

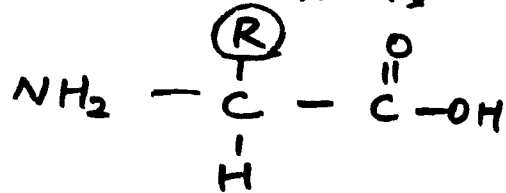
molecular weight: 6000 - 10⁶ $\frac{g}{mole}$

fibrous proteins

globular proteins

protein 是 L-amino acid 组成的单链 polymer.

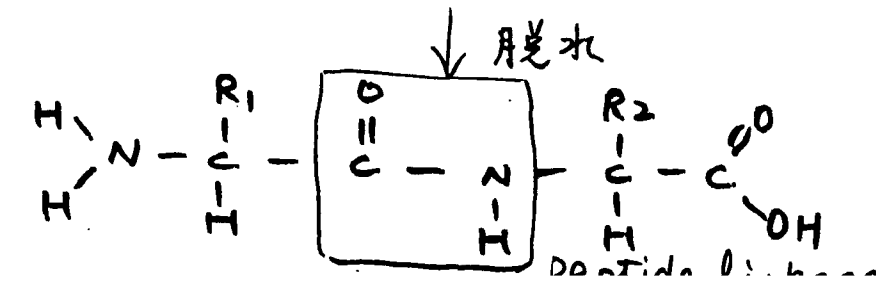
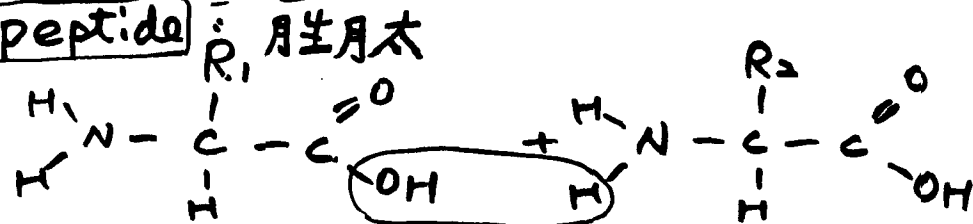
amino acid 氨基酸:



R 共分为 20 种 see Fig 23.3
 ↑ 可缩写成 3 letters or 1 letter

Side chain

peptide 肽



peptide 肽 $Arg - Ala - His - Val_{23-4}$

polypeptide: 含不止 1 个 a.a. 形成的链.

The order or sequence of amino acids in the protein chain: primary structure

e.x.

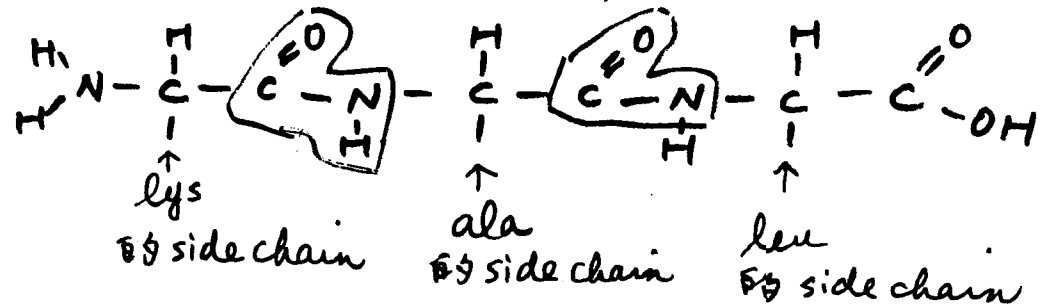
lys - ala - leu Please draw the structure

sol:

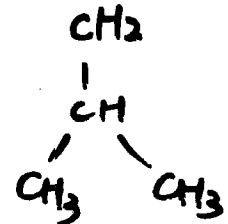
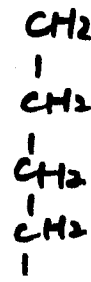
lys - ala - leu

(N 端)

(C 端)



check Fig 23.3



Biochemistry: The study of the chemistry of living systems.

30 elements are known to be essential (or strongly suspected) to human life.

trace elements 微量元素

See Fig. 23.1 purple: most abundant elements
green: trace elements

Table 23.1: essential elements 必需元素

Fig 23.2. A typical animal cell!

nucleus (核): 核内含 chromosomes

cytoplasm (细胞质): 内含 subcellular structures, 如 mitochondria

lysosomes

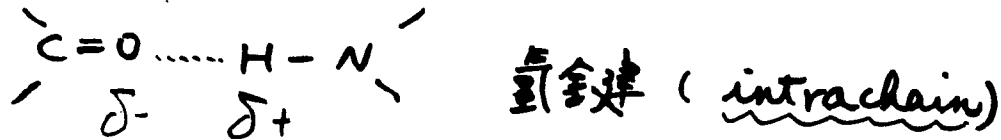
cell membrane. ribosome.

1A	2A	3A	4A	5A	6A	7A	8A
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os
87 Fr	88 Ra	89 Ac	104 Unq	105 Unp	106 Unh	107 Uns	108 Uno
		21 Sc	22 Ti	40 Zr	41 Nb	42 Mo	43 Tc
		39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru
		38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc
		37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo
			21 Sc	22 Ti	40 Zr	41 Nb	42 Mo
			39 Y	40 Zr	41 Nb	42 Mo	43 Tc
			38 Sr	39 Y	40 Zr	41 Nb	42 Mo
			37 Rb	38 Sr	39 Y	40 Zr	41 Nb
				31 Ga	32 Ge	33 As	34 Se
			49 In	50 Sn	51 Sb	52 Te	53 I
			81 Tl	82 Pb	83 Bi	84 Po	85 At
			80 Hg	81 Tl	82 Pb	83 Bi	84 Po
				31 Ga	32 Ge	33 As	34 Se
			49 In	50 Sn	51 Sb	52 Te	53 I
			81 Tl	82 Pb	83 Bi	84 Po	85 At
			80 Hg	81 Tl	82 Pb	83 Bi	84 Po
				32 Ge	33 As	34 Se	35 Br
			49 In	50 Sn	51 Sb	52 Te	53 I
			81 Tl	82 Pb	83 Bi	84 Po	85 At
			80 Hg	81 Tl	82 Pb	83 Bi	84 Po
				18 Ar	19 K	20 Ca	21 Sc
			36 Kr	37 Br	38 Kr	39 Y	40 Zr
			54 Xe	55 I	56 Ba	57 La	58 Ce
			86 Rn	87 Fr	88 Ra	89 Ac	90 Th
			86 Rn	87 Fr	88 Ra	89 Ac	90 Th
				10 Ne	11 Na	12 Mg	13 Al
			18 Ar	19 K	20 Ca	21 Sc	22 Ti
			36 Kr	37 Br	38 Kr	39 Y	40 Zr
			54 Xe	55 I	56 Ba	57 La	58 Ce
			86 Rn	87 Fr	88 Ra	89 Ac	90 Th
			86 Rn	87 Fr	88 Ra	89 Ac	90 Th
				2 He	3 Li	4 Be	5 B
			10 Ne	11 Na	12 Mg	13 Al	14 Si
			18 Ar	19 K	20 Ca	21 Sc	22 Ti
			36 Kr	37 Br	38 Kr	39 Y	40 Zr
			54 Xe	55 I	56 Ba	57 La	58 Ce
			86 Rn	87 Fr	88 Ra	89 Ac	90 Th
			86 Rn	87 Fr	88 Ra	89 Ac	90 Th



