BIOLOGI SEL DAN MOLEKULER

KIMIAWI SEL

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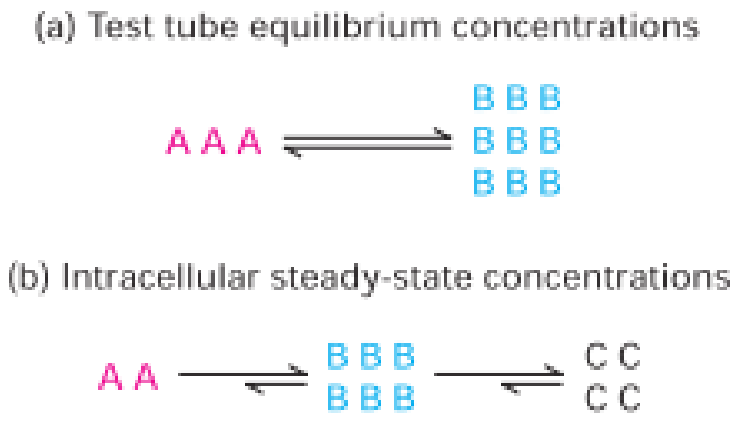
Reaksi Kimia dalam Sel

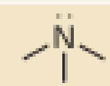
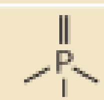
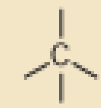
- kehidupan sel bergantung pada ribuan interaksi kimia dan reaksi yang terkoordinasi satu sama lain dalam pengaruh instruksi genetic dan pengaruh lingkungan

