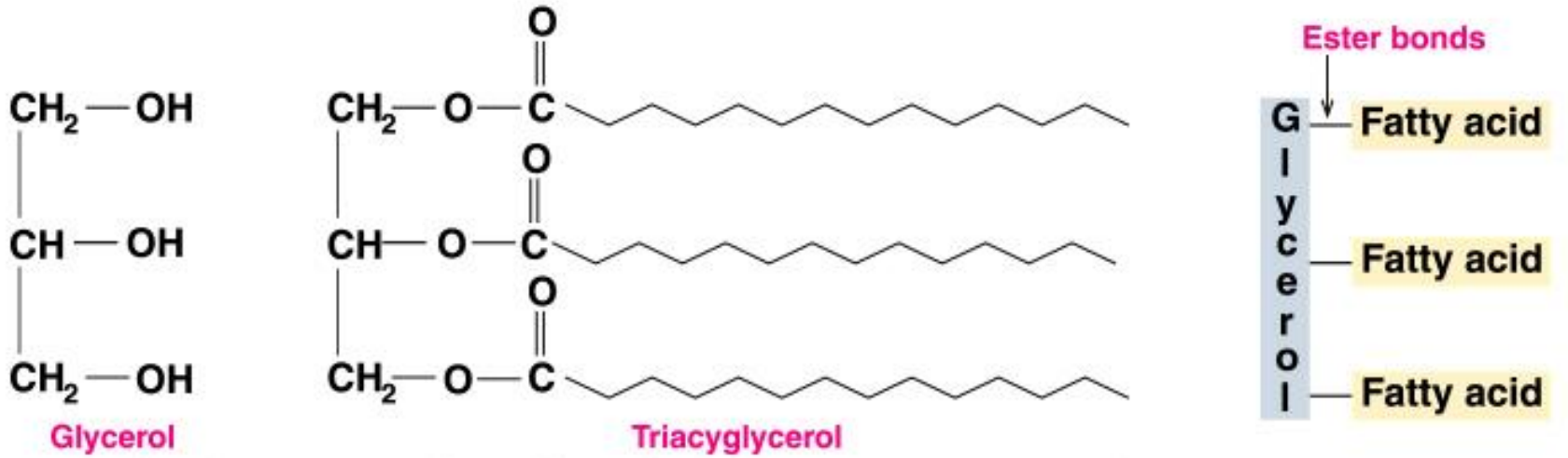
Table 18.1 Structures and Melting Points of Common Fatty Acids *(Continued)*

Name	Carbon Atoms	Structure	Melting Point (°C)	Source
Monounsaturated Fatty Acids				
Palmitoleic acid	16		0	Butter
Oleic acid	18		13	Olives, corn
Polyunsaturated Fatty Acids				
Linoleic acid	18		−9	Soybean, safflower, sunflower
Linolenic acid	18		−17	Corn
Arachidonic acid	20		−50	Prostaglandins

Triacylglycerols

In a triacylglycerol,

Glycerol forms ester bonds with three fatty acids. *

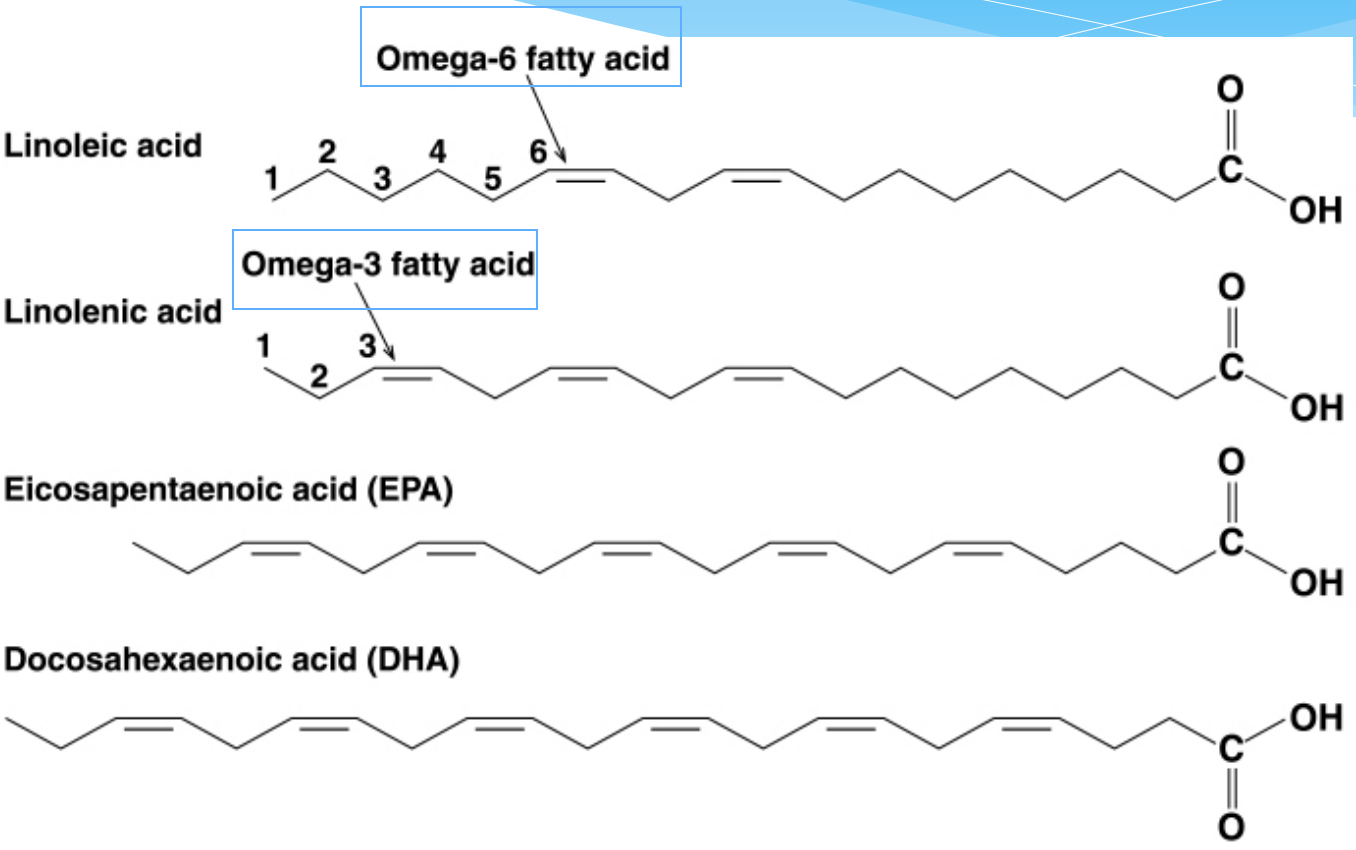


Comparing Melting Points of Some Fatty Acids

Structures and Melting Points of Common Fatty Acids

Name	Carbon Atoms	Double Bonds	Structure	Melting Point (°C)	Source
Saturated					
Lauric acid	12	0	$CH_3—(CH_2)_{10}—COOH$	43	Coconut
Myristic acid	14	0	$CH_3—(CH_2)_{12}—COOH$	54	Nutmeg
Palmitic acid	16	0	$CH_3—(CH_2)_{14}—COOH$	62	Palm
Stearic acid	18	0	$CH_3—(CH_2)_{16}—COOH$	69	Animal fat
Unsaturated					
Palmitoleic acid	16	1	$CH_3—(CH_2)_5—CH=CH—(CH_2)_7—COOH$	0	Butter
Oleic acid	18	1	$CH_3—(CH_2)_7—CH=CH—(CH_2)_7—COOH$	13	Olives, corn
Linoleic acid	18	2	$CH_3—(CH_2)_4—CH=CH—CH_2—CH=CH—(CH_2)_7—COOH$	−9	Soybean, safflower, sunflower
Linolenic acid	18	3	$CH_3—CH_2—CH=CH—CH_2—CH=CH—CH_2—CH=CH—(CH_2)_7—COOH$	−17	Corn

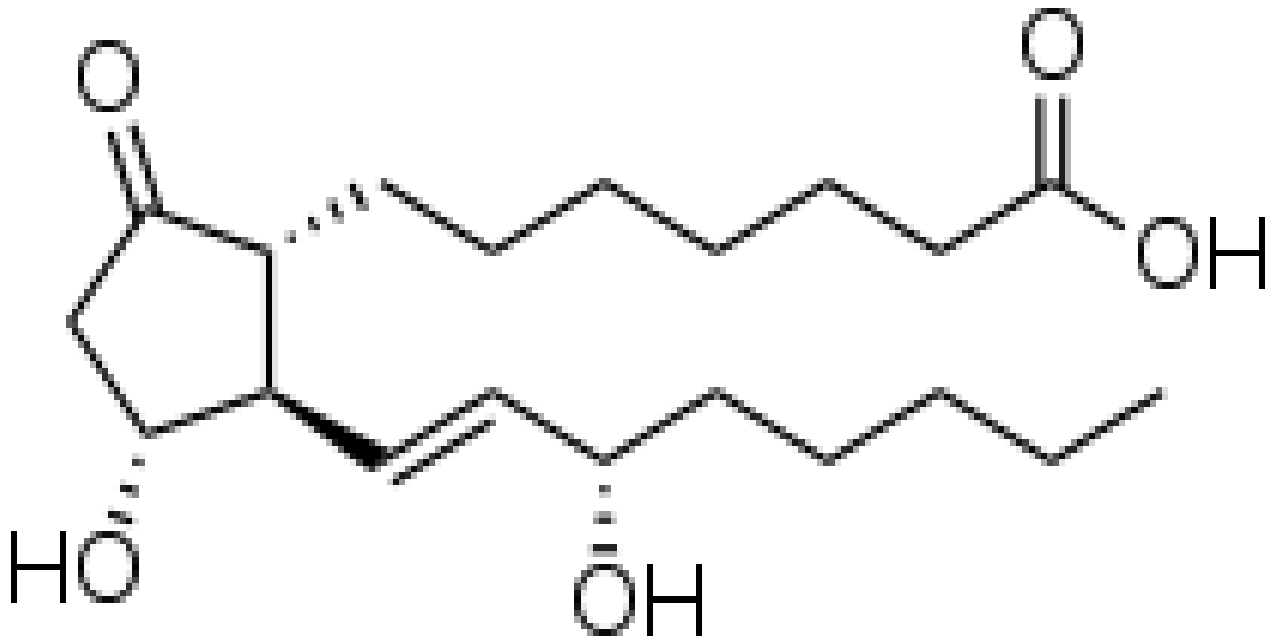
Some Omega-6 and Omega-3 Fatty Acids



Prostaglandins :

The name prostaglandin derived from the prostate gland. They have been found in almost every tissue in humans and other animals .

They are hormone- like compounds, differ from the true hormones in that , they are formed in almost all tissues, not in specialized glands.


O
O
OH
HO
OH

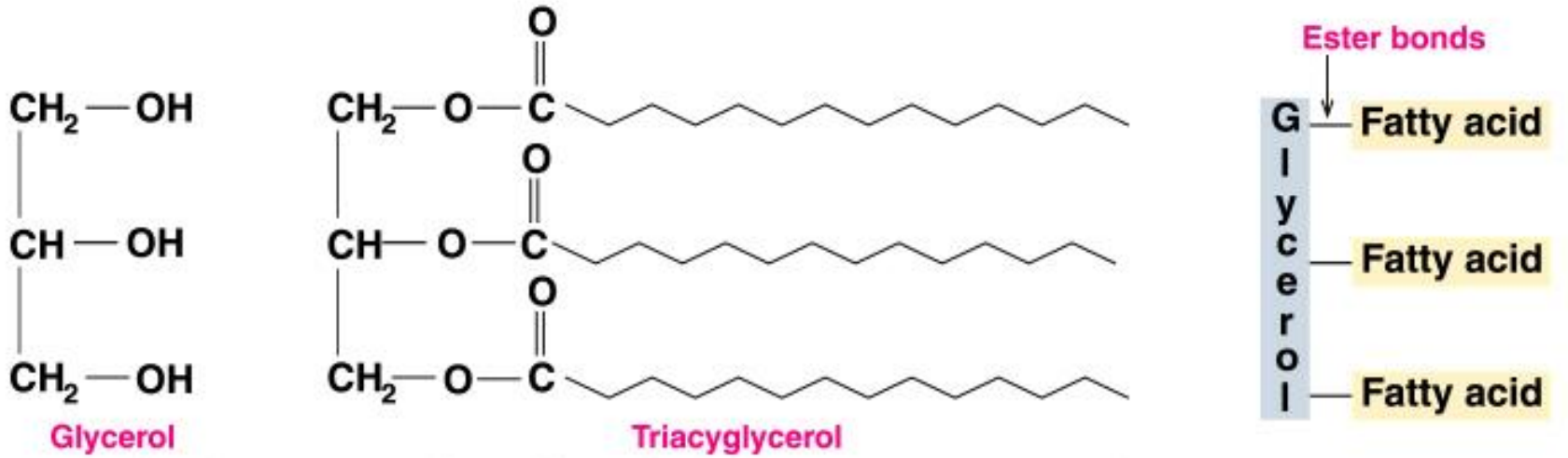
Prostaglandin functions:

- cause constriction or dilation in vascular smooth muscle cells
- cause aggregation or disaggregation of platelets
- sensitize spinal neurons to pain
- decrease intraocular pressure
- regulate inflammation
- regulate calcium movement
- regulate hormones
- control cell growth
- acts on thermoregulatory center of hypothalamus to produce fever
- acts on parietal cells in the stomach wall to inhibit acid secretion
- increase mucus production and bicarbonate secretion