主要是由氫鍵組成而穩定一小段的 sequence, 形成特殊的結構

Ex. ① α-helix



See Fig 23.5 and 23.6

protein backbone 繞著軸

(如 wool, hair 可拉長的 fibrous proteins)



② pleated sheet

氫鍵在 interchain

see Fig 23.7

(如 silk, 很 soft but difficult to stretch)

③ random coil

沒有特別穩定的結構

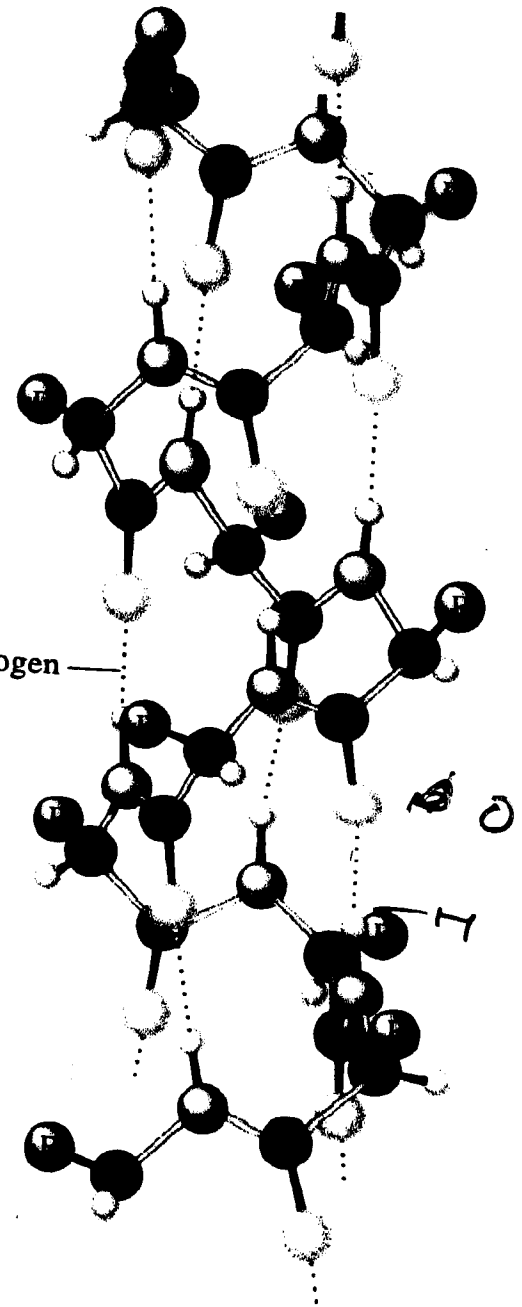


Figure 23.6
The helical structure of proteins

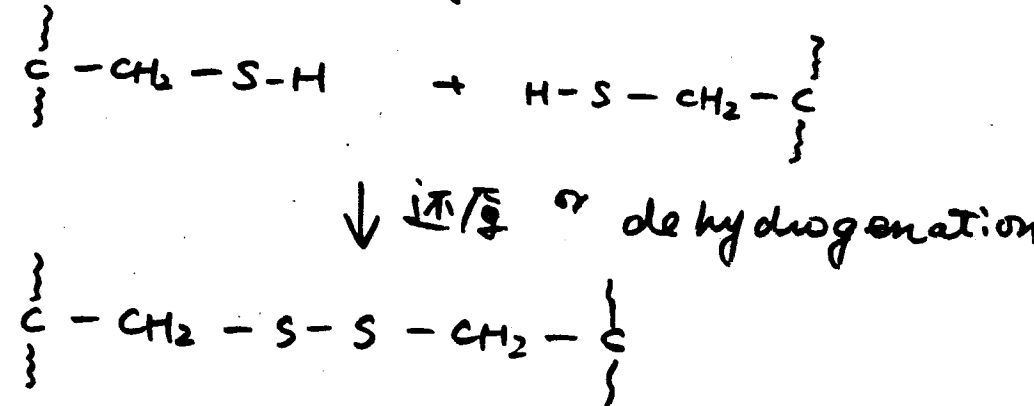
Tertiary structure (3° 結構)

interactions stabilise tertiary structure

- include: (1) ionic
- (2) hydrogen bond
- (3) covalent
- (4) London dispersion (Van der Waal interaction)
- (5) dipole - dipole

See Fig 23.10.

disulfide linkage



ex. 如頭髮 → 捲髮 (see Fig 23.11)
 break disulfide bonds → reform new disulfide bonds

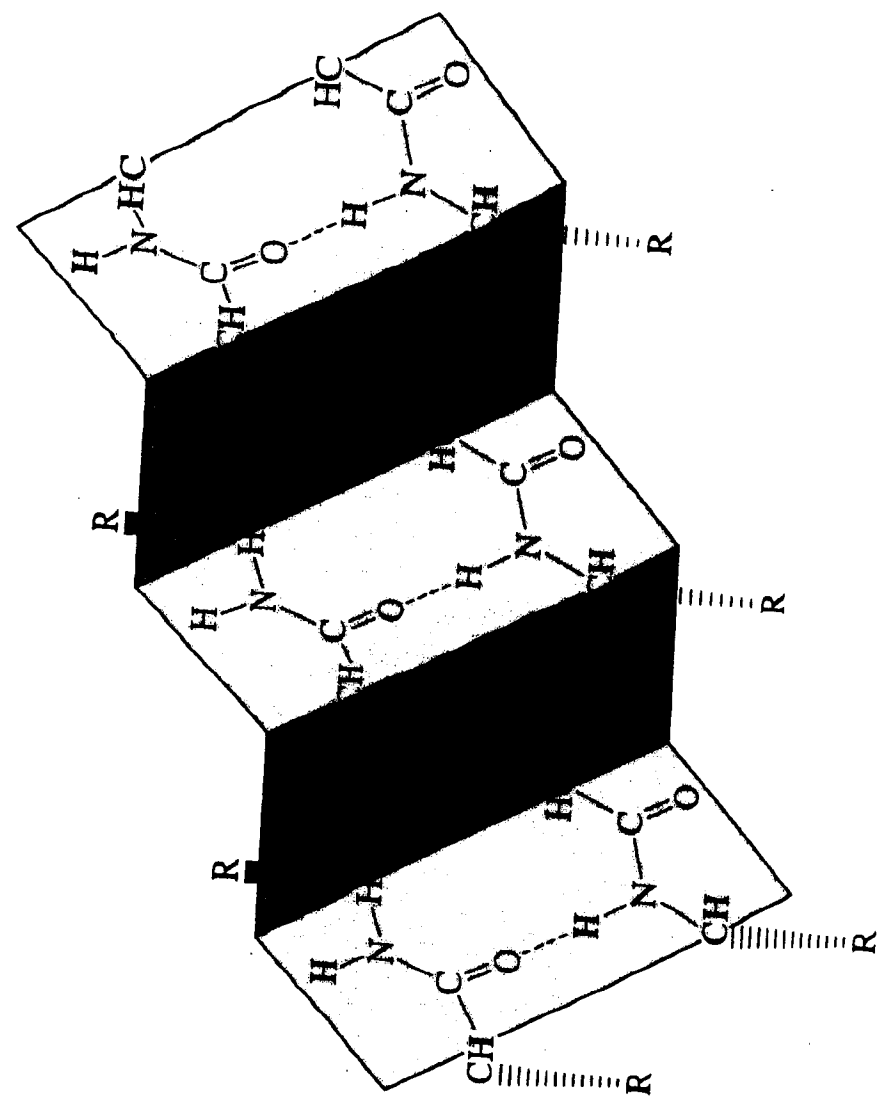


Figure 23.7

The pleated sheet structure for proteins

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three-dimensional structure of protein