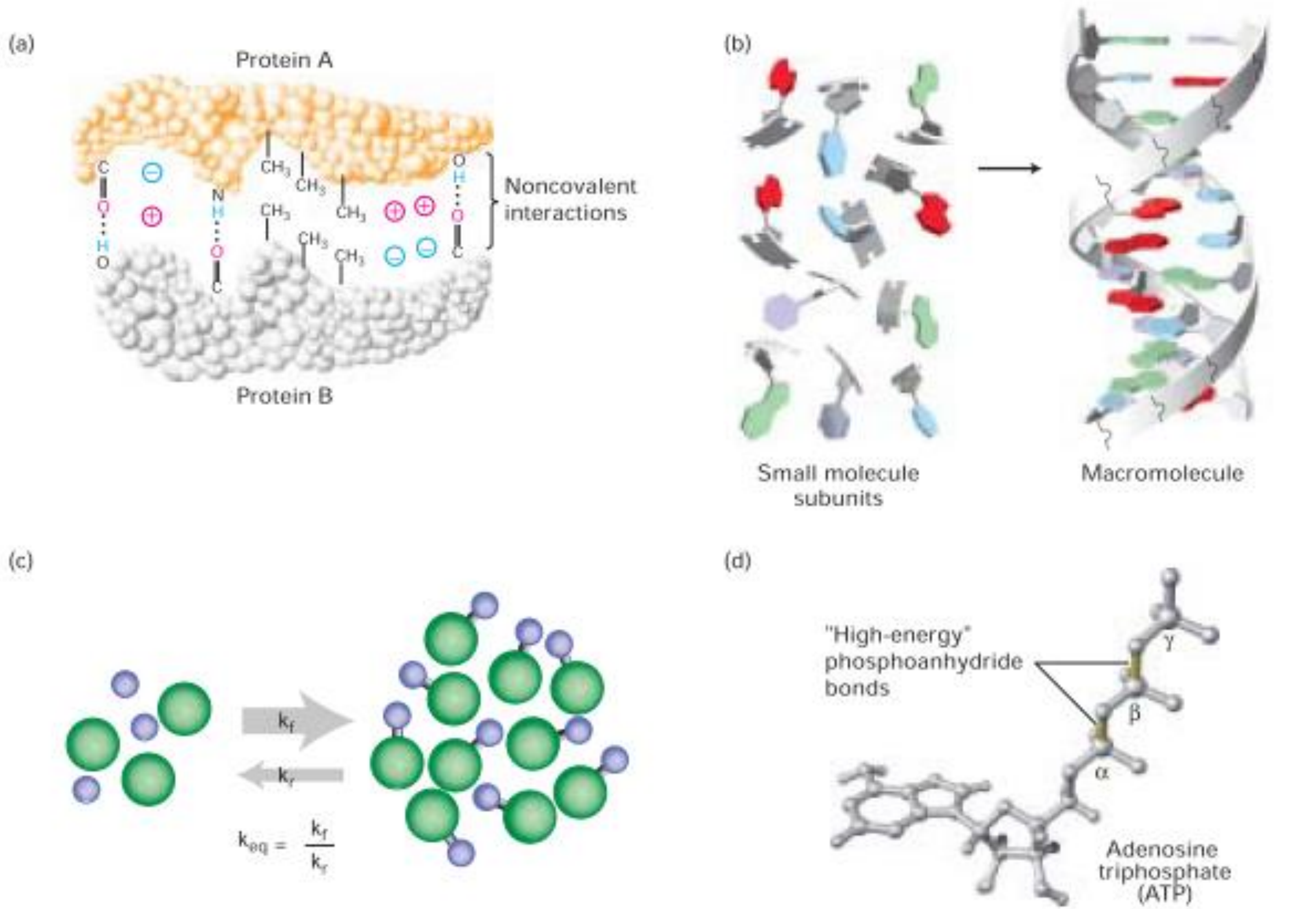


Ikatan kimia

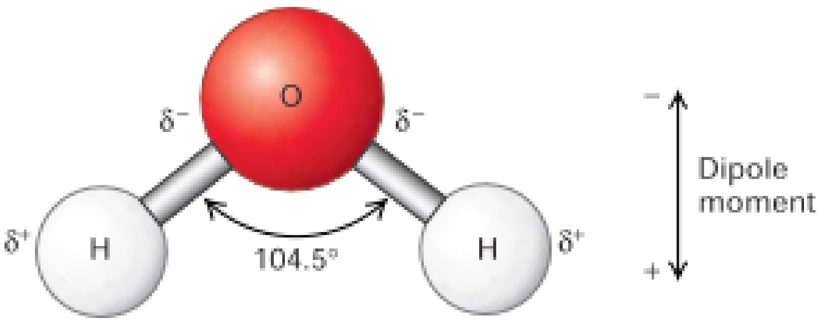
- Ikatan kovalen
- Ikatan non-kovalen
  - Ikatan hydrogen
  - Ikatan van der waals
  - Ikatan ionic
  - Interaksi hidrofobik

TABLE 2-1 Bonding Properties of Atoms Most Abundant in Biomolecules

Atom and Outer Electrons	Usual Number of Covalent Bonds	Bond Geometry
H	1	
O	2	
S	2, 4, or 6	
N	3 or 4	
P	5	
C	4	


(a)
Protein A
Noncovalent interactions
Protein B
(b)
Small molecule subunits
Macromolecule
(c)
k_f
k_r
k_eq = k_f / k_r
(d)
"High-energy" phosphoanhydride bonds
γ
β
α
Adenosine triphosphate (ATP)

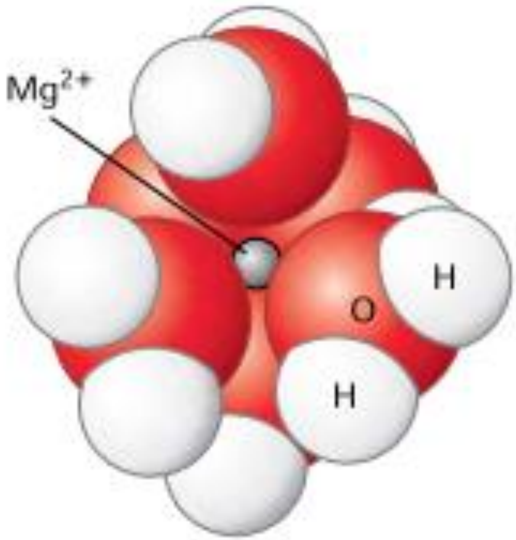
Air



▲ **FIGURE 2-3 The dipole nature of a water molecule.** The symbol δ represents a partial charge (a weaker charge than the one on an electron or a proton). Because of the difference in the electronegativities of H and O, each of the polar H—O bonds in water has a dipole moment. The sizes and directions of the dipole moments of each of the bonds determine the net dipole moment of the molecule.

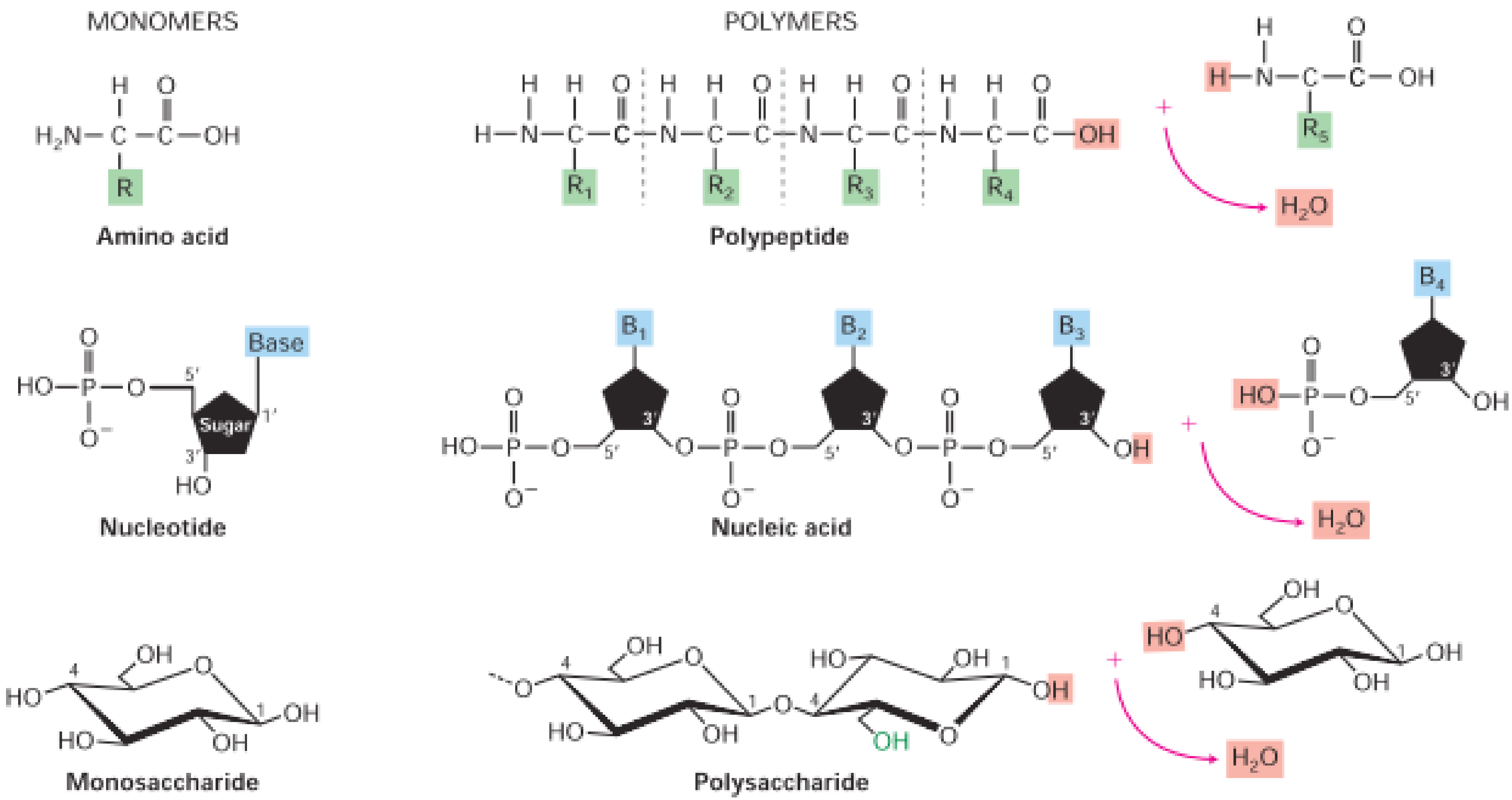
- Merupakan pelarut universal
- 70-80% berat sel → air
- Banyak biomolekul dalam sel
  - Hidrofilik → "suka air" → larut dalam air
  - Hidrofobik → "takut air" → tdk larut dalam air
  - Amfifatik → mengandung bagian yang hidrofilik dan hidrofobik