Triacylglycerols

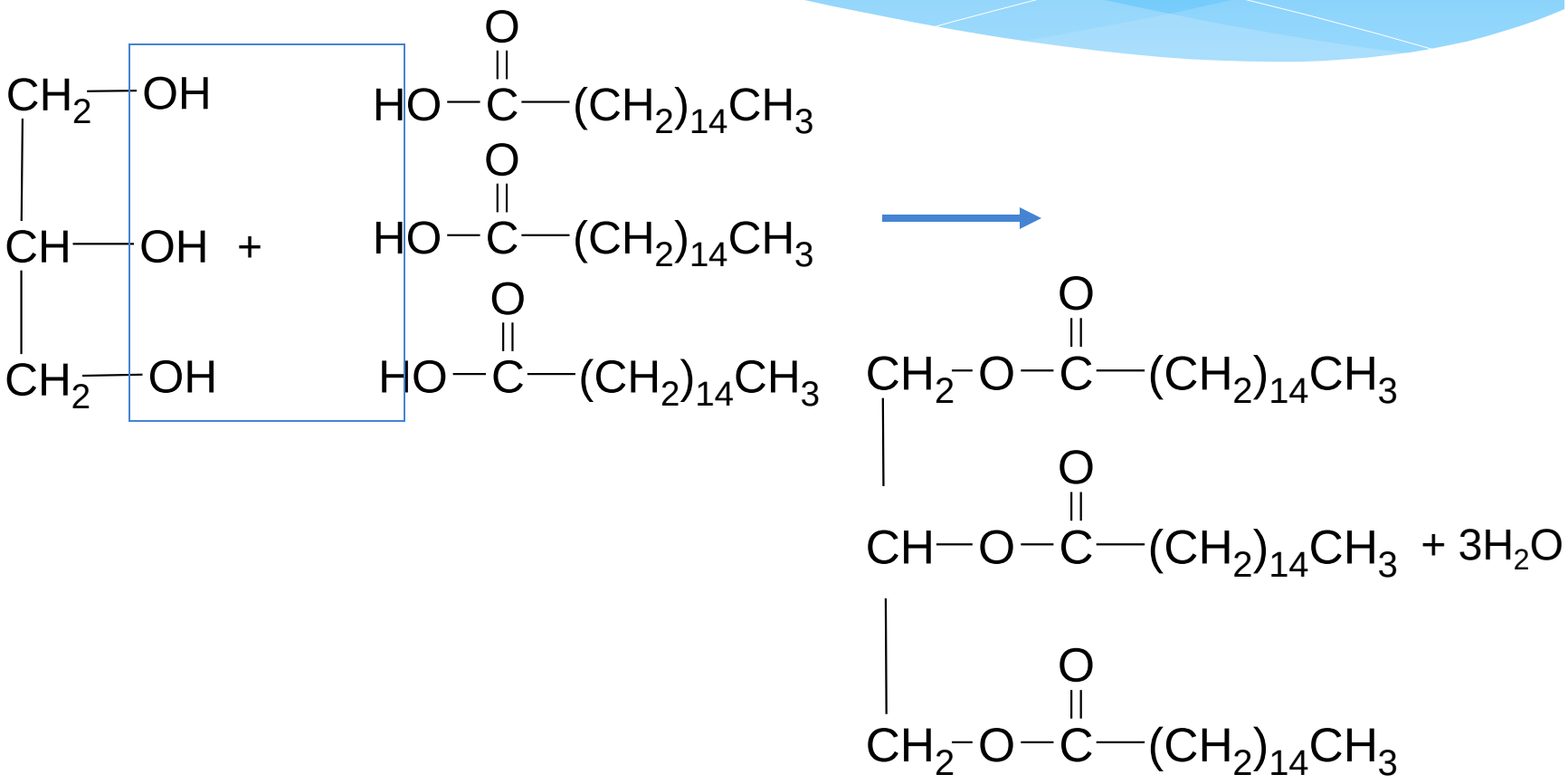
In a triacylglycerol,

Glycerol forms ester bonds with three fatty acids. *



Formation of a Triacylglycerol

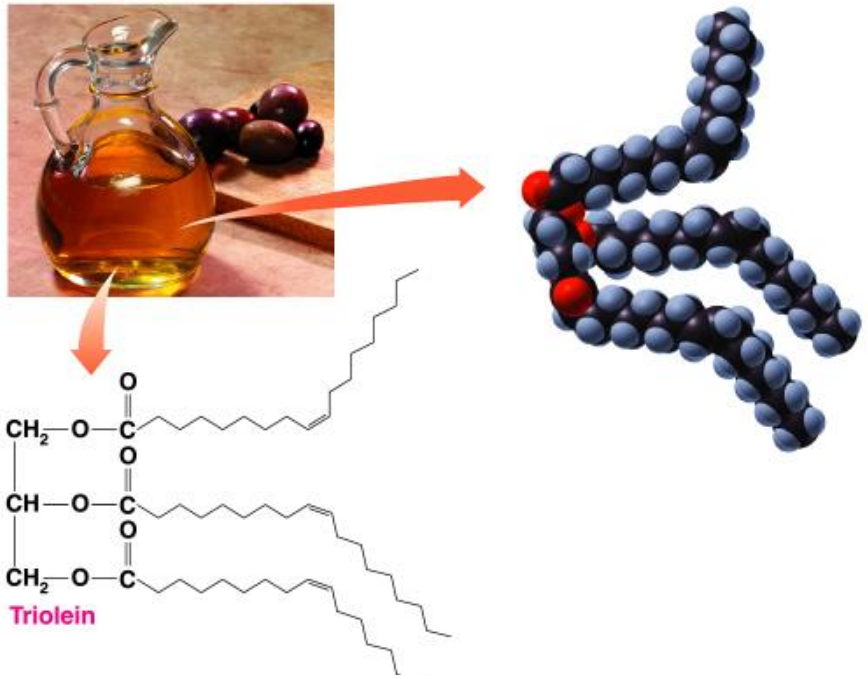
glycerol + three fatty acids → triacylglycerol



Olive Oil

Olive oil

* Contains a high percentage of oleic acid, which is a monounsaturated fatty acid with one cis double bond.



Melting Points of Fats and Oils

A triacylglycerol that is a fat

* Is solid at room temperature.
* Is prevalent in meats, whole milk, butter, and cheese.

A triacylglycerol that is an oil

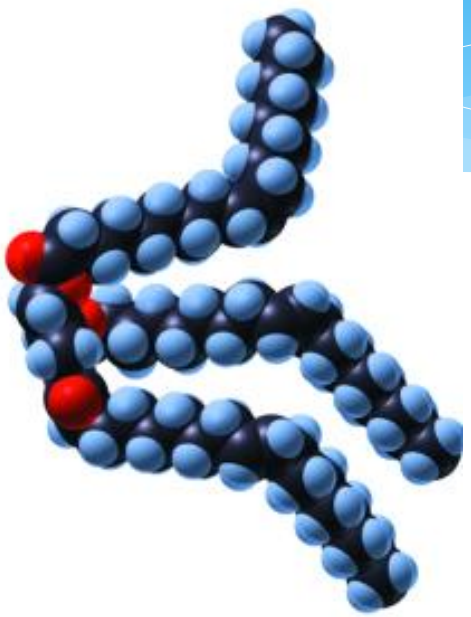
* Is liquid at room temperature.
* Is prevalent in plants such as olive and safflower.

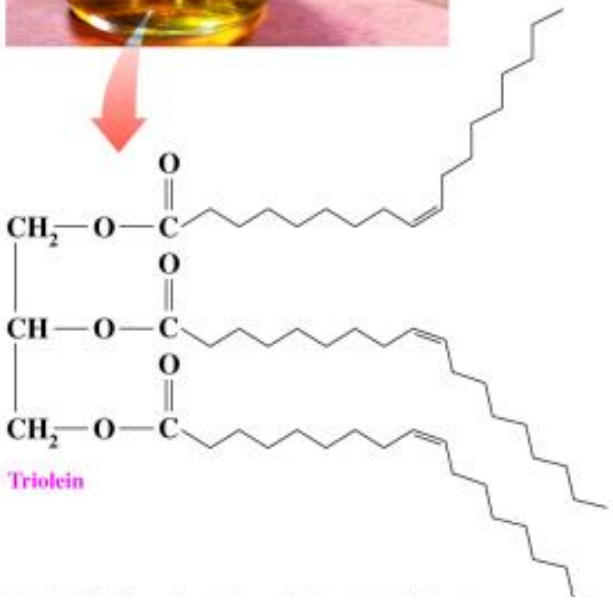
Oils with Unsaturated Fatty Acids

Oils

* Have more unsaturated fats.
* Have *cis* double bonds that cause "*kinks*" in the fatty acid chains.
* Cannot pack triacylglycerol molecules as close together as in fats.
* Have lower melting points than saturated fats.
* Are liquids at room temperature.

Diagram of Triacylglycerol with Unsaturated Fatty Acids



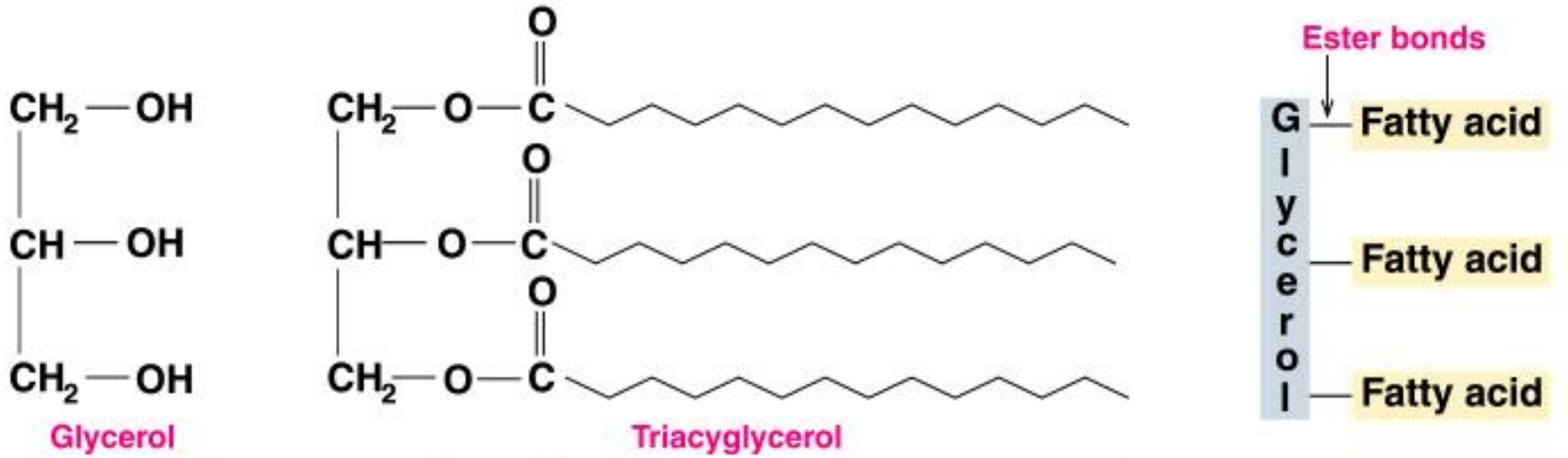


Unsaturated fatty acid chains have kinks that do not allow close packing.

Triacylglycerols

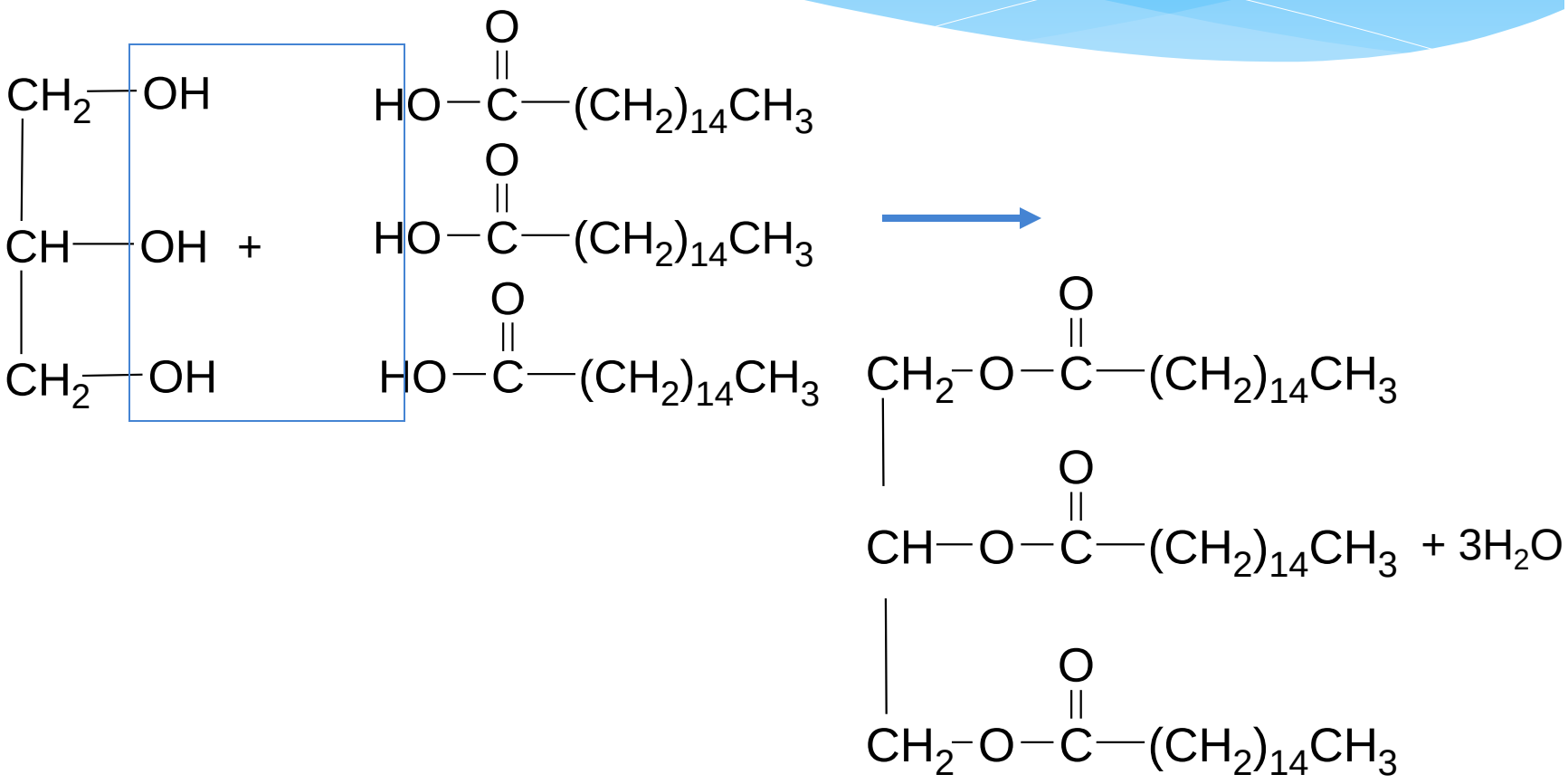
In a triacylglycerol,

Glycerol forms ester bonds with three fatty acids. *



Formation of a Triacylglycerol

glycerol + three fatty acids → triacylglycerol



Chemical Properties of Triacylglycerols

The chemical reactions of triacylglycerols are similar to those of alkenes and esters.