23-9

↓
解构 " 变性 "

lose its "function"

Table 23.2: protein functions include structure, movement, catalysis, transport, storage, energy transformation, ...

enzyme (酶) : biological catalyst
远比 inorganic catalyst 有效率
(1 to 10 million times as efficient)

lock-and-key model: enzyme 与其
作用分子 (substrate) 结合如同 lock
and key 的匹配。

flexible-site model: enzyme 会
modify 自己的 structures significantly
to bind w/ substrate
see Fig 23.13

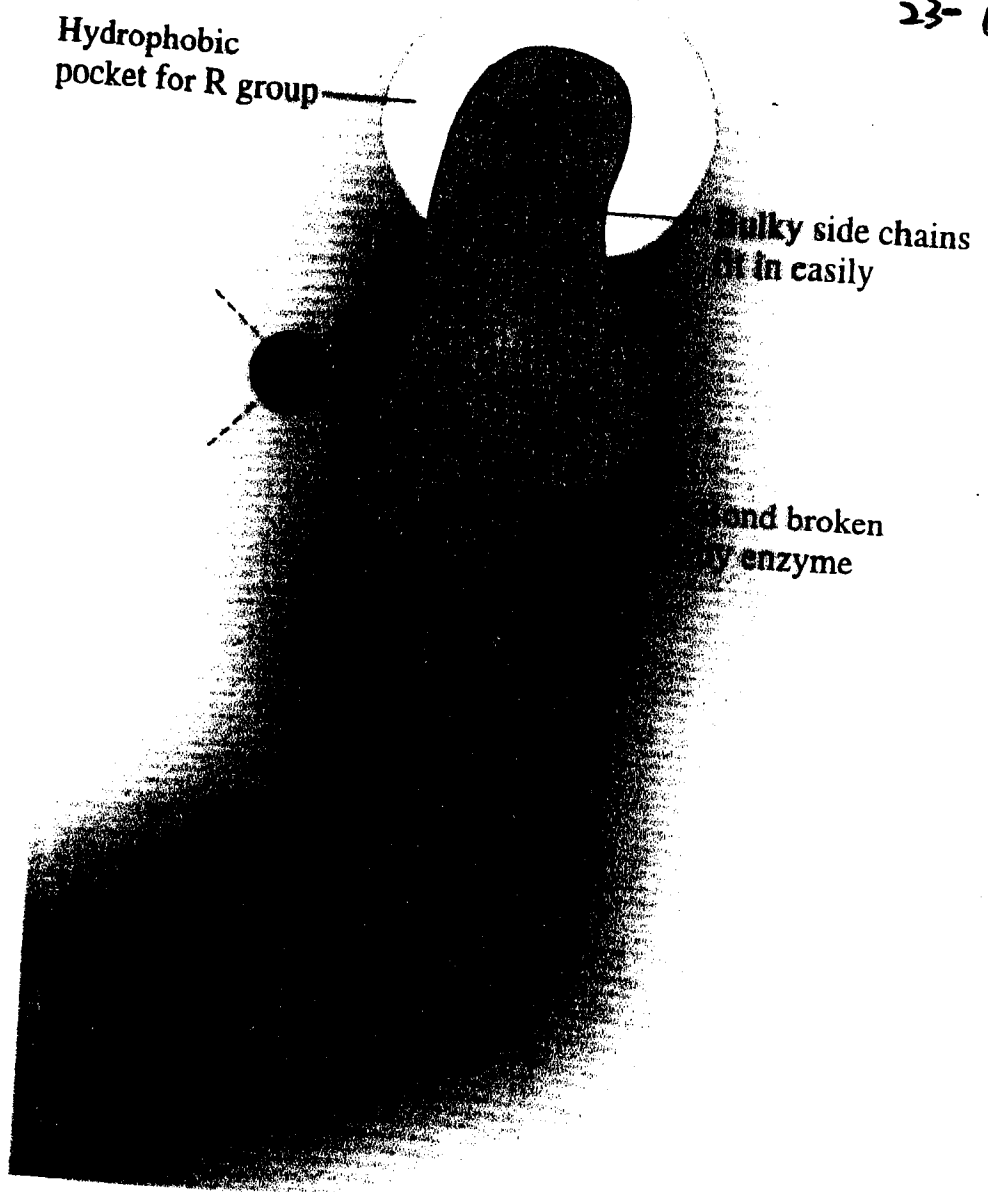


Figure 23.14
The active site in carboxypeptidase
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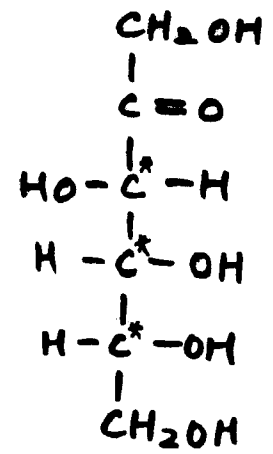
23.2 Carbohydrates (碳水化合物或糖)

food source, structural material for plants

大多的 carbohydrates 由 單糖 组成的 polysaccharide } 單糖
simple sugar

monosaccharides: polyhydroxy ketones and aldehydes

包含 5 C 糖 (pentose),
6 C 糖 (hexose)

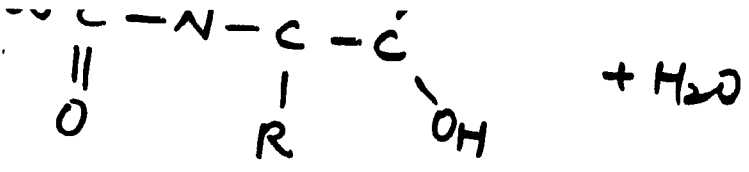


fructose

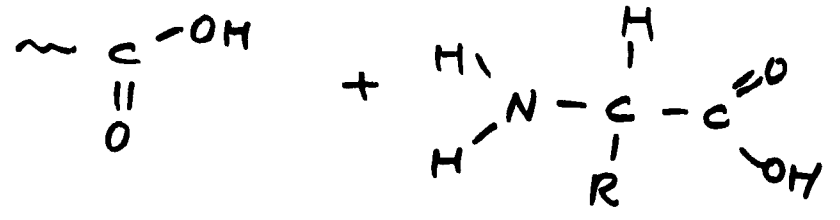
* chiral centers

A carbon atom with 4 different groups bonded to it in a tetrahedral arrangement

always has a non-superimposable mirror image



↓ carboxypeptidase



active site contains

Zn^{2+}
coordinates to carbonyl group

see Fig 23.14.