Like dissolve like
Senyawa polar akan larut dalam pelarut polar
Senyawa non-polar akan larut dalam pelarut non-polar

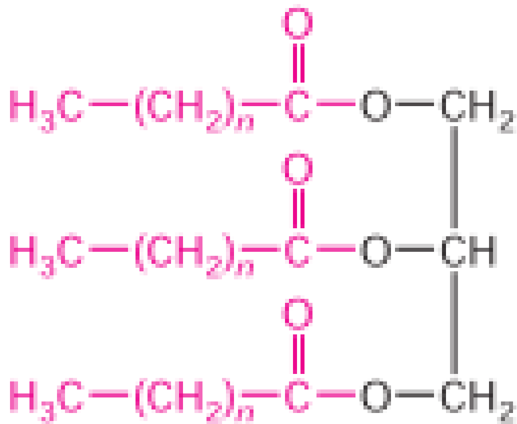


▲ FIGURE 2-5 Electrostatic interaction between water and a magnesium ion (Mg^{2+}). Water molecules are held in place by electrostatic interactions between the two positive charges on the ion and the partial negative charge on the oxygen of each water molecule. In aqueous solutions, all ions are surrounded by a similar hydration shell.

Kimiawi penyusun sel lainnya merupakan molekul anorganik dan molekul organic kecil yang menjadi subunit makromolekul