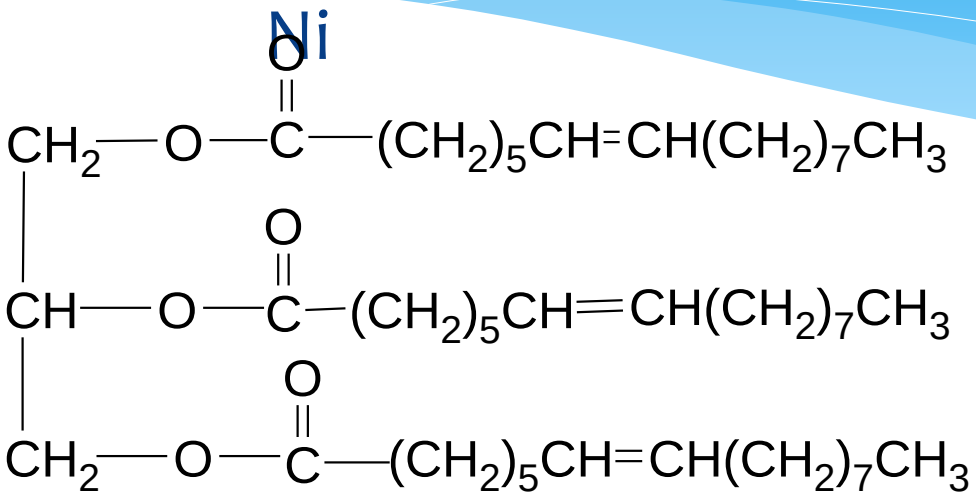
* In hydrogenation, double bonds in unsaturated fatty acids react with H_2 in the presence of a Ni or Pt catalyst.
* In hydrolysis, ester bonds are split by water in the presence of an acid, a base, or an enzyme.

Hydrogenation of Oils

The hydrogenation of oils

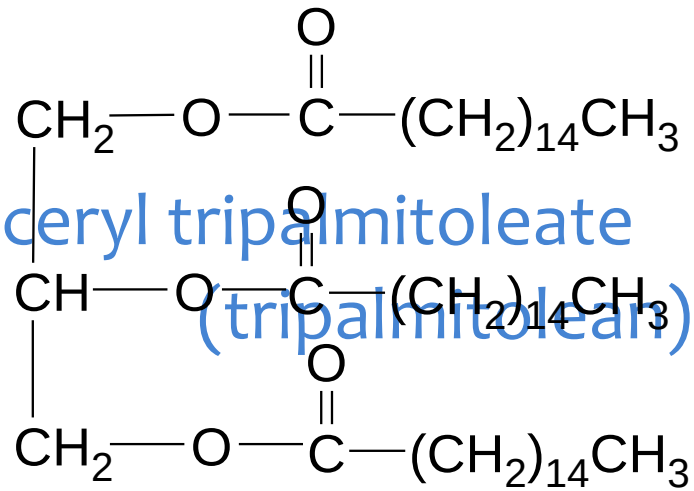
* Adds hydrogen (H_2) to the carbon atoms of double bonds.
* Converts double bonds to single bonds.
* Increases the melting point.
* Produces solids such as margarine and shortening.

Hydrogenation



glyceryl tripalmitate
(tripalmitin)

+ $3H_2$



glyceryl tripalmitoleate
(tripalmitolein)

2-Compound lipids:

They are lipids contain fatty acid ester with glycerol and other groups :

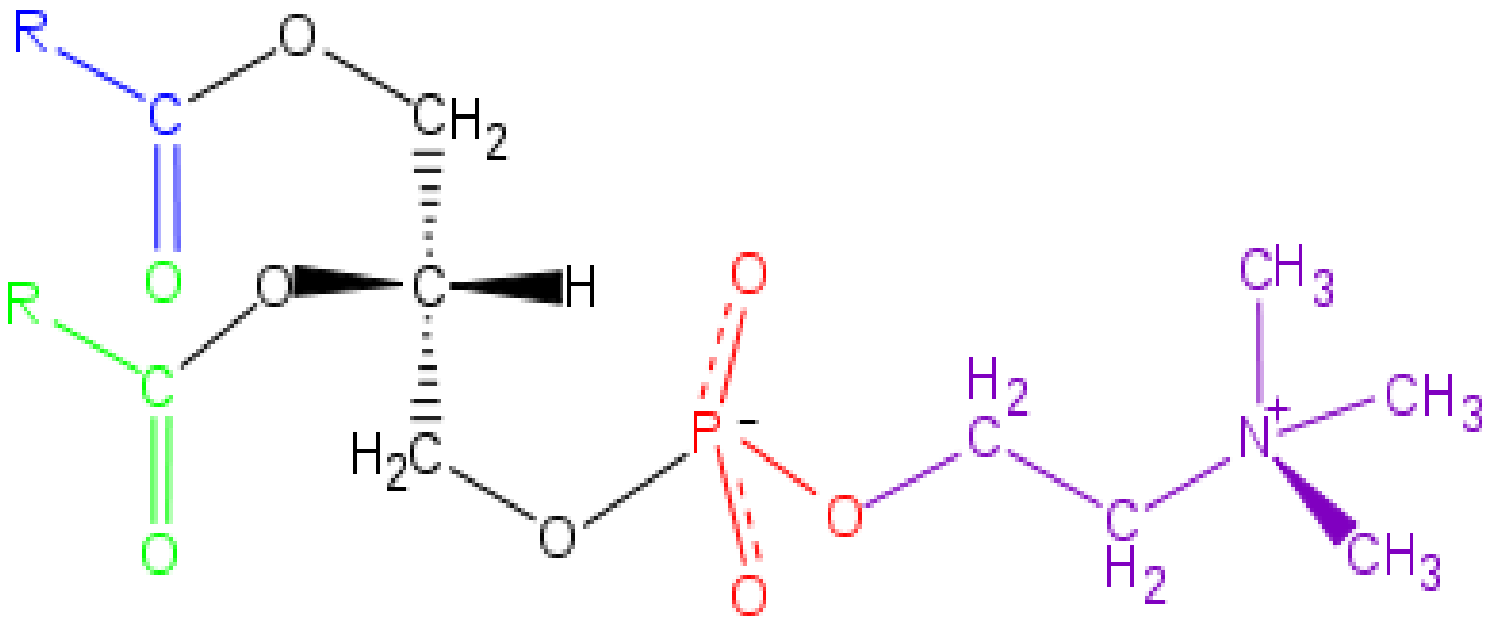
A-Phospholipids : consist of :

fatty acids + glycerol + phosphoric acid + nitrogen base. Present in every living cells , in seed an sprouts, in cell membrane , in mitochondria , in brain , and nervous tissues.

Lecithin: (phosphatidylcholine): **Lecithin is glycerophospholipid attract both water and fatty substances (and so are**

both hydrophilic and lipophilic), aid in

emulsification of lipid.


R
O
CH2
C
O
R
O
C
H
C
O
H2C
O
P
O
O
O
H2
C
C
H2
N+
CH3
CH3
CH3

Omega-6 and Omega 3- Fatty Acids

Fatty acids

- In vegetable oils are mostly omega-6 with the first C=C at C6.

  linoleic acid

  $CH_3—(CH_2)_4—CH=CH—CH_2—CH=CH—(CH_2)_7—COOH$

  6

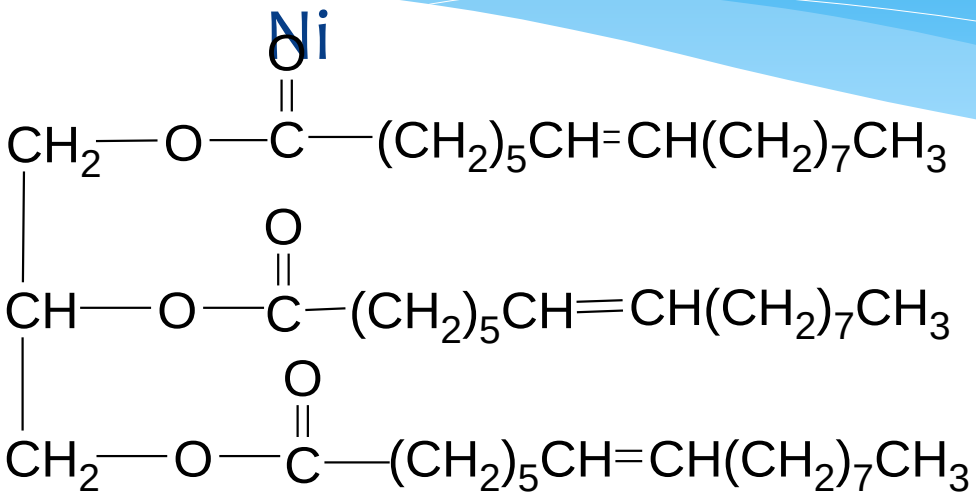
- In fish oils are mostly omega-3 with the first C=C at C3.

  linolenic acid

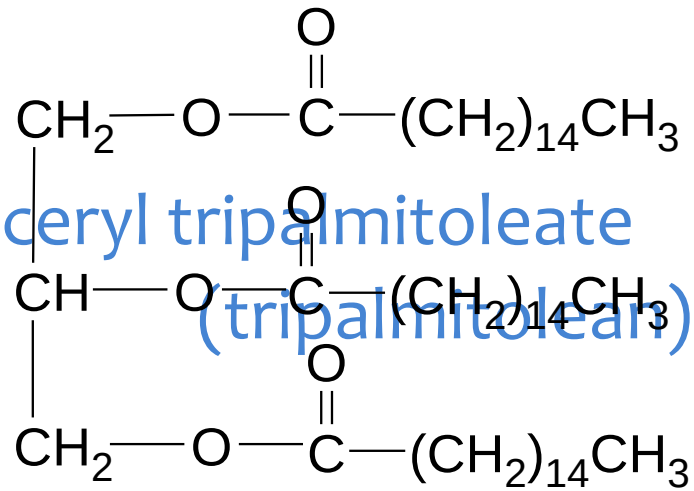
  $CH_3—CH_2—(CH=CH—CH_2)_3—(CH_2)_6—COOH$

  3

Hydrogenation



glyceryl tripalmitate
(tripalmitin)



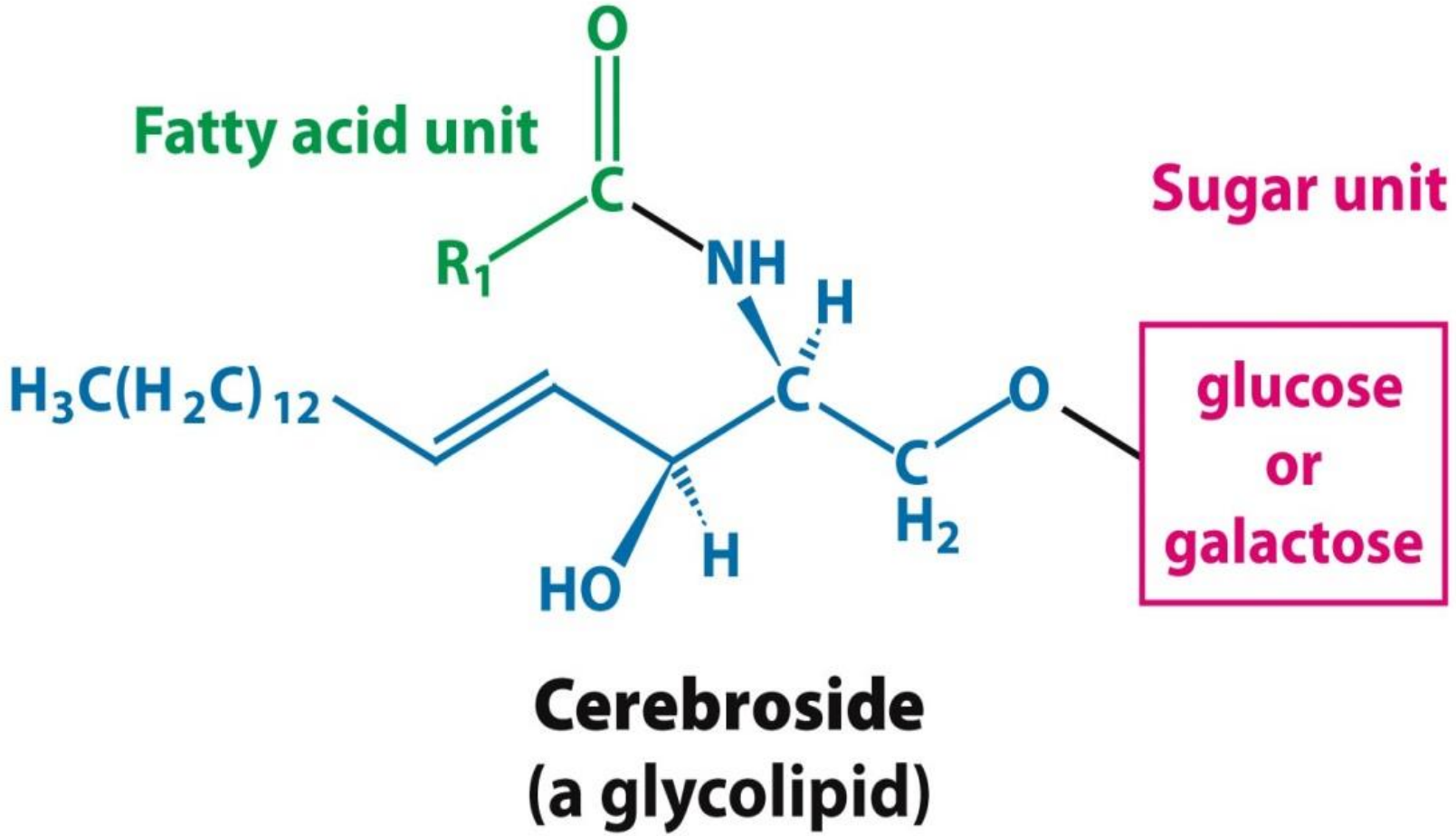
glyceryl tripalmitoleate
(tripalmitolein)