enzyme + substrate

→ product

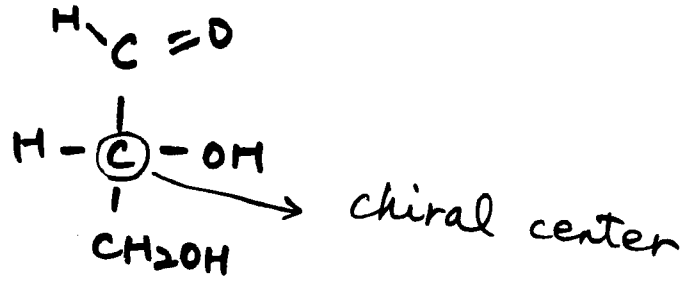
↓ + inhibitor (破壞性)

(enzyme · inhibitor)

↓ no function!

1980: HIV protease inhibitor

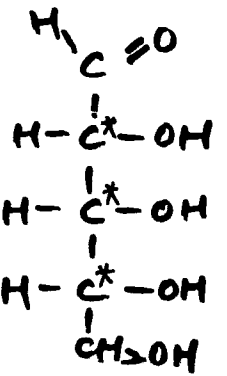
e.x.



会有旋光性

Ex. 23.3

determine the number of chiral carbon atoms in the following pentose:



3 chiral center
 ↓
 产生 2 optical isomers
 3 chiral centers
 ↓
 $2^3 = 8$ optical isomers

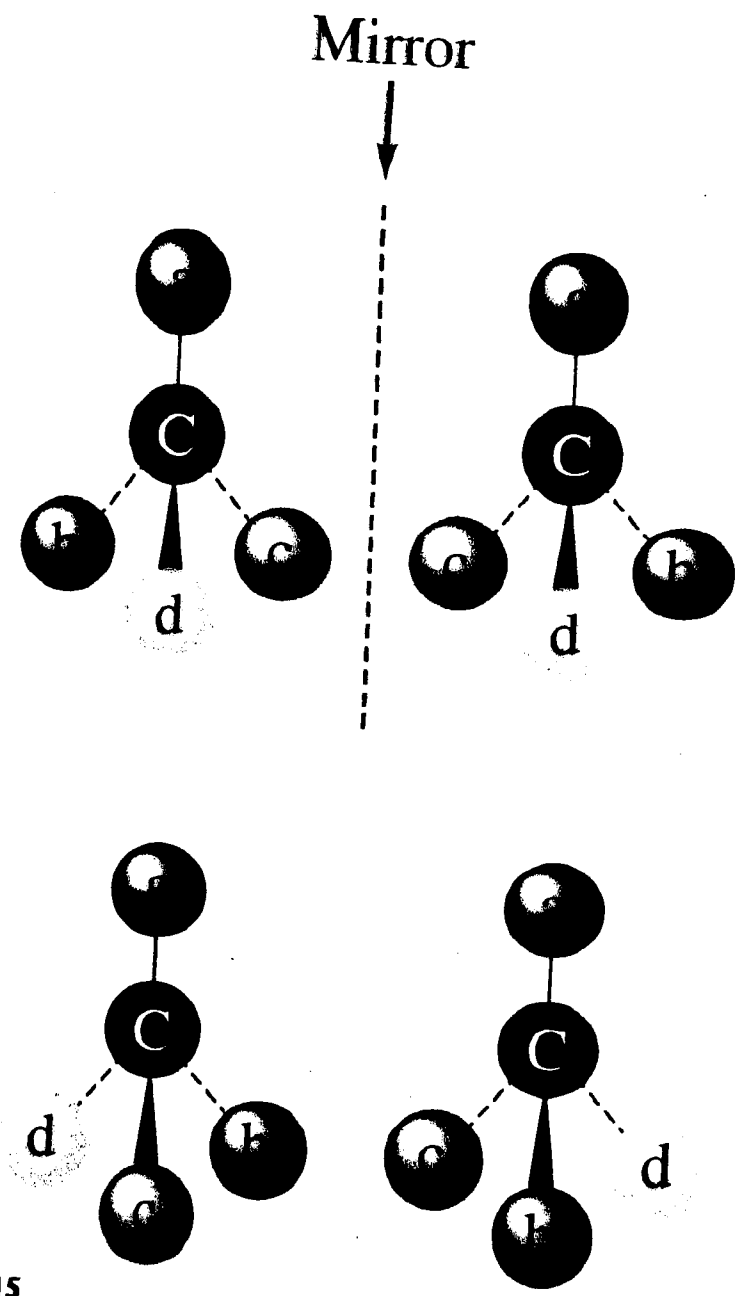


Figure 23.15 Optical isomerism for carbon with four different substituents

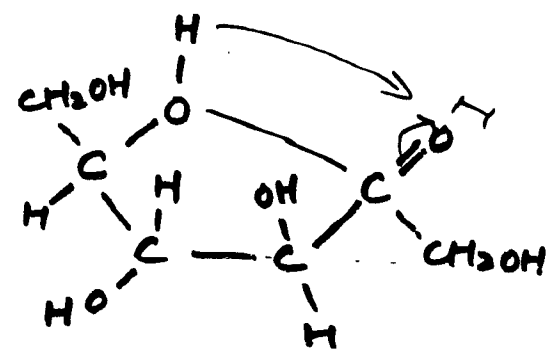


straight-chain molecules
or cyclized molecules

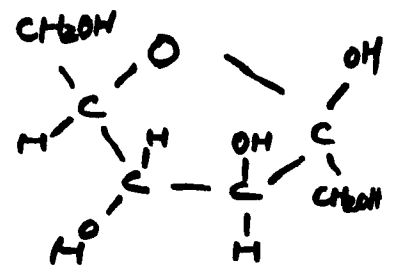
23-16

如 Fig. 23.17. fructose

& Fig 23.18 glucose



straight-chain



cyclized

Large polymers containing many monosacch units (called polysaccharides) when ²³⁻ ring forms two glycoside linkages.

starch, cellulose, and glycog

see fig 23.20.