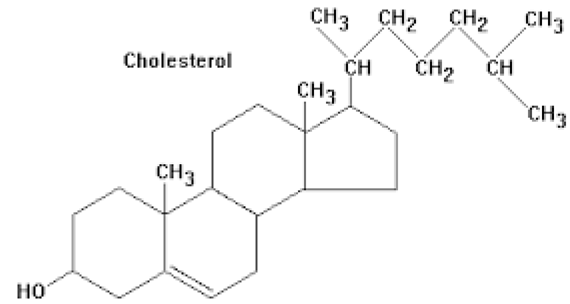


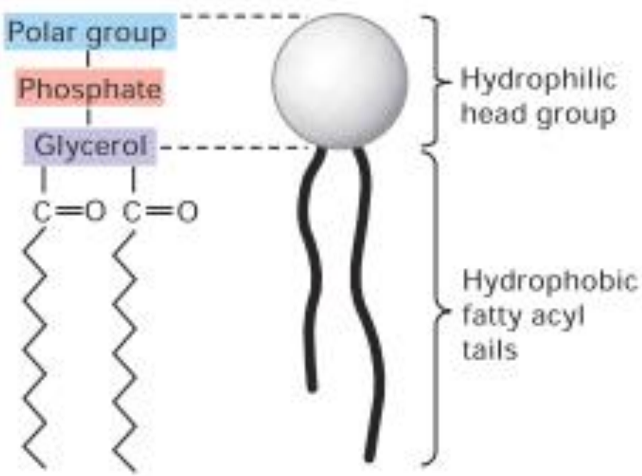
lipid



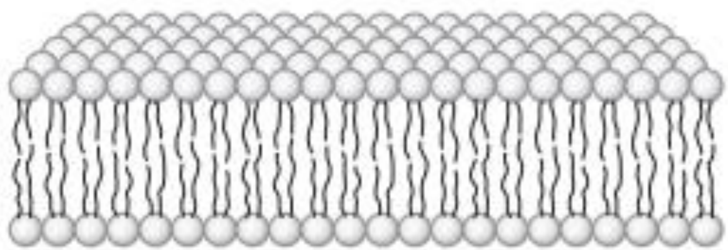
Triacylglycerol

Cholesterol





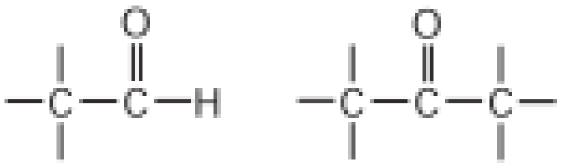
Glycerophospholipid



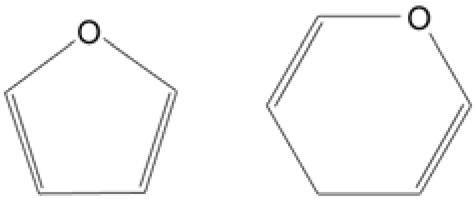
Phospholipid bilayer

Karbohidrat

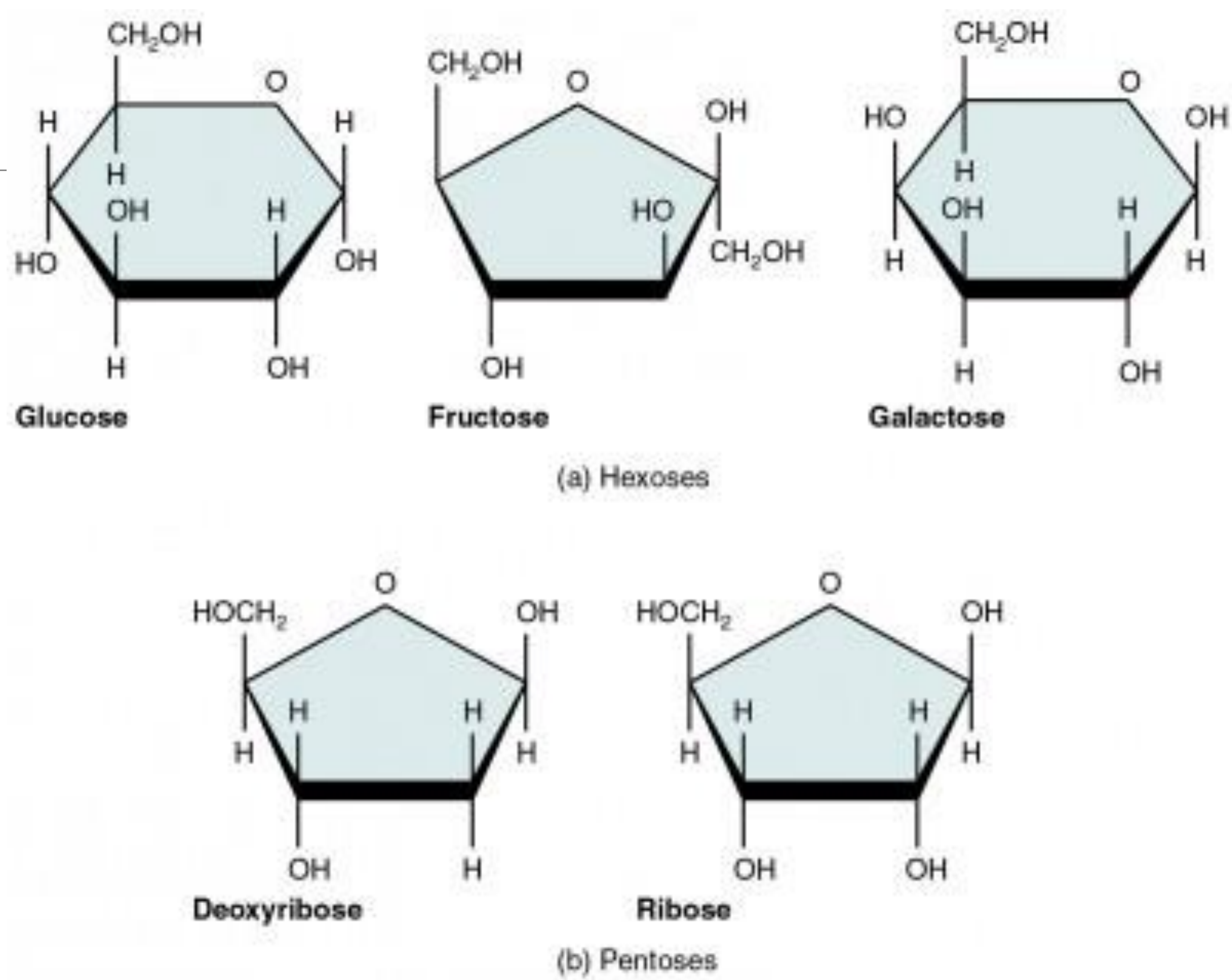
- Polimer yang tersusun atas monosakarida
- Monosakarida
  - Berdasarkan gugus: aldose dan ketosa
  - Berdasarkan rantai: alifatik dan siklik
    - Siklik: piran dan furan
  - Berdasarkan jumlah atom C penyusunnya:
    - C3 → triosa
    - C4 → tetrosa
    - C5 → pentosa
    - C6 → heksosa
    - C7 → heptulosa