- **Glycolipids**: **Glycolipids are lipids with a carbohydrate attached by a glycosidic bond. Their role is to maintain the stability of the cell membrane and to facilitate cellular recognition,: The essential feature of a glycolipid is the presence of a monosaccharide or oligosaccharide bound to a lipid moiety. The most common lipids in cellular membranes are glycerolipids.**

glycolipids function is responses within the body is the interaction between leukocytes and endothelial cells during inflammation. The four main human blood types (A, B, AB, O) are determined by the oligosaccharide attached to a specific glycolipid on the surface of red blood cells, which acts as an antigen.

Cerebrosides : It is a compound lipids consist of fatty acid , sphingolalcohol , and glucose or galactose. The fundamental structure of a Cerebroside is ceramide, having a mono or polysaccharide bonded glycosidically to the terminal OH group of ceramide .

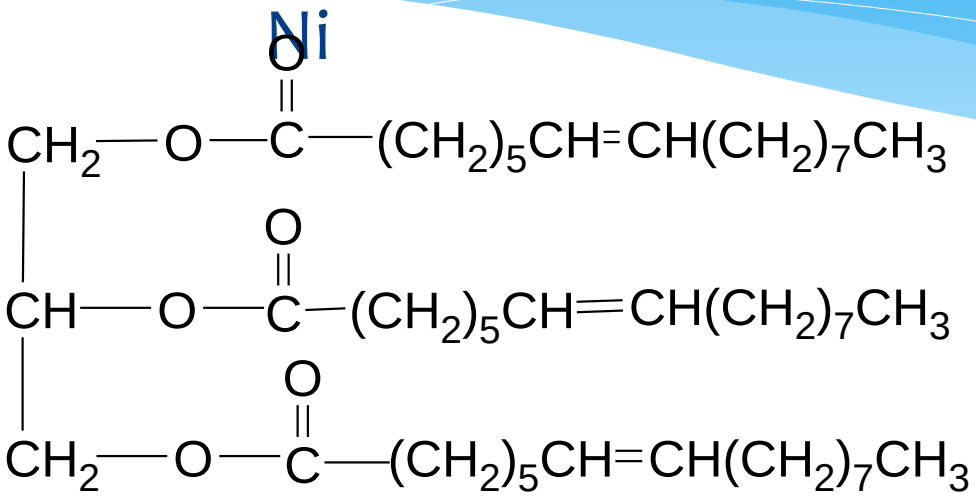
Galactosylceramide is the principal Glycosphingolipid in brain tissue. Galactosylceramides are present in all nervous tissues, and can compose up to 2% dry weight of grey matter and 12% of white matter.



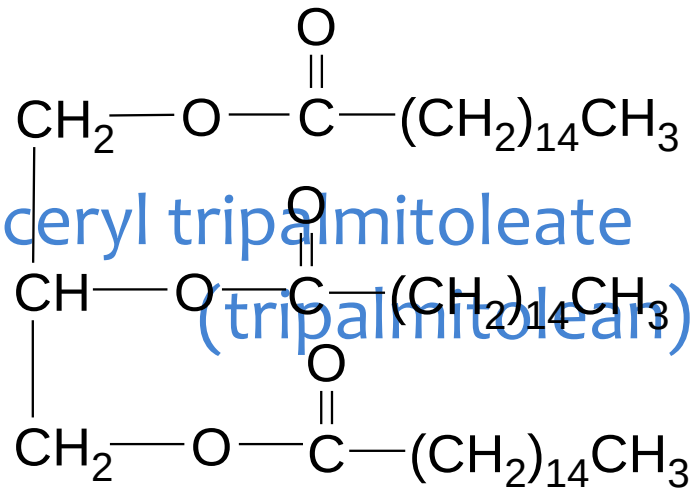
Cerebroside
(a glycolipid)

Unnumbered 12 p350a
***Biochemistry*, Seventh Edition**

Hydrogenation



glyceryl tripalmitate
(tripalmitin)



glyceryl tripalmitoleate
(tripalmitolein)

Lipoproteins

The role of lipoprotein particles is to transport triacylglycerols (triglycerides) and cholesterol in the blood between all the tissues of the body

Lipoproteins may be classified as follows, listed from larger and less dense to smaller and high denser. Lipoproteins are larger and less dense when the fat to protein ratio is increased.

- Chylomicrons carry triglycerides (fat) from the intestines to the liver, to skeletal muscle, and to adipose tissue.

- Very-low-density lipoproteins (VLDL) carry triglycerides from the liver to adipose tissue.

- Low-density lipoproteins (LDL) carry 3,000 to 6,000 fat molecules (phospholipids, cholesterol, triglycerides, etc.) around the body. LDL particles are sometimes referred to as "bad" lipoprotein because concentrations, dose related, correlate with atherosclerosis progression.

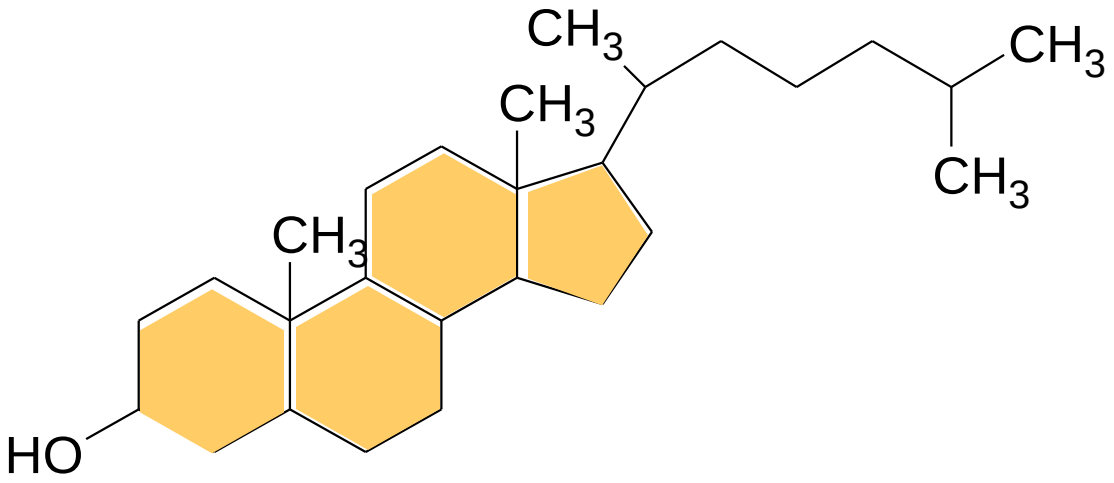
- High-density lipoproteins (HDL) collect fat molecules (phospholipids, cholesterol, triglycerides, etc.) from the body's cells/tissues, and take it back to the liver. HDLs are sometimes referred to as "good" lipoprotein because higher concentrations correlate with low rates of atherosclerosis progression and/or regression.

For young healthy research subjects, ~70 kg (154 lb.), this data represents averages across individuals studied:

Density (g/mL)	Class	Diameter (nm)	% protein	% cholesterol	% phospholipid	% triacylglycerol & cholesterol ester
>1.063	HDL	5–15	33	30	29	4
1.019–1.063	LDL	18–28	25	50	21	8
1.006–1.019	IDL	25–50	18	29	22	31
0.95–1.006	VLDL	30–80	10	22	18	50
<0.95	Chylomicrons	100-1000	<2	8	7	84

3- Derived lipids:

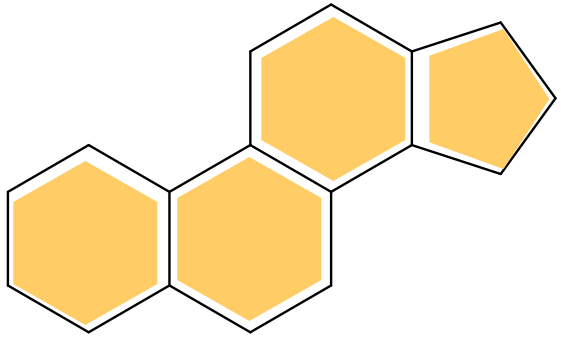
Steroids: Cholesterol, Bile Salts, and Steroid Hormones



Steroid Nucleus

A steroid nucleus consists of

* 3 cyclohexane rings.
* 1 cyclopentane ring.
* No fatty acids.

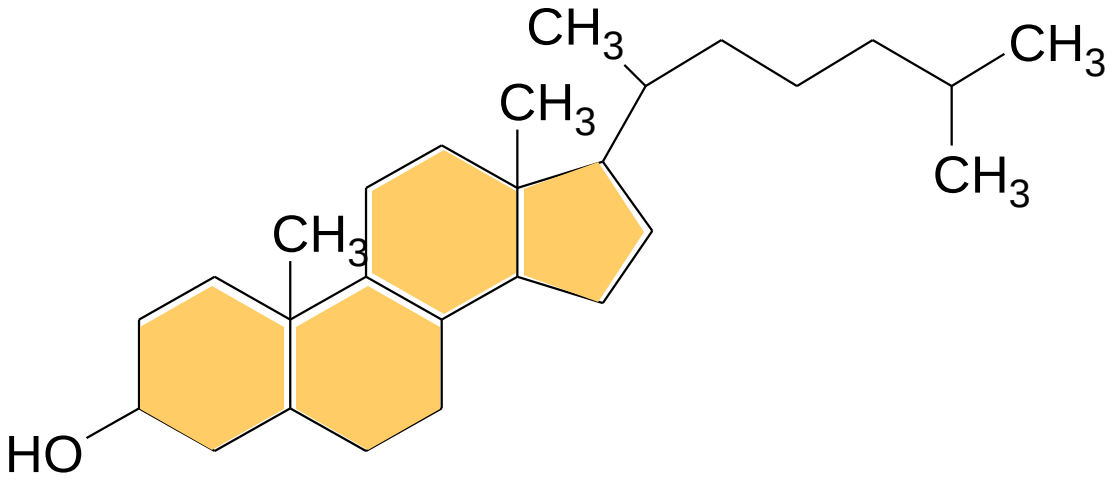


steroid nucleus

Cholesterol

Cholesterol

* Is the most abundant steroid in the body.
* Has methyl CH_3- groups, alkyl chain, and -OH attached to the steroid nucleus.

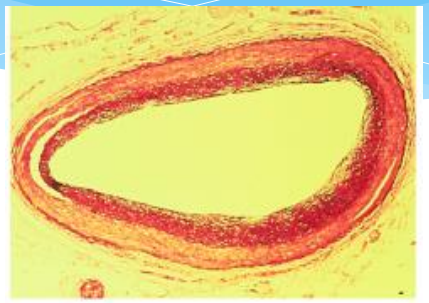


Cholesterol in the Body

Cholesterol in the body

* Is obtained from meats, milk, and eggs.
* Is synthesized in the liver.
* Is needed for cell membranes, brain and nerve tissue, steroid hormones, and Vitamin D.
* Clogs arteries when high levels form plaque.

A normal, open artery.



An artery clogged by cholesterol plaque

Cholesterol in Foods

Cholesterol is

* Synthesized in the liver.
* Obtained from foods.
* Considered elevated if plasma cholesterol exceeds 200 mg/dL.