§ 23.3 Nucleic Acids 核酸

DNA: deoxyribonucleic acid

RNA: ribonucleic acid

均為 polymers

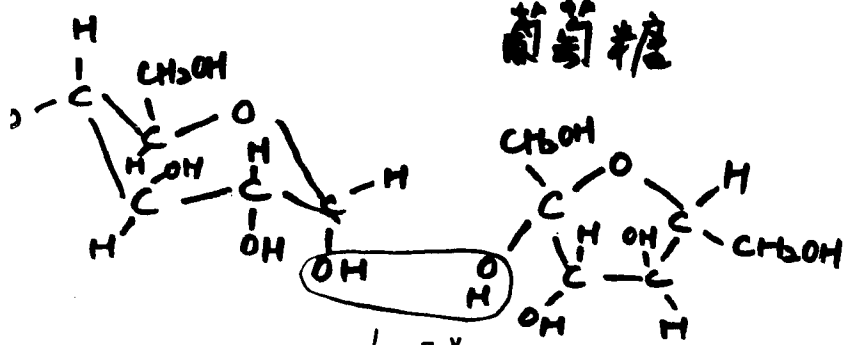
雙糖 disaccharide (含 2 个 monosaccharis)

e.x. sucrose 蔗糖

雙糖: 1 个 glucose, 1 个 fructose

葡萄糖

果糖



↓ 脱水
C-O-C

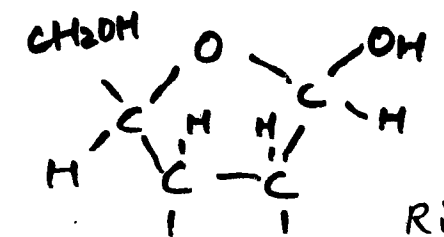
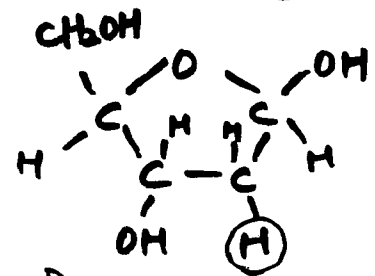
glycoside linkage

DNA → 遺傳物質

monomer 稱為 nucleotide, 包含

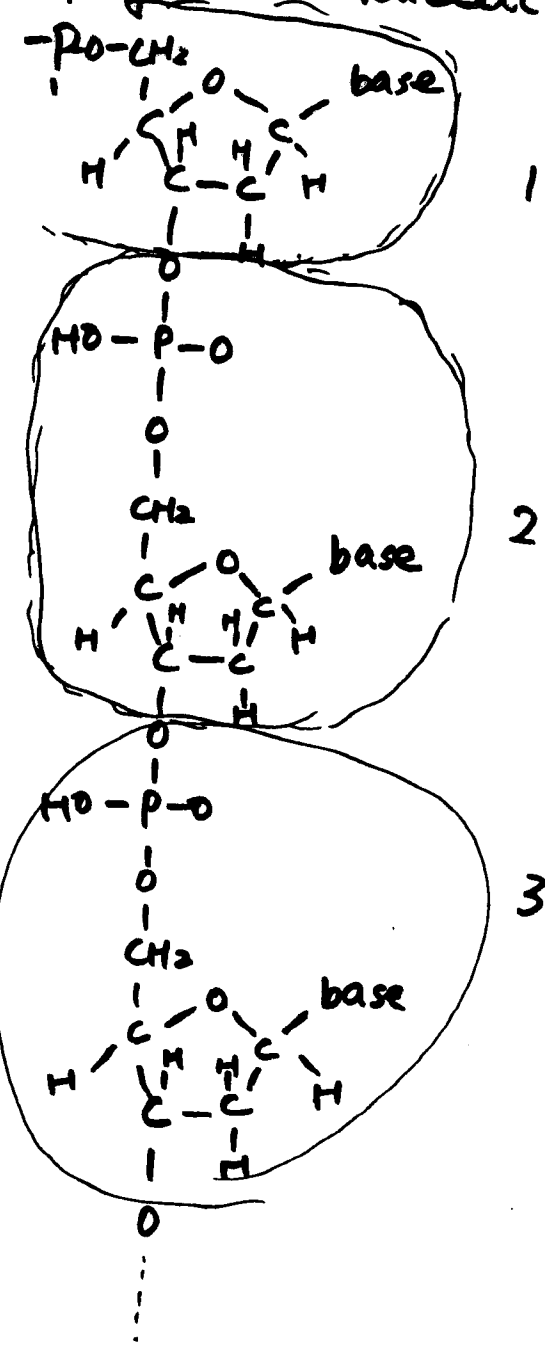
1. A five-carbon sugar

(deoxyribose for DNA
ribose for RNA)



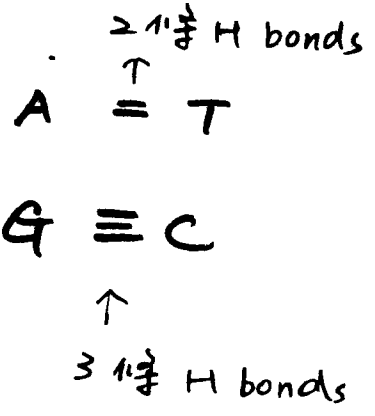
Ribose

Fig 23.24 nucleic acid chain 23-



DNA 即由此
chain 组成
(2 个以氢键
组成双螺旋)

figure 23.25



see figure
on page 1105
(右下角)

A 嘌呤 (Amino)