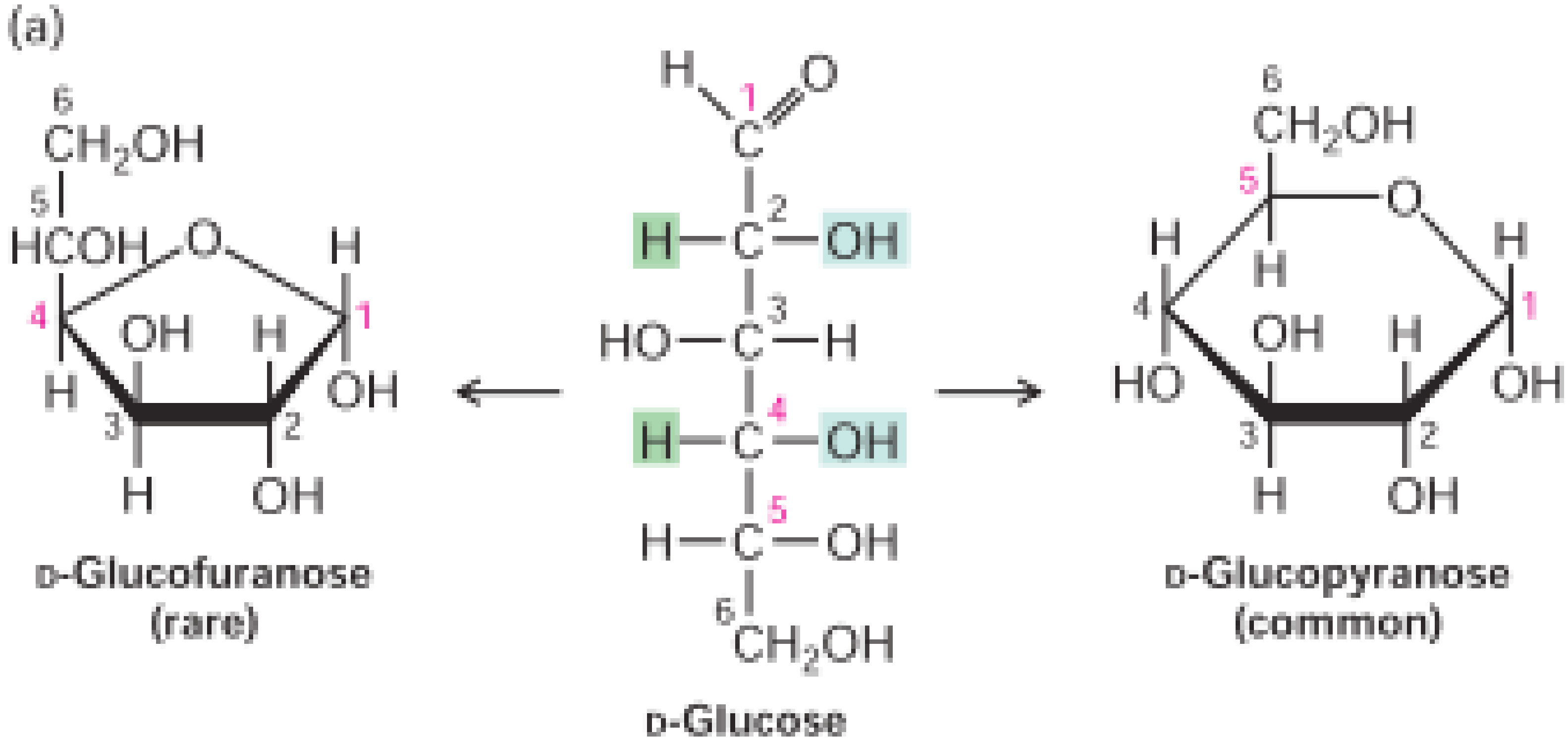
Aldehyde   Keto



Furan   Pyran

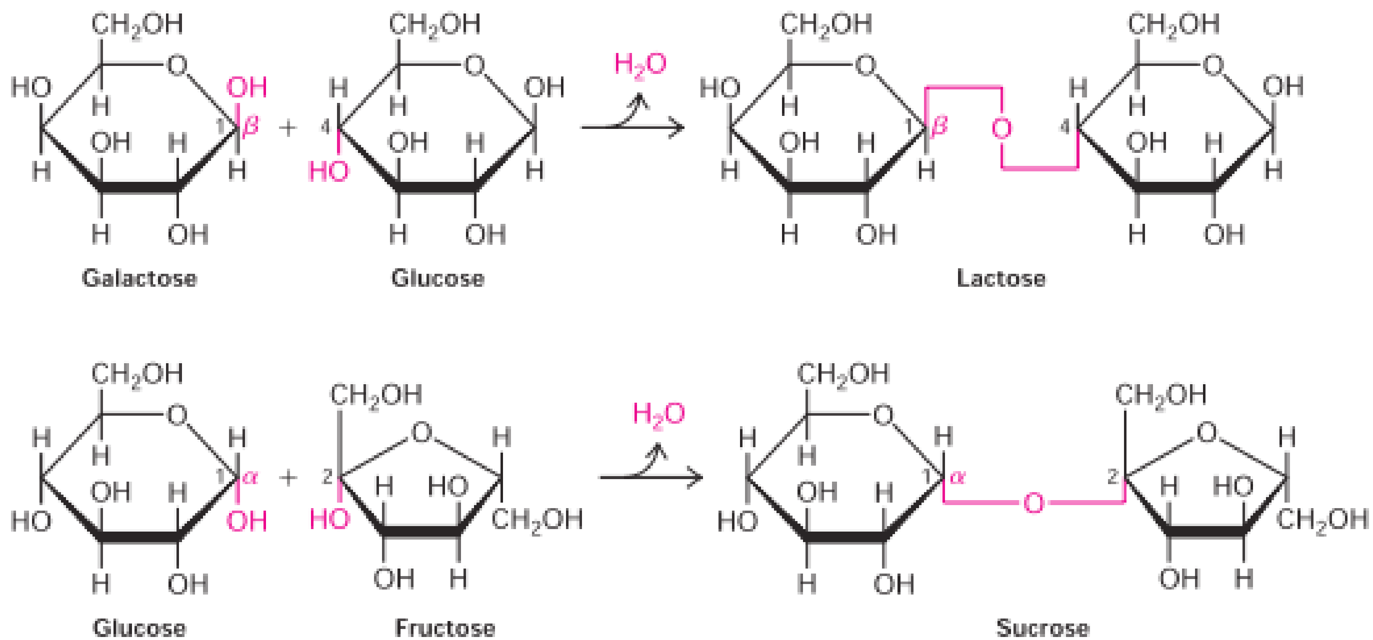


CH2OH
O
H
H
H
OH
H
HO
OH
H
OH
Glucose
CH2OH
O
OH
HO
CH2OH
OH
Fructose
CH2OH
O
HO
OH
H
OH
H
H
H
H
OH
Galactose
(a) Hexoses
O
HOCH2
OH
H
H
H
H
OH
H
Deoxyribose
O
HOCH2
OH
H
H
H
H
OH
OH
Ribose
(b) Pentoses


(a)
6
CH_2OH
5
HCOH
O
H
4
OH
H
1
H
OH
3
2
H
OH
D-Glucofuranose
(rare)
H
O
1
C
2
H—C—OH
3
HO—C—H
4
H—C—OH
5
H—C—OH
6
CH_2OH
D-Glucose
6
CH_2OH
5
O
H
H
H
4
1
OH
H
HO
OH
3
2
H
OH
D-Glucopyranose
(common)

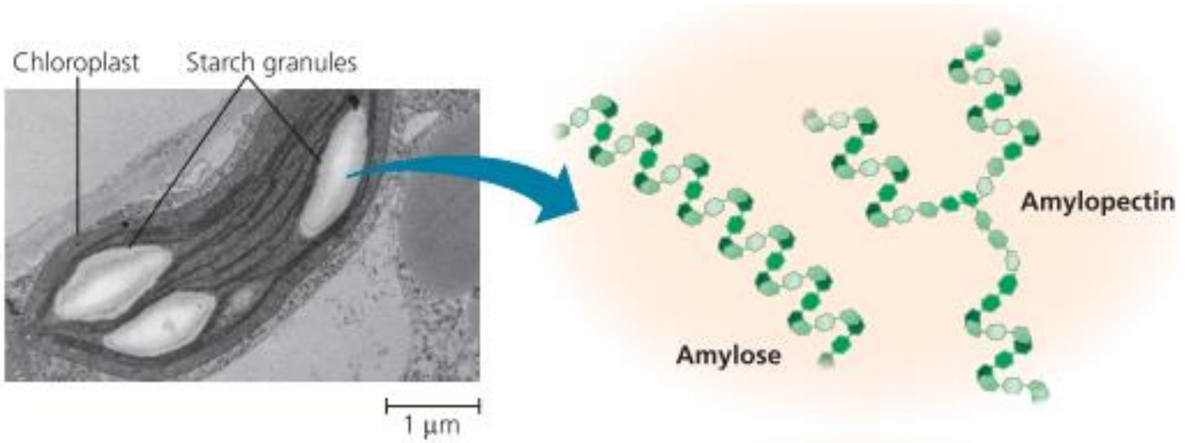
Disakarida