TABLE 17.4 **Cholesterol Content of Some Foods**

Food	Serving Size	Cholesterol (mg)
Liver (beef)	3 oz	370
Egg	1	250
Lobster	3 oz	175
Fried chicken	3½ oz	130
Hamburger	3 oz	85
Chicken (no skin)	3 oz	75
Fish (salmon)	3 oz	40
Butter	1 tablespoon	30
Whole milk	1 cup	35
Skim milk	1 cup	5
Margarine	1 tablespoon	0

Learning Check

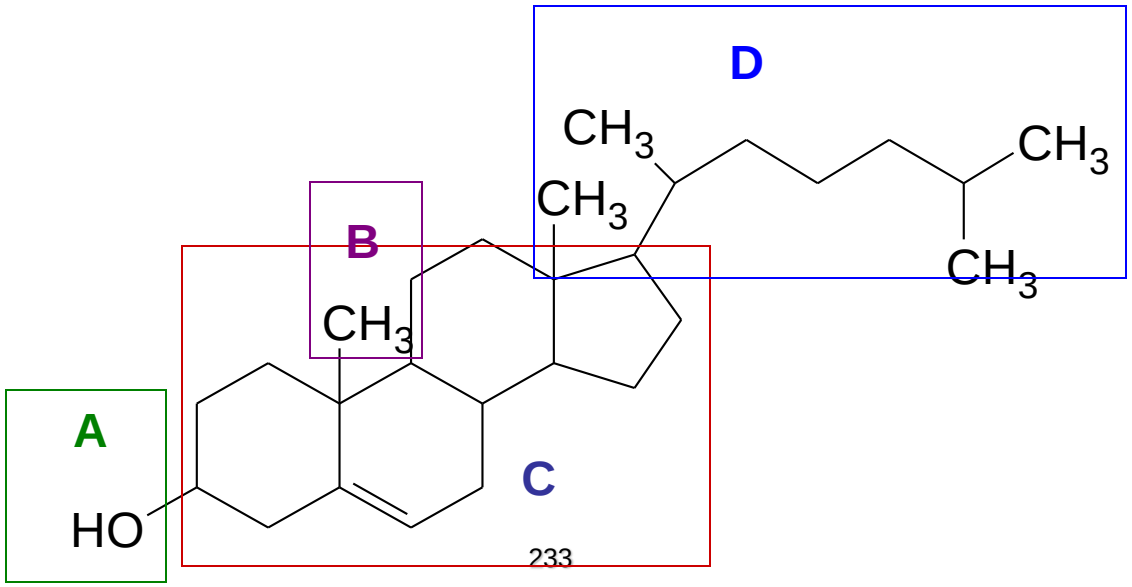
Match the components of the cholesterol molecule with the following:

___hydroxyl group

___methyl group

___ carbon chain

___ steroid nucleus



Solution

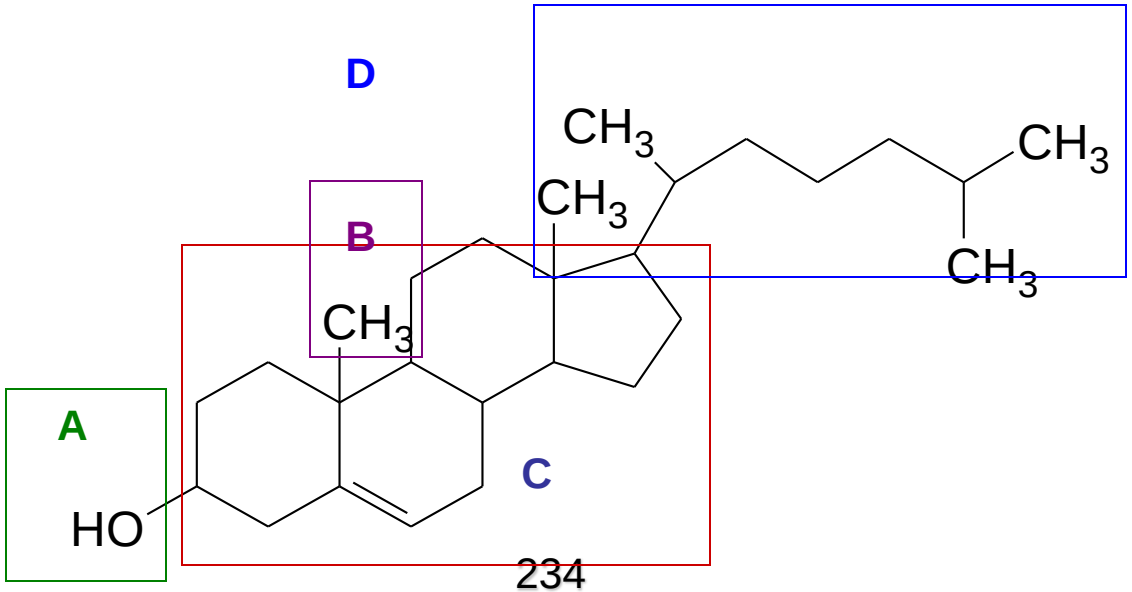
Match the components of the cholesterol molecule with the following:

A hydroxyl group

B methyl group

C steroid nucleus

D carbon chain



Learning Check

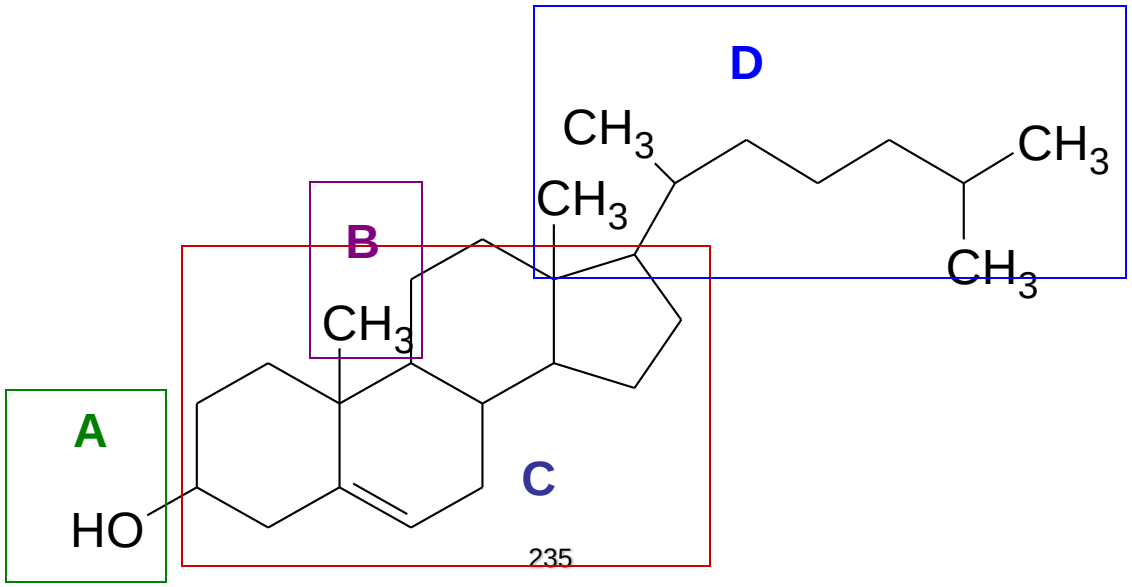
Match the components of the cholesterol molecule with the following:

___hydroxyl group

___methyl group

___ carbon chain

___ steroid nucleus



Bile Salts

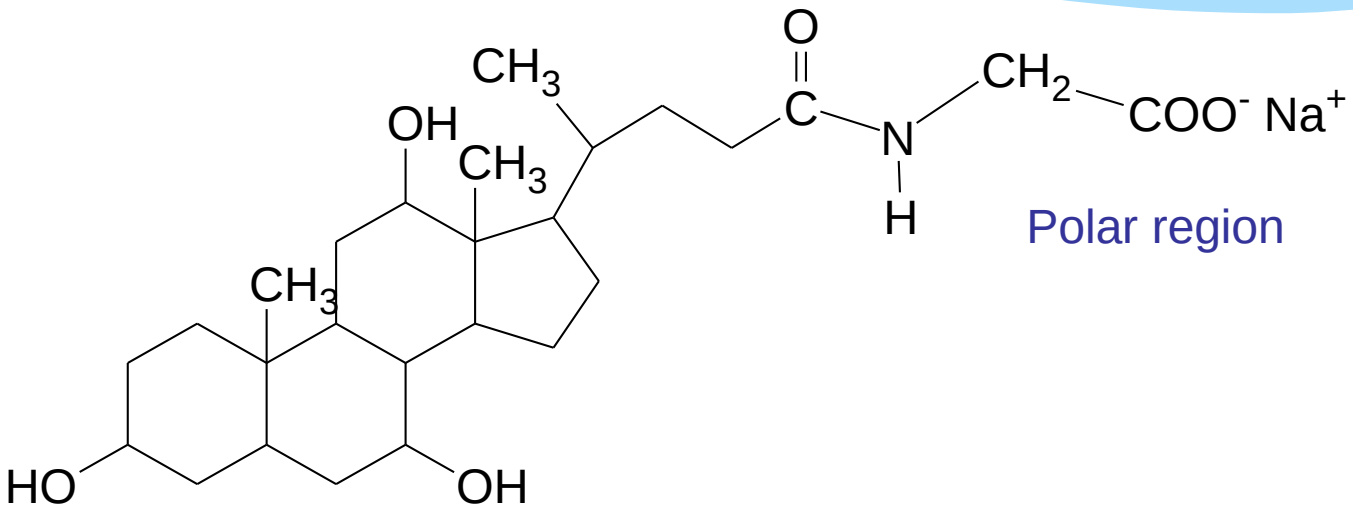
Bile salts

* Are synthesized in the liver from cholesterol.
* Are stored in the gallbladder.
* Are secreted into the small intestine.
* Have a polar and a nonpolar region
* Mix with fats to break them part.
* Emulsify fat particles to provide large surface

Bile Salts

cholic acid, a bile acid

glycine, an amino acid



Polar region

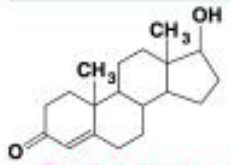
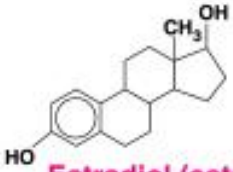
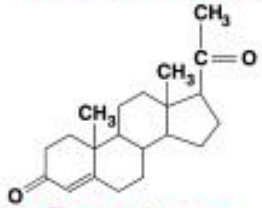
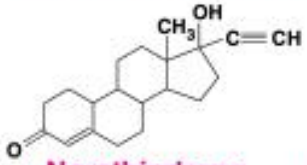
Nonpolar region

sodium glycocholate, a bile salt

Steroid Hormones

Steroid hormones

* Are chemical messengers in cells.
* Are produced from cholesterol.
* Include sex hormones such as androgens (testosterone) in males and estrogens (estradiol) in females.

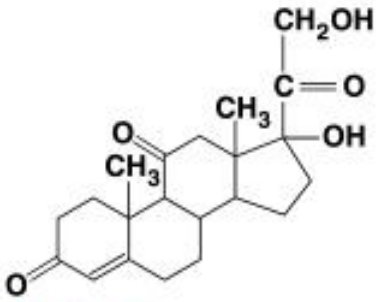
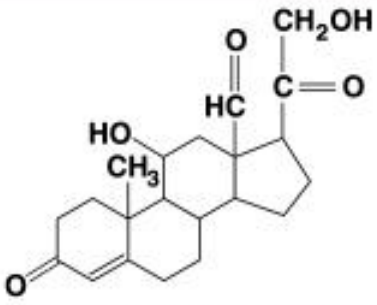
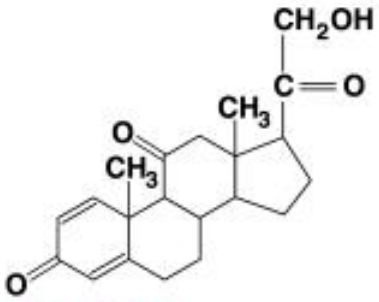
Hormone	Biological Effects
 Testosterone (androgen) (produced in testes)	Development of male organs; male sexual characteristics including muscles and facial hair; sperm formation
 Estradiol (estrogen) (produced in ovaries)	Development of female sexual characteristics; ovulation
 Progesterone (produced in ovaries)	Prepares uterus for fertilized egg
 Norethindrone (synthetic progestin)	Contraceptive (birth control) pill

Adrenal Corticosteroids

Adrenal corticosteroids are steroid hormones that

* Are produced by the adrenal glands located on the top of each kidney.
* Include *aldosterone*, which regulates electrolytes and water balance by the kidneys.
* Include *cortisone*, a glucocorticoid, which increases blood glucose level and stimulates the synthesis of glycogen in the liver.

Adrenal Corticosteroids

Corticosteroids			
			
	Cortisone (produced in adrenal gland)	Aldosterone (mineralocorticoid) (produced in adrenal gland)	Prednisone (synthetic corticoid)
Biological Effects			
	Increases the blood glucose and glycogen levels from fatty acids and amino acids	Increases the reabsorption of Na^+ in kidneys; retention of water	Reduces inflammation; treatment of asthma and rheumatoid arthritis

Learning Check

Identify each as a

3. triacylglycerol 2. steroid 1. fatty acid

5. sphingolipid 4. phospholipid

A. cholesterol

B. glycerol, 2 fatty acids, phosphate, and choline

C. glyceryl tristearate

D. sphingosine, fatty acid, phosphate, and choline

E. estradiol

F. bile salts

G. lipids in plasma membranes

Solution

2 steroid cholesterol A.

glycerol, 2 fatty acids, phosphate, and choline B.

4 phospholipid

3 triacylglycerol glyceryl tristearate C.

sphingosine, fatty acid, phosphate, and choline D.

5 sphingolipid

estradiol 2 steroid E.

bile salts 2 steroid F.

lipids in plasma membranes G.

4 phospholipid, 5 sphingolipid

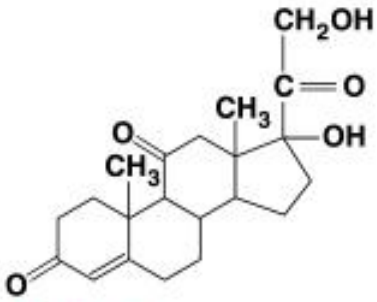
Adrenal Corticosteroids

Adrenal corticosteroids are steroid hormones that

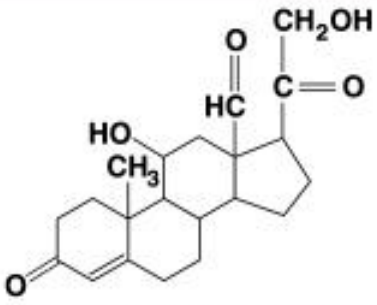
* Are produced by the adrenal glands located on the top of each kidney.
* Include *aldosterone*, which regulates electrolytes and water balance by the kidneys.
* Include *cortisone*, a glucocorticoid, which increases blood glucose level and stimulates the synthesis of glycogen in the liver.