see Fig 23.22
(U) uracil RNA

(C) cytosine DNA RNA

(T) thymine DNA

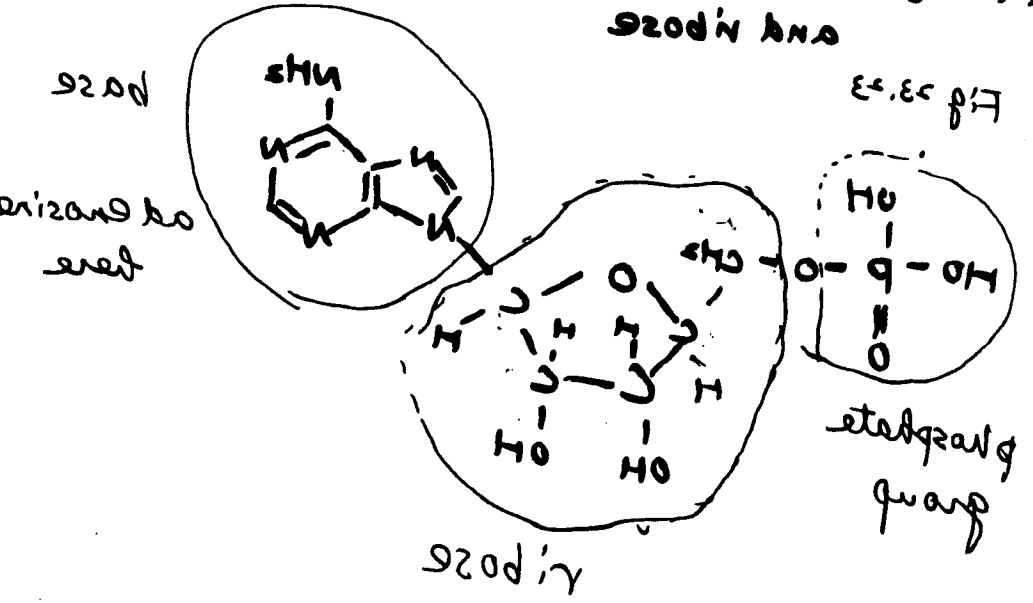
(A) adenine DNA RNA

3. A base pair and molecules

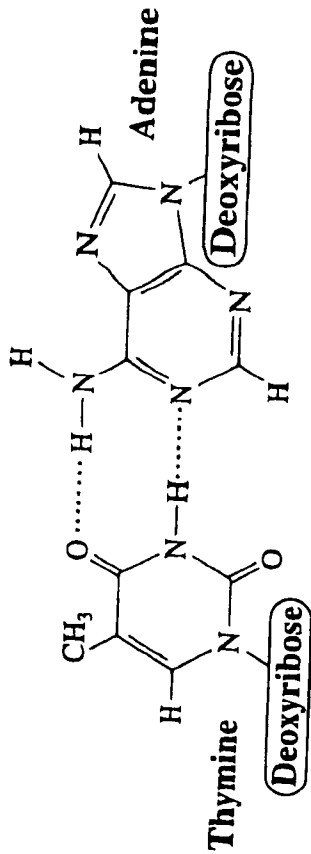
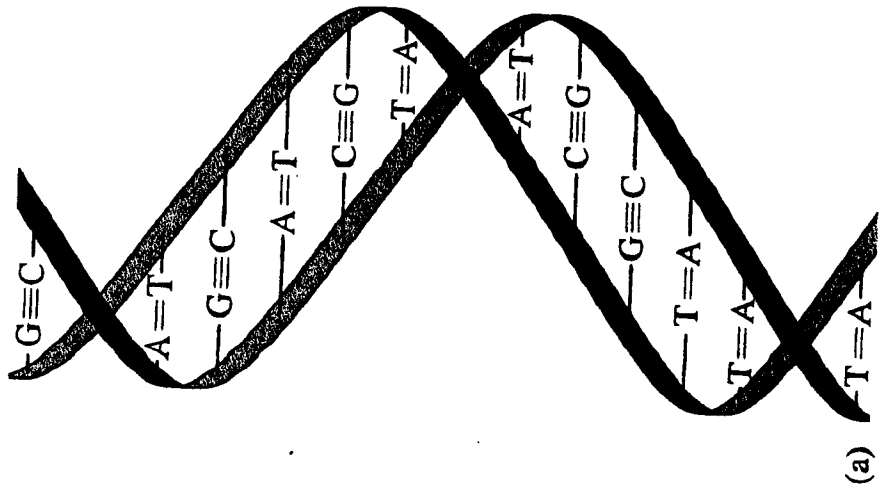
guanine DNA RNA

Ex: a molecule containing guanine and uracil

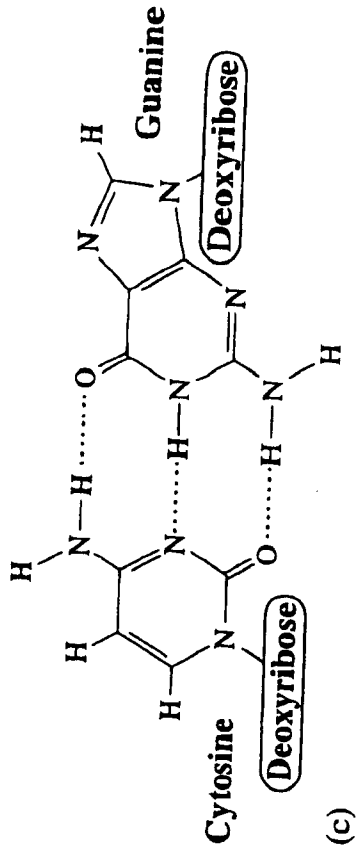
Fig 23.23



23.23
base
of guanine



(b)



(c)

Figure 23.25

The double helix in DNA

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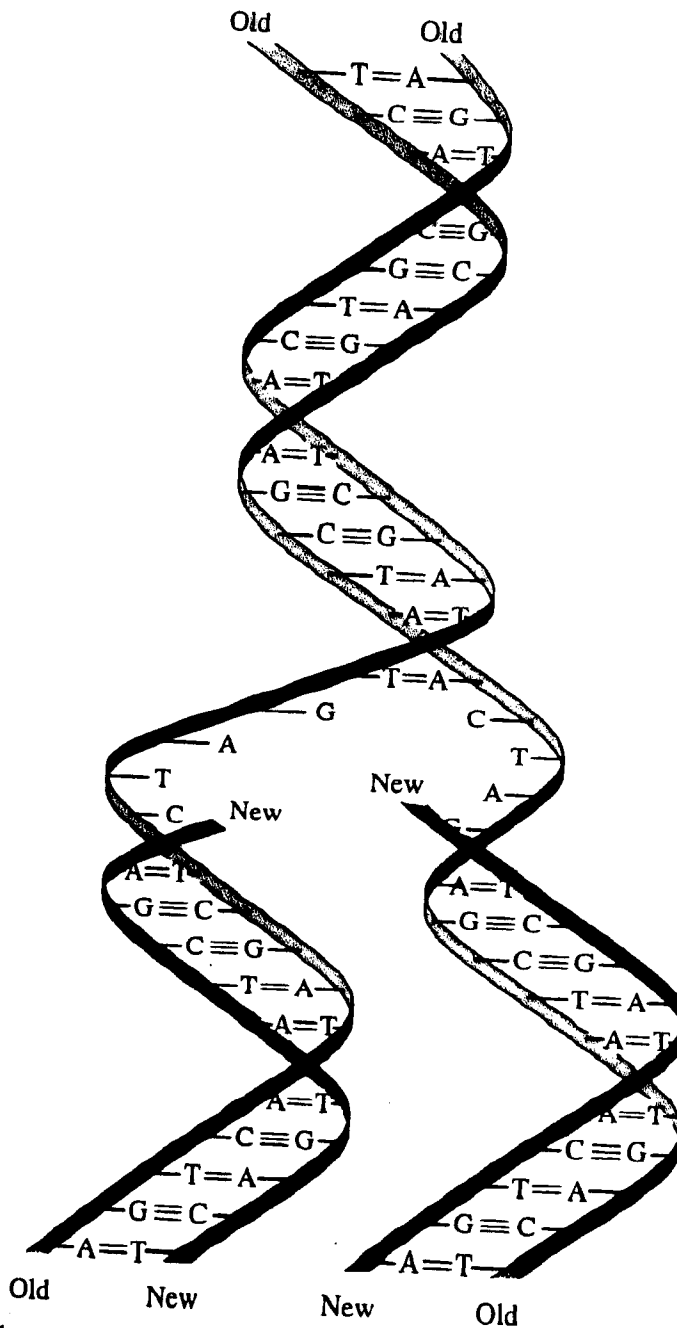