► FIGURE 2-17 Formation of the disaccharides lactose and sucrose. In any glycosidic linkage, the anomeric carbon of one sugar molecule (in either the α or β conformation) is linked to a hydroxyl oxygen on another sugar molecule. The linkages are named accordingly: thus lactose contains a β(1 → 4) bond, and sucrose contains an α(1 → 2) bond.

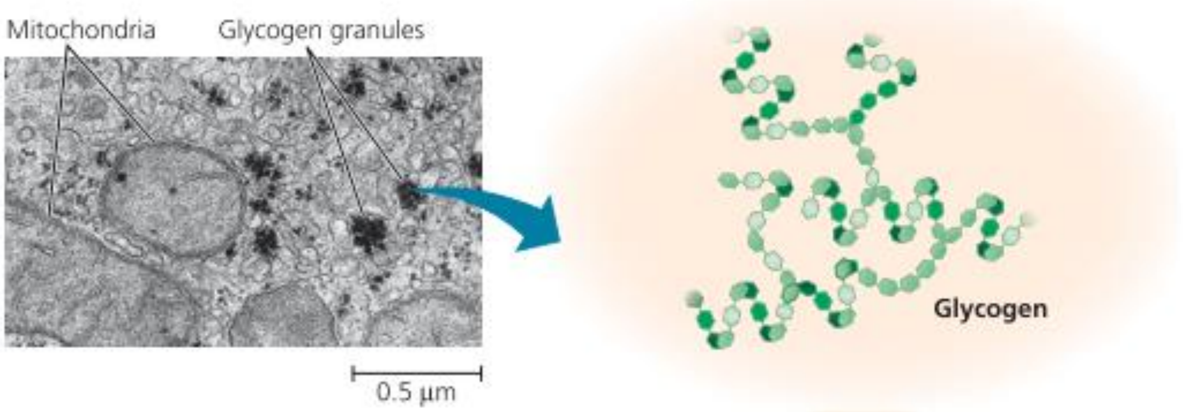


Polisakarida

(a) Starch: a plant polysaccharide. This micrograph shows part of a plant cell with a chloroplast, the cellular organelle where glucose is made and then stored as starch granules. Amylose (unbranched) and amylopectin (branched) are two forms of starch.