Adrenal Corticosteroids

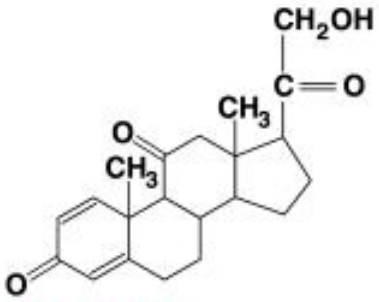
Corticosteroids



Cortisone
(produced in adrenal gland)



Aldosterone (mineralocorticoid)
(produced in adrenal gland)



Prednisone
(synthetic corticoid)

Biological Effects

Increases the blood glucose and glycogen levels from fatty acids and amino acids	Increases the reabsorption of Na^+ in kidneys; retention of water	Reduces inflammation; treatment of asthma and rheumatoid arthritis

Learning Check

Identify each as a

3. triacylglycerol 2. steroid 1. fatty acid

5. sphingolipid 4. phospholipid

A. cholesterol

B. glycerol, 2 fatty acids, phosphate, and choline

C. glyceryl tristearate

D. sphingosine, fatty acid, phosphate, and choline

E. estradiol

F. bile salts

G. lipids in plasma membranes

Solution

2 steroid cholesterol A.

glycerol, 2 fatty acids, phosphate, and choline B.

4 phospholipid

3 triacylglycerol glyceryl tristearate C.

sphingosine, fatty acid, phosphate, and choline D.

5 sphingolipid

estradiol 2 steroid E.

bile salts 2 steroid F.

lipids in plasma membranes G.

4 phospholipid, 5 sphingolipid

Learning Check

Assign the melting points of –17°C, 13°C, and 69°C to the correct fatty acid. Explain.

saturated	stearic acid (18 C)
one double bond	oleic acid (18 C)
two double bonds	linoleic acid (18 C)

Solution

Stearic acid is saturated and would have a higher melting point than the unsaturated fatty acids. Because linoleic has two double bonds, it would have a lower mp than oleic acid, which has one double bond.

stearic acid mp 69°C saturated

oleic acid mp 13°C

linoleic acid mp -17°C most unsaturated

Learning Check

Write a fatty acid with 10 carbon atoms that is:

A. saturated

B. monounsaturated omega-3

C. monounsaturated omega-6

Adrenal Corticosteroids

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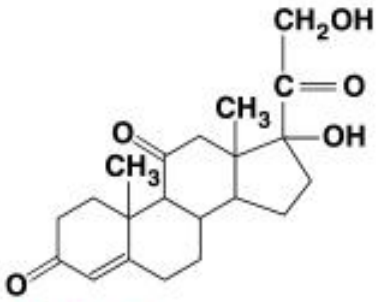
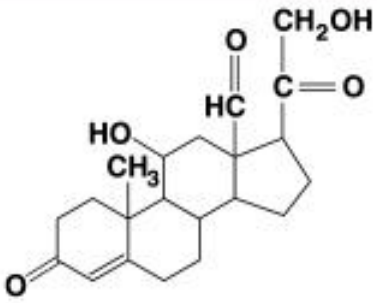
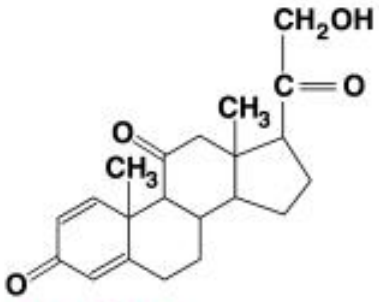
Adrenal Corticosteroids

Corticosteroids			
			
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Biological Effects			
	Increases the blood glucose and glycogen levels from fatty acids and amino acids	Increases the reabsorption of Na^+ in kidneys; retention of water	Reduces inflammation; treatment of asthma and rheumatoid arthritis

Learning Check

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3. triacylglycerol 2. steroid 1. fatty acid

5. sphingolipid 4. phospholipid

A. cholesterol

B. glycerol, 2 fatty acids, phosphate, and choline

C. glyceryl tristearate

D. sphingosine, fatty acid, phosphate, and choline

E. estradiol

F. bile salts

G. lipids in plasma membranes

Solution

2 steroid cholesterol A.

glycerol, 2 fatty acids, phosphate, and choline B.

4 phospholipid

3 triacylglycerol glyceryl tristearate C.

sphingosine, fatty acid, phosphate, and choline D.

5 sphingolipid

estradiol 2 steroid E.

bile salts 2 steroid F.

lipids in plasma membranes G.

4 phospholipid, 5 sphingolipid

Learning Check

Assign the melting points of –17°C, 13°C, and 69°C to the correct fatty acid. Explain.

saturated	stearic acid (18 C)
one double bond	oleic acid (18 C)
two double bonds	linoleic acid (18 C)

Solution

Stearic acid is saturated and would have a higher melting point than the unsaturated fatty acids. Because linoleic has two double bonds, it would have a lower mp than oleic acid, which has one double bond.

stearic acid mp 69°C saturated

oleic acid mp 13°C

linoleic acid mp -17°C most unsaturated

Learning Check

Write a fatty acid with 10 carbon atoms that is:

A. saturated

B. monounsaturated omega-3

C. monounsaturated omega-6

Solution

What product(s) is obtained from the complete hydrogenation of glyceryl trioleate?

2. Glyceryltristearate

Learning Check

(1) True or (2) False

A. There are more unsaturated fats in vegetable oils.

B. Vegetable oils have higher melting points than fats.

C. Hydrogenation of oils converts some *cis*-double bonds *to trans*- double bonds.

D. Animal fats have more saturated fats.

Solution

(1) True or (2) False

A. **T** There are more unsaturated fats in vegetable oils.

B. **F** Vegetable oils have higher melting points than fats.

C. **T** Hydrogenation of oils converts some *cis*- double

bonds *to trans*- double bonds.

D. **T** Animal fats have more saturated fats.

Solution

(1) True or (2) False

A. **T** There are more unsaturated fats in vegetable oils.

B. **F** Vegetable oils have higher melting points than fats.

C. **T** Hydrogenation of oils converts some *cis*- double

bonds *to trans*- double bonds.