Figure 23.26
Replication of DNA

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先 unwind (双螺旋先鬆開) DNA ²³⁻²⁰
 再複製 (see Fig 23.26)

protein synthesis

DNA (非常長的核酸 polymer)
 ↓
 gene (比較短, 含有蛋白質密碼)
 ↓ transcription ^{轉譯}
 and translation ^{轉錄}
 protein

see Fig. 23.27

DNA
 ↓ transcription
 mRNA (messenger RNA)
 ↓ translation
 protein

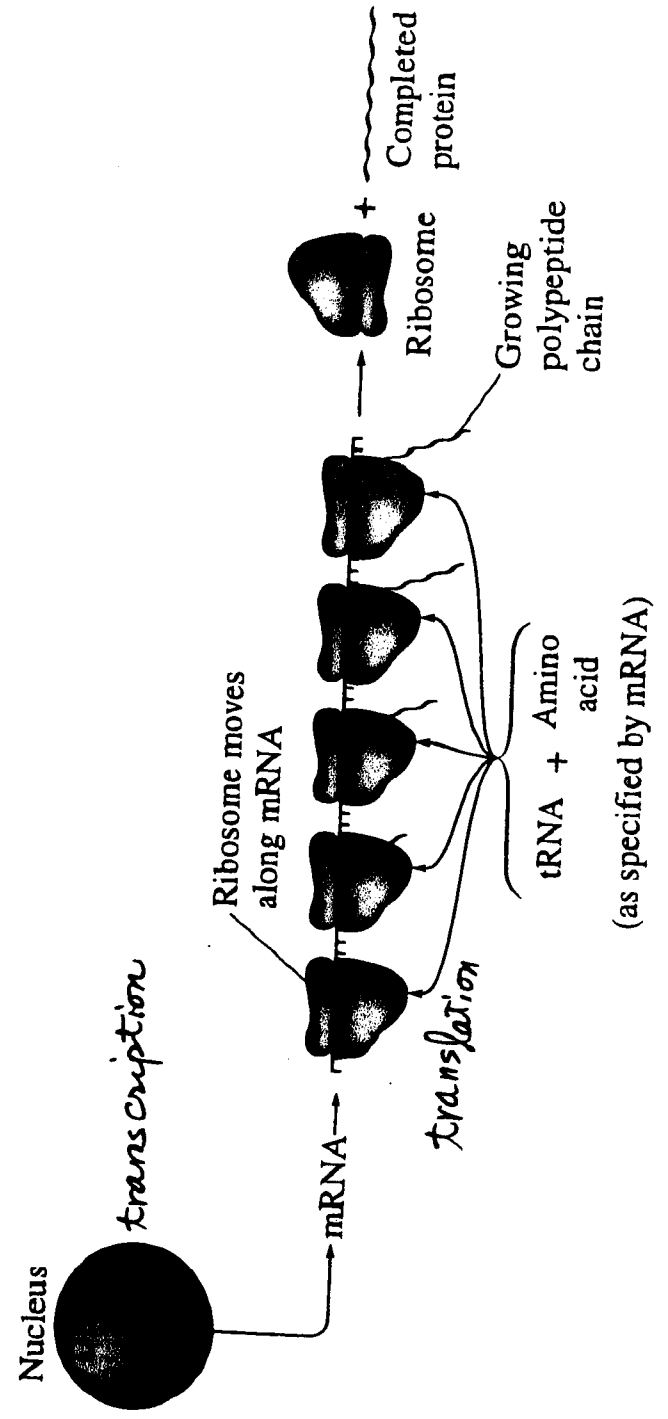


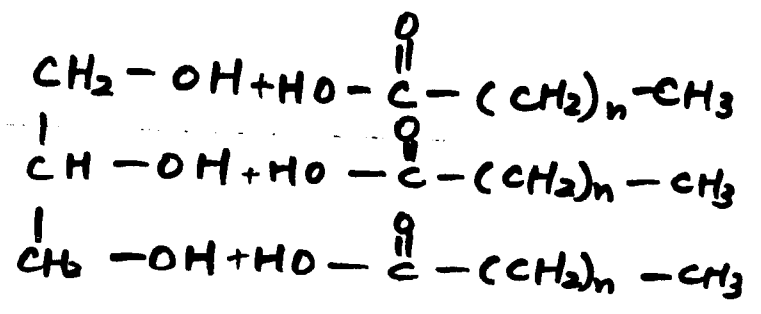
Figure 23.27

Schematic of protein synthesis

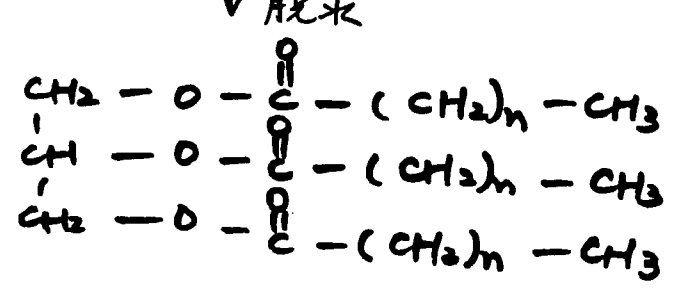
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包括: fats, phospholipids, waxes, and steroids

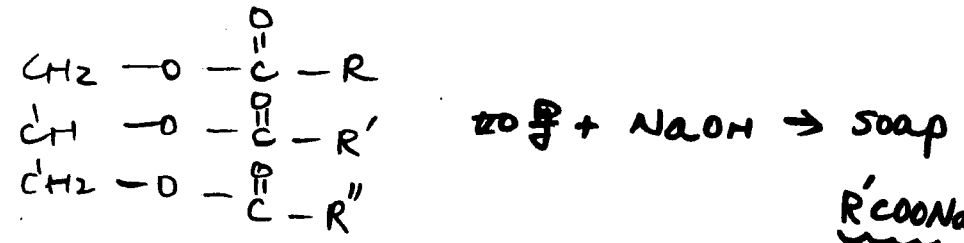
fats: composed of glycerol (甘油) fatty acid (脂肪酸)



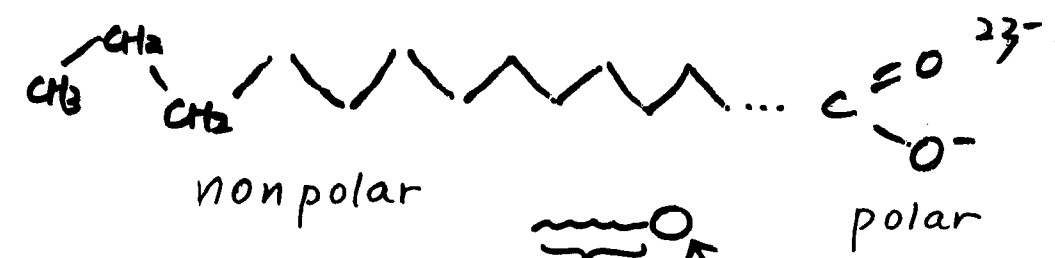
1个甘油 + 3个 fatty acids



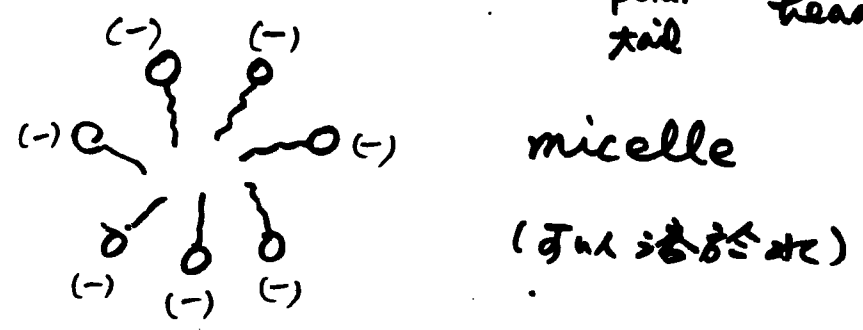
tri glycerides



Soap 肥皂: 脂肪酸的盐类



(see Fig 23.28) non-polar tail polar head



see Fig 23.29. Soap 的 除污 能力

But, soap 会与 硬水 中的 Ca^{2+} Mg^{2+}

→ 沉淀 → 降低 除污 能力

改进 soap,

alkyl benzene sulfonates (不与 Ca^{2+} Mg^{2+})