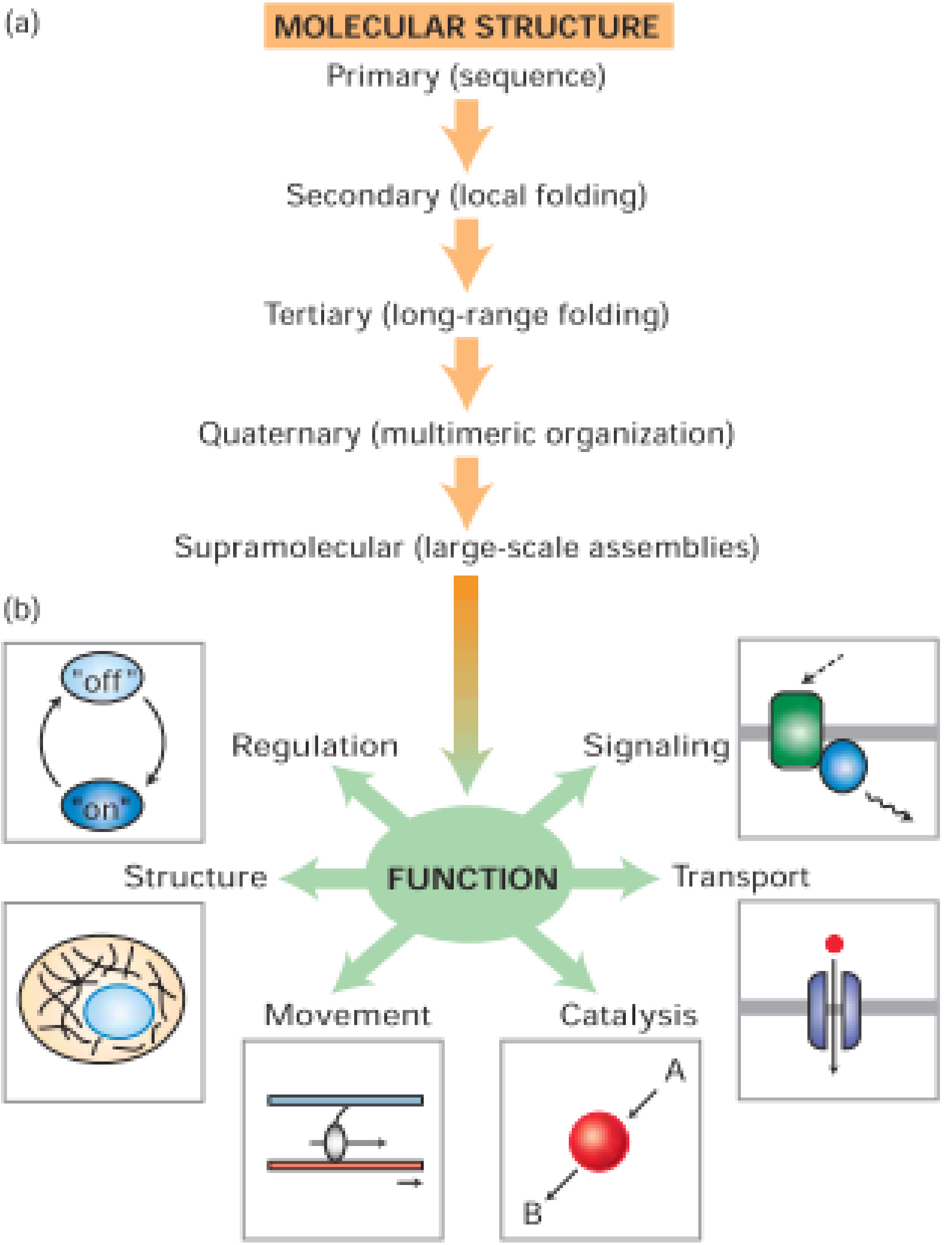
(b) Glycogen: an animal polysaccharide. Animal cells stockpile glycogen as dense clusters of granules within liver and muscle cells, as shown in this micrograph of part of a liver cell. Mitochondria are cellular organelles that help break down glucose released from glycogen. Note that glycogen is more branched than amylopectin starch.