D. **T** Animal fats have more saturated fats.

Learning Check

Identify each as a

B. triacylglycerol

A. fatty acid

D. glycerophospholipid

C. amino alcohol

1. glyceryl trioleate
2. cephalin
3. choline
4. palmitic acid

Solution

Identify each as a

B. triacylglycerol A. fatty acid

D. glycerophospholipid C. amino alcohol

B. triacylglycerol 1. glyceryl trioleate

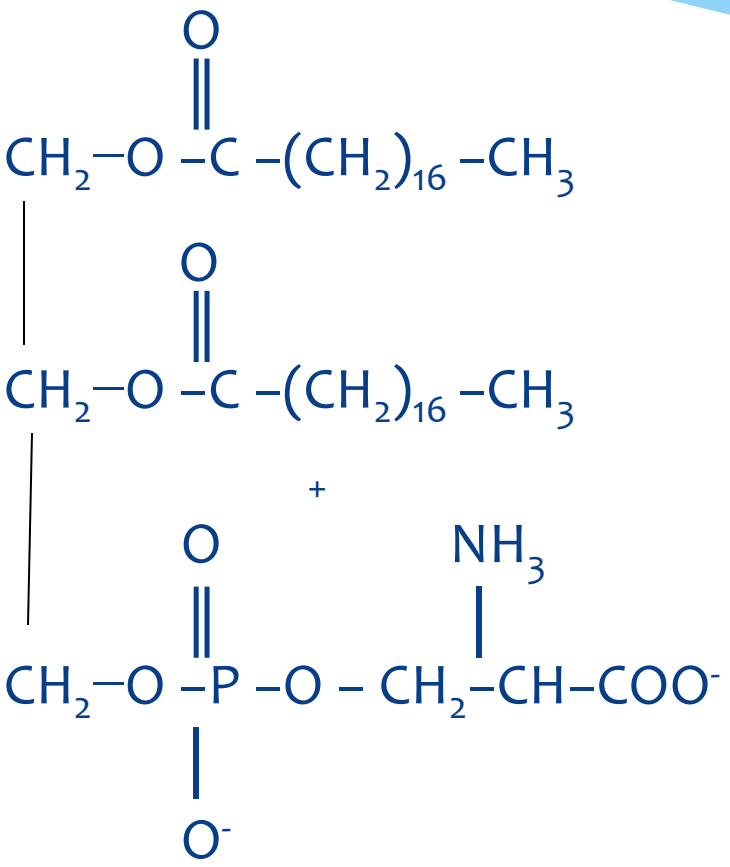
D. glycerophospholipid 2. cephalin

C. amino alcohol 3. choline

A. fatty acid 4. palmetic acid

Learning Check

Identify the components and type of glycerophospholipid



Solution

Identify each as a

B. triacylglycerol A. fatty acid

D. glycerophospholipid C. amino alcohol

B. triacylglycerol 1. glyceryl trioleate

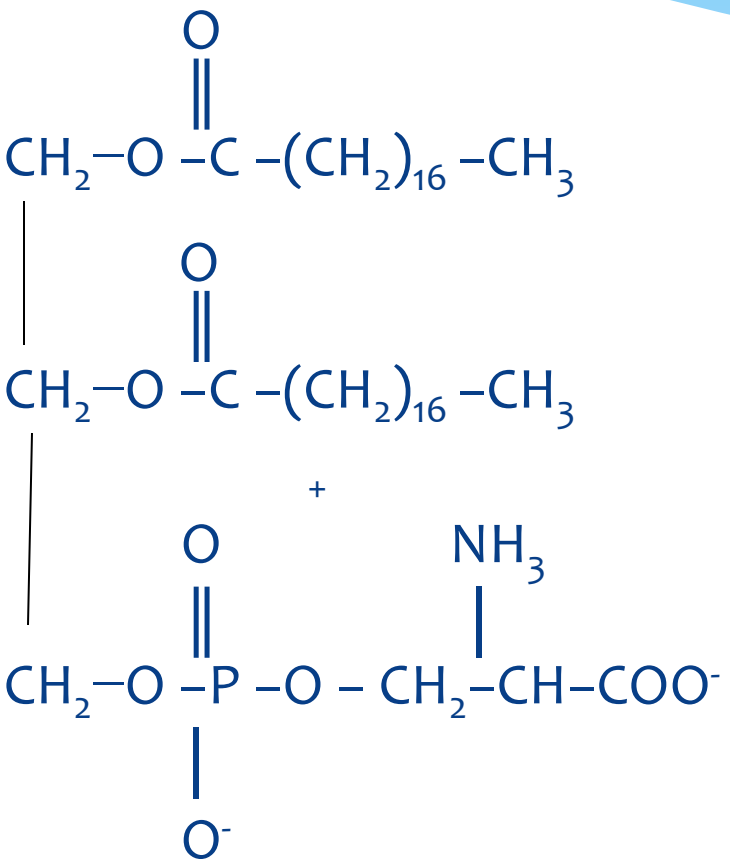
D. glycerophospholipid 2. cephalin

C. amino alcohol 3. choline

A. fatty acid 4. palmetic acid

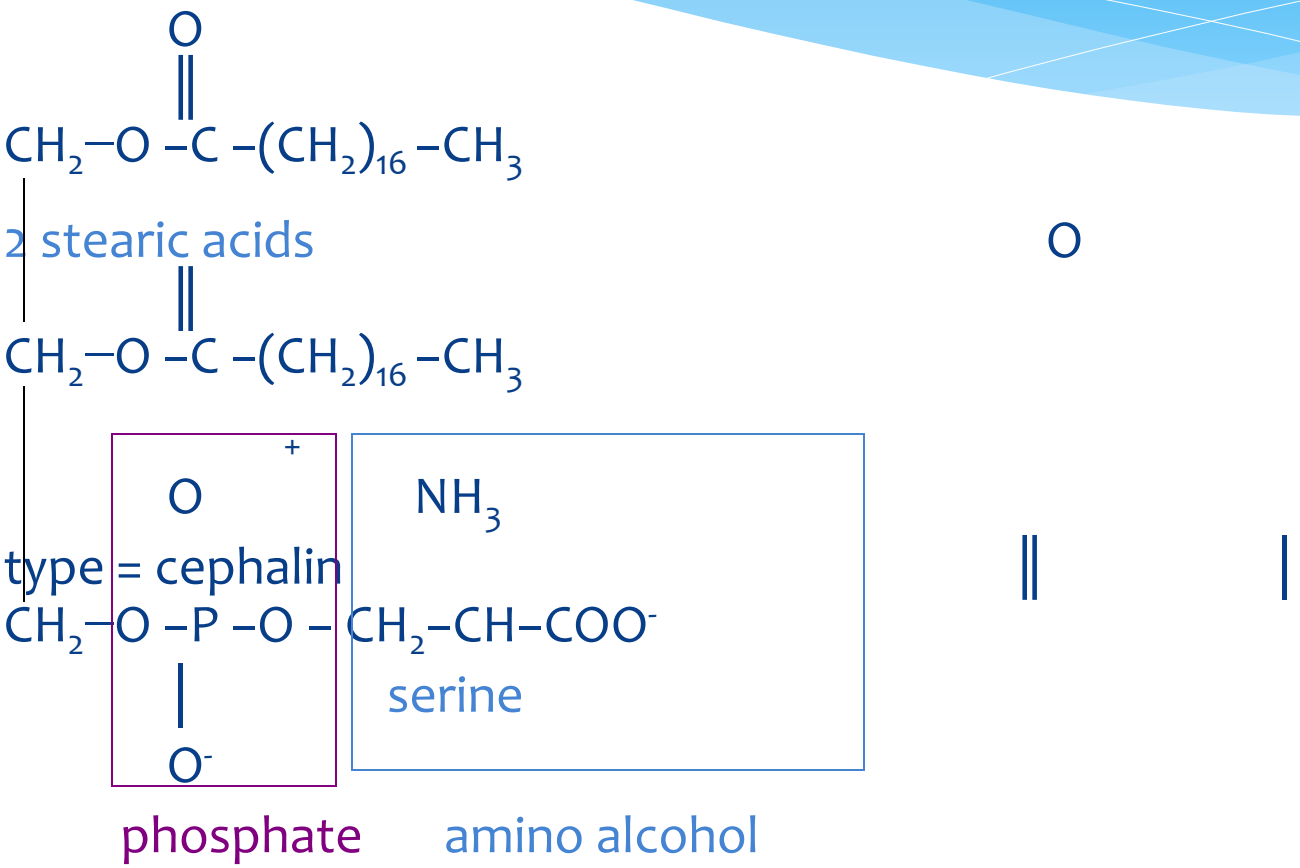
Learning Check

Identify the components and type of glycerophospholipid



Solution

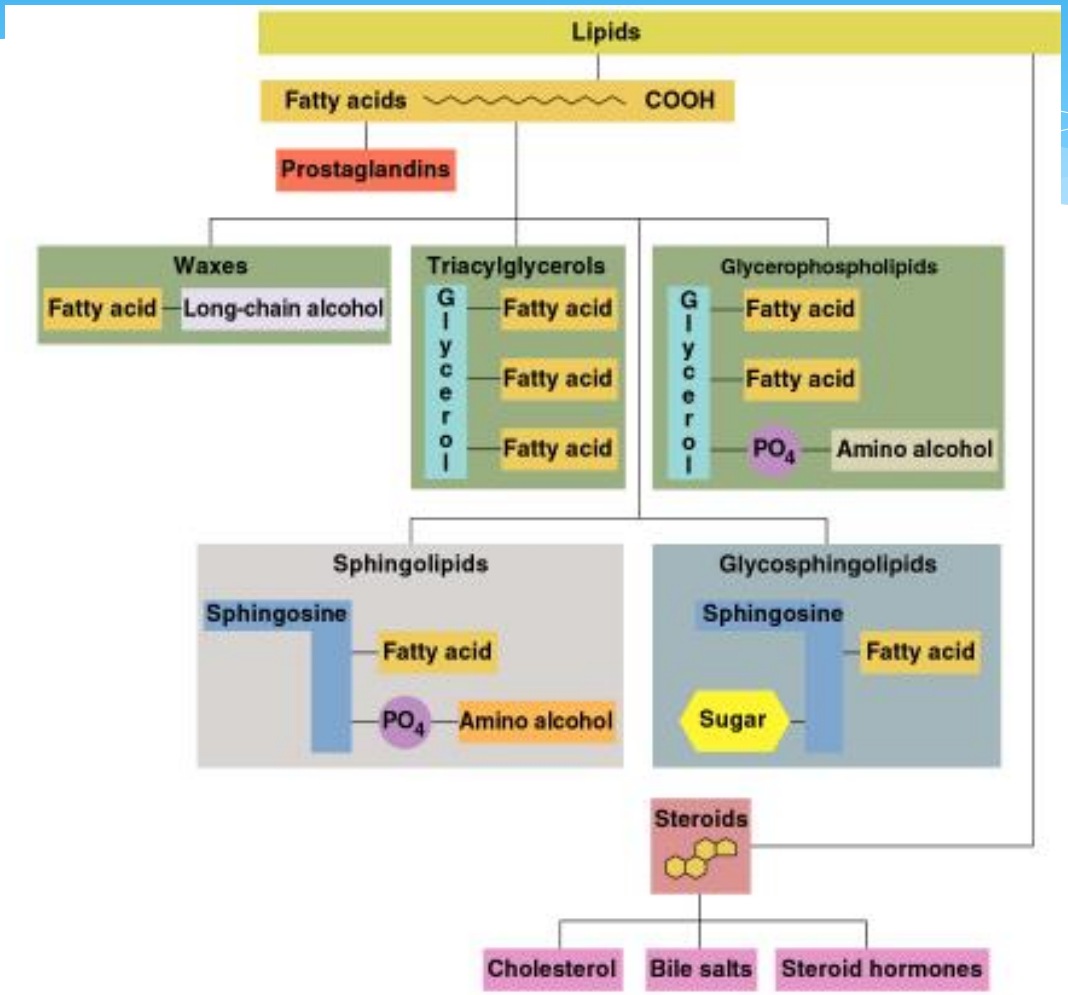
Identify the components and type of glycerophospholipid



Digestion of lipid

Lipo proteins

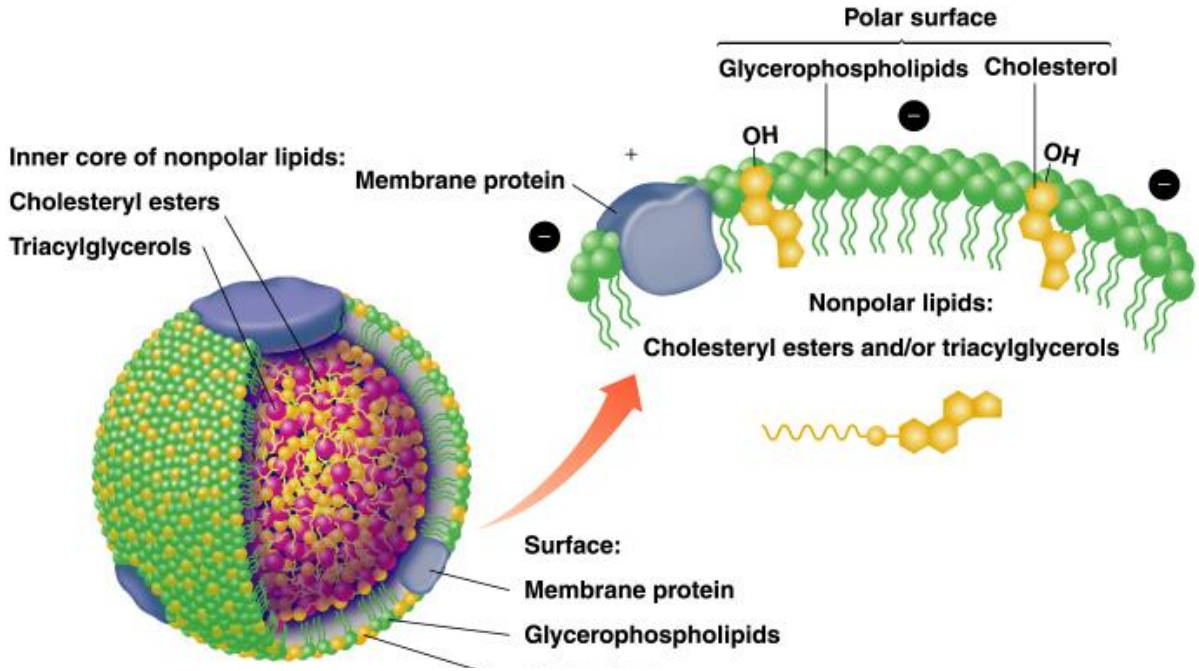
Structures of Lipids



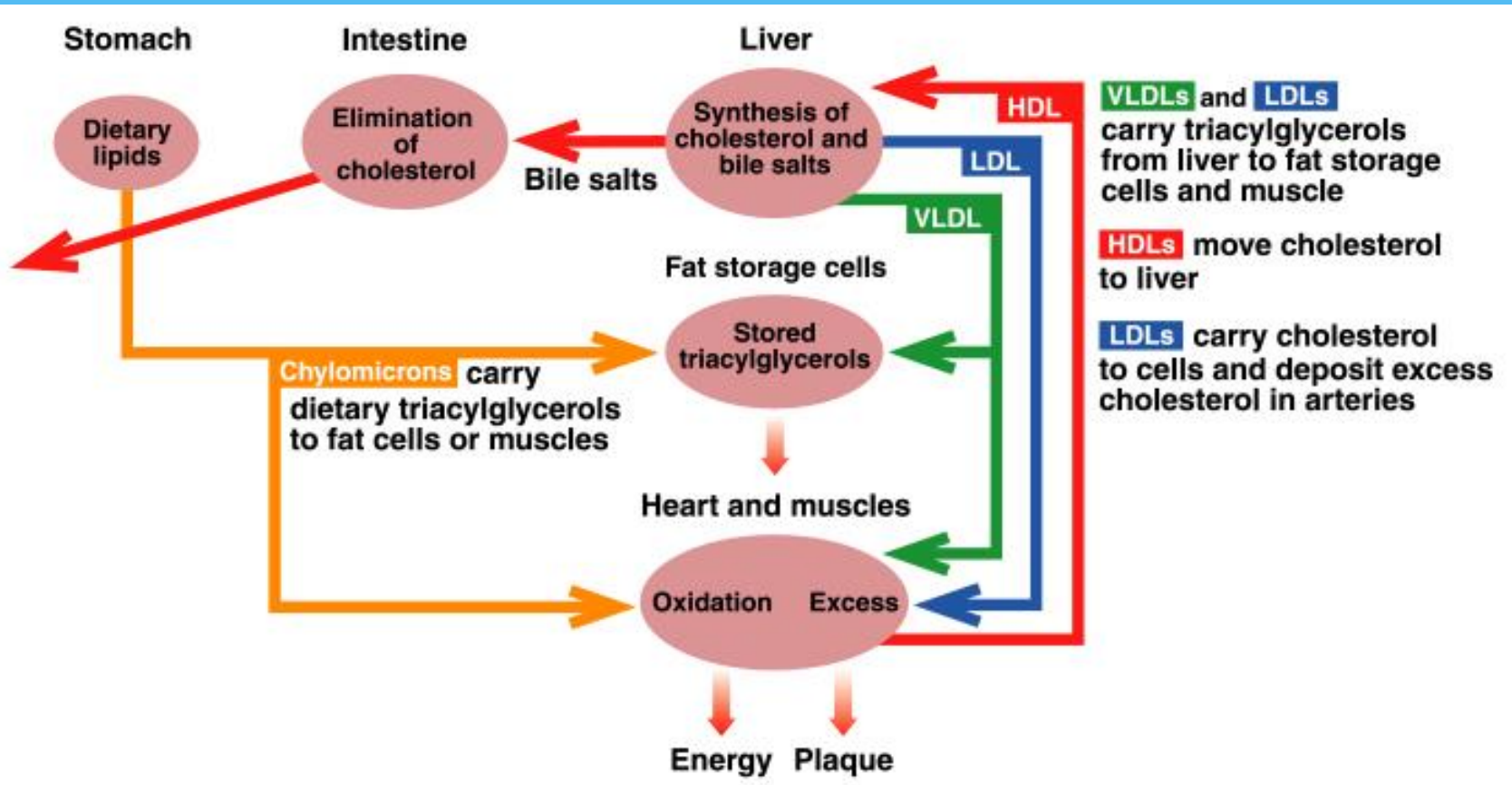
Lipoproteins

Lipoproteins

* Combine lipids with proteins and phospholipids.
* Are soluble in water because the surface consists of polar lipids.



Transport of Lipoproteins in the Body



LDL	
Acceptable:	100 mg/dL or lower
Borderline:	130 to 159 mg/dL
High:	160 mg/dL or higher

Reference

1-Marks' Basic Medical Biochemistry: A Clinical Approach 5th Edition, by Michael Lieberman (Author), Alisa Peet MD.

2-Marks' Basic Medical Biochemistry: A Clinical Approach Sixth, North American Edition, by Michael A. Lieberman PhD (Author), Alisa Peet MD .

3-Textbook of Biochemistry with Clinical Correlations 7th Edition, by Thomas M. Devlin

References

4-BRS Biochemistry, Molecular Biology, and Genetics (Board Review Nutrition in Clinical Practice Fourth Edition, by Michael A. Lieberman PhD ,Dr. Rick Ricer MD , by David Katz ,Ming-Chin Yeh ,Joshua Levitt , Kofi D Essel , & 2 more.

5-Lippincott Illustrated Reviews: Biochemistry (Lippincott Illustrated Reviews Series) Eighth, North American Edition, by Michael A. Lieberman PhD ,Dr. Rick Ricer MD , by David Katz ,Ming-Chin Yeh ,Joshua Levitt , Kofi D Essel , & 2 more.

6-Nutrition in Clinical Practice Fourth Edition, by David Katz ,Ming-Chin Yeh ,Joshua Levitt , Kofi D Essel.

References

7-**The Science of Nutrition: Debunk the Diet Myths and Learn How to Eat Responsibly for Health and Happiness (DK Science of) Hardcover – March** by Rhiannon Lambert **1, 2022.**

8-**Nutrition For Dummies Paperback – May 4 by Carol Ann Rinzler , 2021.**

9-**Textbook of Biochemistry with Clinical Correlations 7th Edition** by Thomas M. Devlin

References

* 10-Introduction to human Nutrition by Talib KH. Hussein ,june 2019.

11-Marks' Essentials of Medical Biochemistry: A Clinical Approach Secon by Michael A. Lieberman .

12-Marks' Essentials of Medical Biochemistry: A Clinical Approach by Michael A. Lieberman ,Dec 17, 2014.

13-Water Soluble Vitamins: Clinical Research and Future Application (Subcellular Biochemistry Book 56) 2012th Edition, Kindle Edition,by Olaf Stanger.