phospho lipids

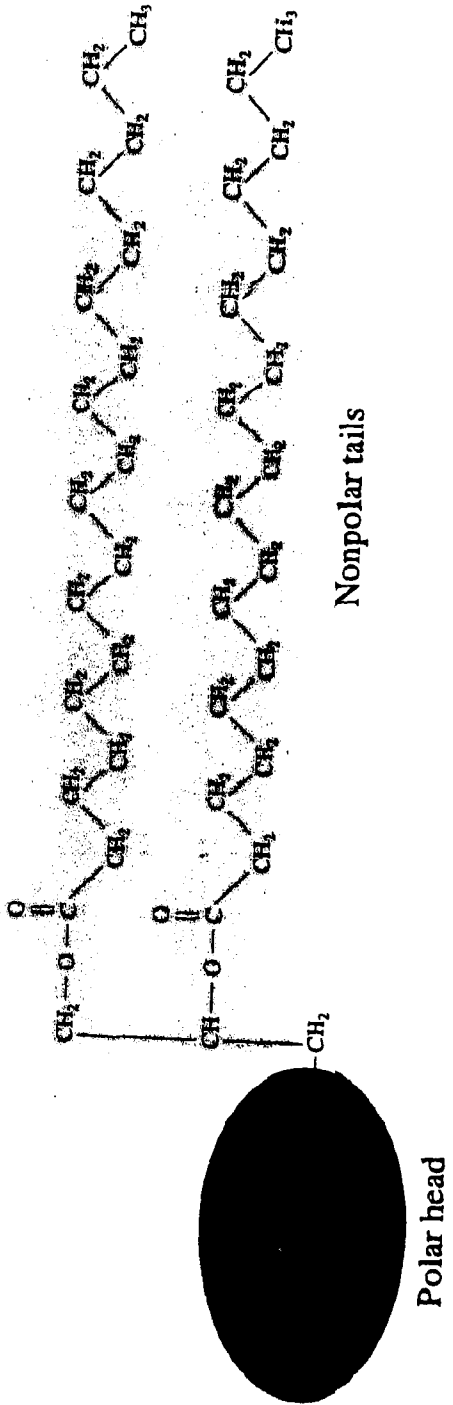


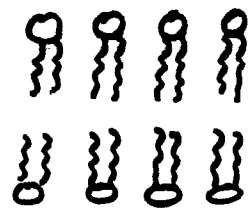
Figure 23.30
A phospholipid structure

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23-28

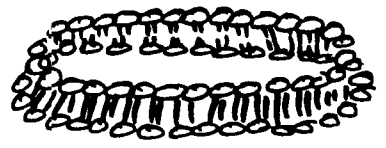
phospholipids (cell membrane 的 主要成分) ²³⁻²

(see Fig 23.30)



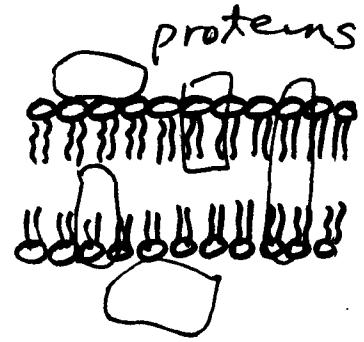
bilayer

figure 23.31

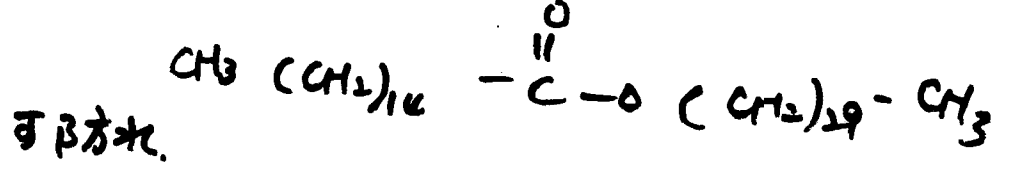


vesicles

Fig. 23.32

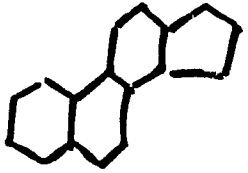


waxes (esters)

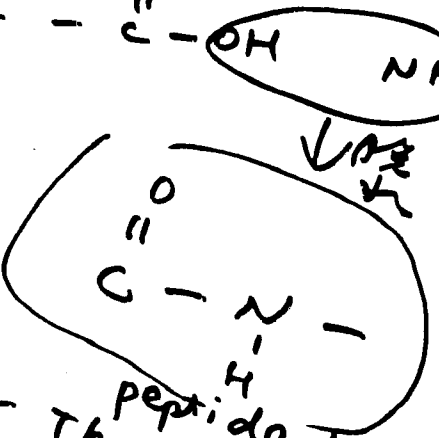
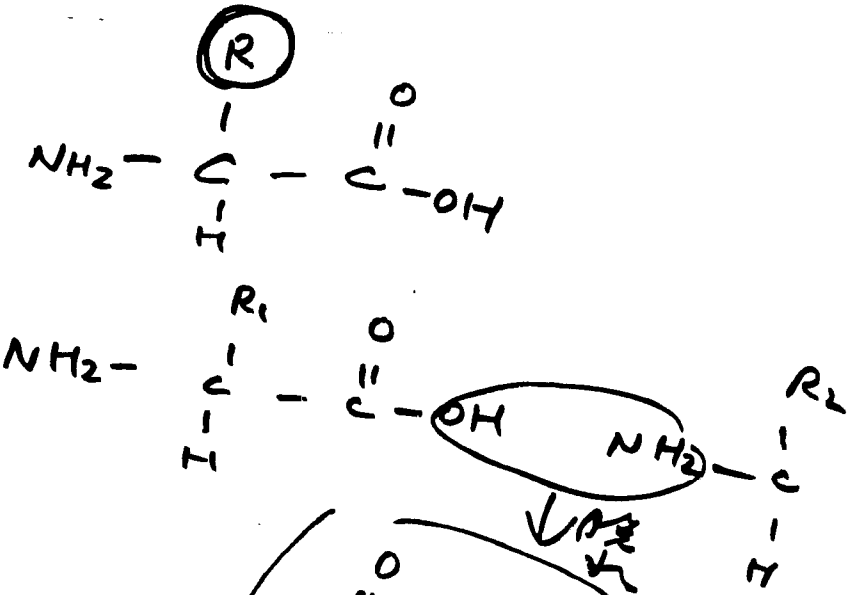


包括膽固醇、賀爾蒙等

29



See Fig 23.33



Ala- Gly- Thr peptide bond