14-Clinical Studies in Medical Biochemistry 3rd Edition, by **Robert H. Glew , Miriam D. Rosenthal .**

REFERENCES

15- **Clinical Biochemistry and Metabolic Medicine 8th Edition, by Martin Andrew Crook.**

16-**Clinical Biochemistry (Fundamentals of Biomedical Science) 2nd Edition,** by Nessar Ahmed

17- **Clinical Biochemistry for Health Science Students 2nd Edition,by Todd Hrubey.**

18- **Clinical Biochemistry: An Illustrated Colour Text 6th Edition, by Michael J. Murphy MA MD FRCP FRCPath (Author), Rajeev Srivastava MS FRCS FRCPath.**

Arabic references

المصادر العربيه:

19- اساسيات الكيمياء الحياتيه, الدكتور سامي مهدي المظفر(2009)

20- الكيمياء الحياتيه (الدهون),مؤيد عمران الغزال (2019))

21- الكيمياء الحياتيه التطبيقيه, دلاور محمد صابر(2017).

22- مبادىء الكيمياء الحياتيه التركيبيه, علي عبد اله التميمي(2011).

23-اسس الكيمياء العضويه وتطبيقاتها الحياتيه, مصطفى عبد اللطيف عباس(2010).

الاسئله المتداوله

Q1: Fill in blanks for the following:(20 MARKS)

* **1- Hyperproteinemia is increase level of …… .**
* **2- Lipids are biomolecular that extracted from cells using ……. ..**
*
* **3- Solid fats have ……. melting point, while oils have …… melting point.**
*
* **4-un saturated fatty acid as ……..**

Q1: Fill in blanks for the following :(20 MARKS)

1- Hyperproteinemia is increase level of plasma protein (increase both Albumin and Globulin.)

2- Lipids are bimolecular that extracted from cells using organic solvents.

3- Solid fats have high melting point, while oils have low melting point.

4-un saturated fatty acid as linoleic, linolenic and Arachidonic acids are essential for health and life.

5- fats and oils are contain fatty acids linked to glycerol

6- Triglyceride is an ester derived from glycerol and three fatty acids

7- Fatty acids are long-chain of carboxylic acids, Typically contain 4 -18 carbon atoms.

8- The melting point of oleic acid is 13c

9- - Saturated fatty acids have Single C–C bonds Molecules.

10-- Fatty acids In vegetable oils are mostly omega-6 with the first C=C at C6

11- In fish oils are mostly omega-3 with the first C=C at C3.
12- Prostaglandins have 20 carbon atoms in their fatty acid chains including a 5 carbon ring.
13- Prostaglandins have An OH group on carbon 11, and 15 .
14- Prostaglandins have A trans double bond at carbon 13.
15- CLA IS Abbreviation for conjugated Linoleic acid
16- DHA is Abbreviation for Decosa hexanoic acid.
17- EPA is Abbreviation for ECOSA PENTAENOIC ACID
18-GLA is Abbreviation for GAMA CARBOXYGLUTAMIC ACID.
19- M.p is Abbreviation for melting point.
20- Omega 9 is Abbreviation for the double bond in carbon number 9.
21- CLA IS Abbreviation for conjugated Linoleic acid
22- EPA is Abbreviation for ECOSA PENTAENOIC ACID
23-GLA is Abbreviation for GAMA CARBOXYGLUTAMIC ACID.
24- Decarboxylationis removal of carboxyl group from the amino acids to give rise to some of biological active amines.

25 - Histidine → Histamine

26- Glutamic acid → Amino butyric acid (stimulates neuronal activity

27- Catabolism is break down the Proteins from diet and tissue are break down in to amino acids.

28- The amino acids are transport fat, iron, calcium in the blood.

29- In the small intestine the act of pancreatic juice which contains of proteiolytic enzymes (Trypsin, chymotrypsin, Carboxypeptidases, and amino acid peptidase).

30 – proteins are Converts to metaproteins which are easily digested by……

31-The synthesis of Tissue proteins, blood protein, enzymes, and hormones called …….

32- In the stomach the act of proteolytic enzyme (pepsin) with PH 1.5-2.0 of gastric juice break down the proteins to peptone .

33- In a *dipeptid*e glycylalanine two α-amino acids……. are joined by a peptide bond.

34- There are 3 amino acids , they have two or more positive charge NH_3^+ and one negative charge COO^- .

35- There are 15 amino acids which have …….charge positive NH_3^+ and ……. charge negative COO-nd one charge negative COOHhich have one charge positive $NH3^-$.

36- Prostaglandin function is ……. mucus production and

37- In a triacylglycerol the Glycerol forms ester bonds with three fatty acid .

38-The name prostaglandin derived from the prostate gland.

39-In vegetable oils are mostly omega-6 with the first C=C at C6

40- The linolenic acid have…….carbons atoms and ……double bonds.

41- The palmitoleic acid have …….. carbons atoms and ……double bond.

42- Waxes are esters of saturated fatty acids and long-chain of alcohols.

- Answer by true or false for these sentences (20Marks).

1- Vegetable oils have lower melting points than fats.

2- Animal fats have more unsaturated fatty acids

3- HDL lipoprotein collect fat molecules from the body tissues to the liver.

4- α- amylase of saliva break down the peptide bonds.

5- The glycolysis pathways is converted the glucose to pyruvate.

6- The insulin hormone only is responsible of regulation of blood glucose.

7-Glycogon hormone is synthesized in the α-cells of islets of Langerhans of the pancreas.

8-Hypo glycaemia I/G ratio is lower.

9-Cholesterol is converted to vit D3 by ultraviolet.

10-- Hypo proteinemia is mean increase of plasma protein level.

11-Lecithin is phospholipids with choline nitrogen base.

12-LDL lipoprotein has lower lipids and higher protein.

13-Hyper glycaemia I/G ratio is lower.

14-The OH of the fifth carbon of D-glucose is on the left side of molecule.

15- The OH of the first carbon of α- galactose is on up of molecule.

16- the structure of aspartic acid has two of amine groups.

17- The structure of lysine has two of carboxylic groups.

18 – The structure of stearic acid has one double bond.

19- The structure of oleic acid has two double bonds.

20- O-mega 3 fatty acid has one double bond on carbon number 3 from carboxylic group.

Q2-: Choose the correct answer? (15 Marks)•

1-One of these enzymes act on peptide bond:•

A-Lipase, B- Pepsin, C- Amylase.•

2-One of these amino acids is classified as basic amino acid: •

A-Lysine, B- Glycine, C- Valine.•

3-One of these fatty acids is unsaturated: •

A- Oleic acid, B-Palmitic acid, C- Butyric acid.•

4- Lecithin is phospholipid with:•

A - Ethanol amine, B - Choline, C – Serine•

5- HDL Lipoprotein contains:•

A- High Protein, and Low Lipid.•

B- Low Protein, and High Lipid.•

C- High Protein, and High Lipid.•

6- Acceptable total serum cholesterol (normal value) for adult man:•

A – 200 mg/dl. or lower.•

B – 200 to 239mg/dl. •

C - 240 mg/dl or higher.•

7 - Insulin hormone is synthesized by: A -The α-cells of Langerhans of • pancreas.

B - The β-cells of Langerhans of pancreas.•

C - The ϰ-cells of Langerhans of pancreas. •

8 – Hyper glycaemia is:•

A – I/G Ratio is high. B – I/G Ratio is lower. C – I/G Ratio is equal. •

9-One of these enzymes act on glycedic bond:•

A-Lipase, B- Pepsin, C- Amylase.•

10 -One of these amino acids is classified as acidic amino acid: •

A-Lysine, B- Glycine, C- Aspartic acid•

11-One of these fatty acids is saturated: •

A- Oleic acid, B-Palmitic acid, C- Linoleic acid.•

12- LDL Lipoprotein contains:•

A- High Protein, and Low Lipid.•

B- Low Protein, and High Lipid.•

C- High Protein, and High Lipid.•

13- normal value of blood glucose for adult man is:•

A- 70-110 g./dl•

B- 70 -110 mg, /dl •

C- 110-145 mg. /dl•

14 - Acceptable total blood protein (normal value) for adult man:•

A- 5.6 mg/dl•

B – 5.6 mg/dl or higher.•

C - 5.6 g/dl •

15– Glucagon hormone is synthesized by: A -The α-cells of Langerhans of • pancreas.

B - The β-cells of Langerhans of pancreas.•

C - The ϰ-cells of Langerhans of pancreas. •

Fill in blanks for the following :(15 MARKS)(answer 15 only)

1- There are different ways of classifying the amino acids; the most common are …….

2- There are …… amino acids which have one charge positive NH_3^+ and one charge negative COO-nd one charge negative COOHhich have one charge positive $NH3^-$

3- Aspartic acid and glutamic acid they have …… Negative charge COO^- and …… positive charge NH_3^+.

4- There are 3 basic amino acids , they have …….. positive charge NH_3^+ and ……. negative charge COO^- .

5- Asparagine is amino acid with polar but …….. side chains.

6- - Peptides are compounds in which an amide bond links the …….. of one α-amino acid and the …… of another.

7- Two α-amino acids ……., ……..are joined by a peptide bond in alanylglycine.

8- All of the polymer(Amino acids) information applies …….

9- Hemoglobin is composed of ……., each containing a heme group .

10- Denaturation is Any physical or chemicaagent that destroys the conformation of a protein like .....

11- There are a group of amino acids, that cannot be synthesized by the body they include.....

12-Deamination is Removal of ..... from the amino acids to form – keto acid and ammonia (NH_3).

13-Half (semi-essential amino acids): These amino acids are formed in the body in amount enough for adults, but not for growing children. They include: .....,.....

14-In the stomach the act of ..... with PH 1.5-2.0 of gastric juice break down the proteins to peptone .

15 – The role of gastric juice HCl is Converts proteins ....., which are easily digested.

16- In the small intestine: the act of pancreatic juice which contains of proteiolytic enzymes ....., ... ,.....

17- The amino acids are absorbed in to the blood and transported to ..... for Build new tissues in children

18- The amino acids are trasport ....., ... ,....., in the blood.

19- Anabolism is synthesis of ....., ... protein, ..., and hormones.

20- Decaboxyation is removal of ..... from the amino acids to form – keto acid and ammonia (NH_3).

21- Tyrosine is converted to ..... (increase blood pressure)

22- Hyperproteinemia is .....level of plasma protein (both Albumin and Globulin.)

23- Lipids are Biomolecules that Extracted from cells using .....

24- The melting point of stearic acid is ..... .

25- DHA is Abbreviation for .....

26- Prostaglandins have An OH group on carbon ....., ...

Match the words in the first and second columns (5MARKS)

A	B
1- Polypeptides	1- Convert AA to keto acid+NH3
2- Lipids	2- Bone marrow
3- Glycine	3- 8gm
4- Acidic amino acid	4--Trypsin
5- Basic amino acid	5- Half essential AA
6- Alanylglycine	6- Essential AA
7- Hemoglubine	7- Break S-S bond
8- Denaturation	8- Addition of 6M Urea
9- Reducing Agents	9- Four subunits
10-Valine	10- Alanine+ Glycine
11-Histidine	11- Arginine
12-Proteolytic enzyme	12- Glutamic acid
13-we need about	13-GLy
14-Synthesis of hemoglubine	14-Triglycerides
15-Catabolism	15- More than 10 AA

: Matching the words of group A with group B: **(ANSWER 10 ONLY)**

A	B
1- Oxidoreductase	1-Isomerases
2-Hydrolase	2-Lyases
3-Lyases	3-Small intestine
4-Ligase	4- In mouth , Small intestine
5-Co-factors	5-Have lower molecular weight
6-Co- enzymes	6-inorganic compound
7-Lipase	7-Synthetase
8- Hydratase	8-Pyruvate decarbxylase
9-TPI	9-Lipase
10- Amylase	10-Lactate dehydrogenase

: fill in blanks for the following) (answer 15 only)

1- There are different ways of classifying the amino acids; the most common are ……..

2- There are ……. amino acids which have one charge positive NH_3^+ and one charge negative COO-nd one charge negative COOHhich have one charge positive $NH3^-$

3- Aspartic acid and glutamic acid they have …… Negative charge COO^- and ……. positive charge NH_3^+.

4- There are 3 basic amino acids , they have …….. positive charge NH_3^+ and ……. negative charge COO^- .

5- Asparagine is amino acid with polar but …….. side chains.

6- - Peptides are compounds in which an amide bond links the …….. of one α-amino acid and the …… of another.

7- Two α-amino acids ……., ……..are joined by a peptide bond in alanylglycine.

8- All of the polymer(Amino acids) information applies …….

9- Hemoglobin is Composed of ……., each containing a heme group .

10- Denaturation is Any physical or chemical agent that destroys the conformation of a protein like ……

11- There are a group of amino acids, that cannot be synthesized by the body they include……

Answer TRU or FALSE to the following:)

1-Lipids or fats store 80% of energy in human body ( ) .

2-Amino acids not usually need but for making new proteins ( ) .

3-Carbohydrates are the molecules most commonly broken down to make ADP ( ) .

4-Food molecules stores chemical energy in their bonds ( ) .

5-Energy is measured either in joles or calories ( ) .

6-1 gm of protein = 4 k cal ( ) .

7- 1 gm of carbohydrate = 4 k cal ( ) .

8-ADP is changed into ATP when a phosphate group added ( ) .

9-ADP is a lower energy molecule can be converted into ATP ( ) .

10-The protein store about the same amount of energy as a carbohydrate ( ) .

Videos

What is a Lipid Profile Test_ _ 1mg.mp4

KREBS CYCLE MADE SIMPLE - TCA Cycle Carbohydrate Metabolism Made Easy.mp4

Human digestive system - How it works! (Animation).mp4

Thanks for following