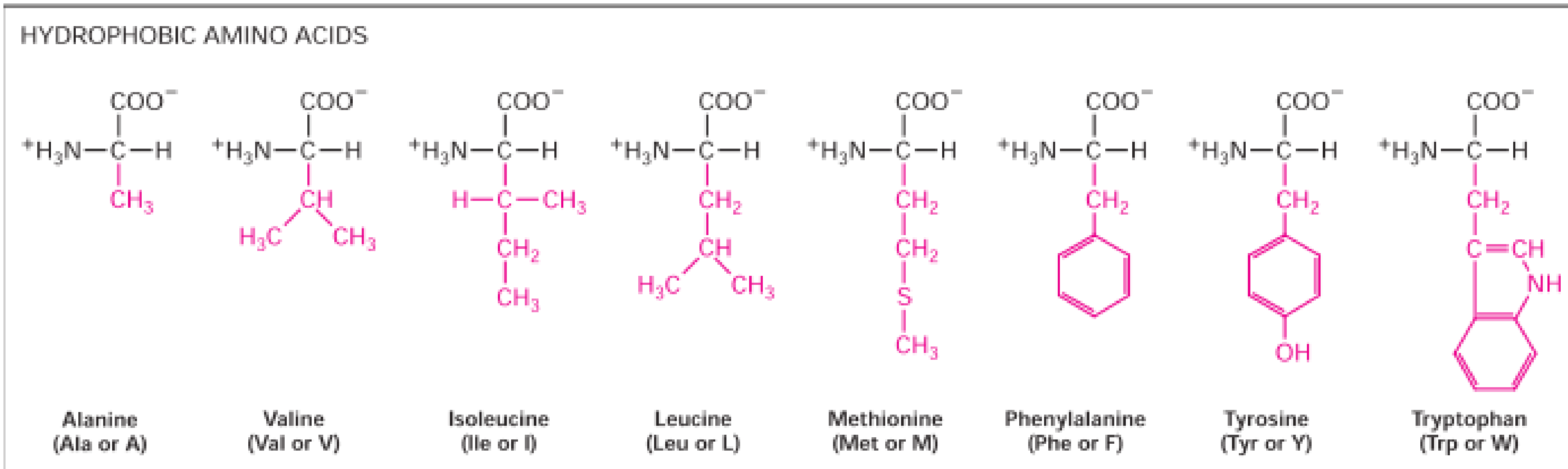
Protein

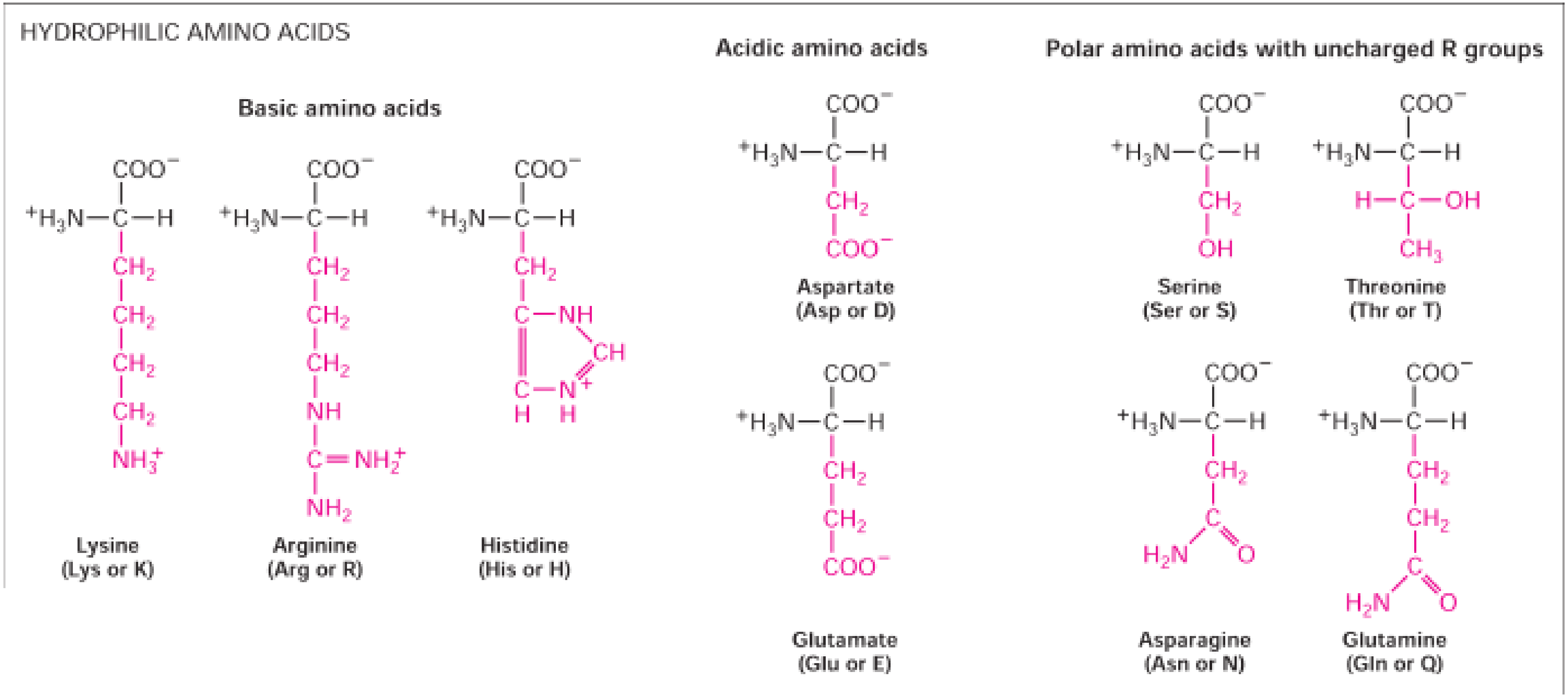
❑Dirangkai oleh monomer asam amino

❑Memiliki banyak peran di dalam sel

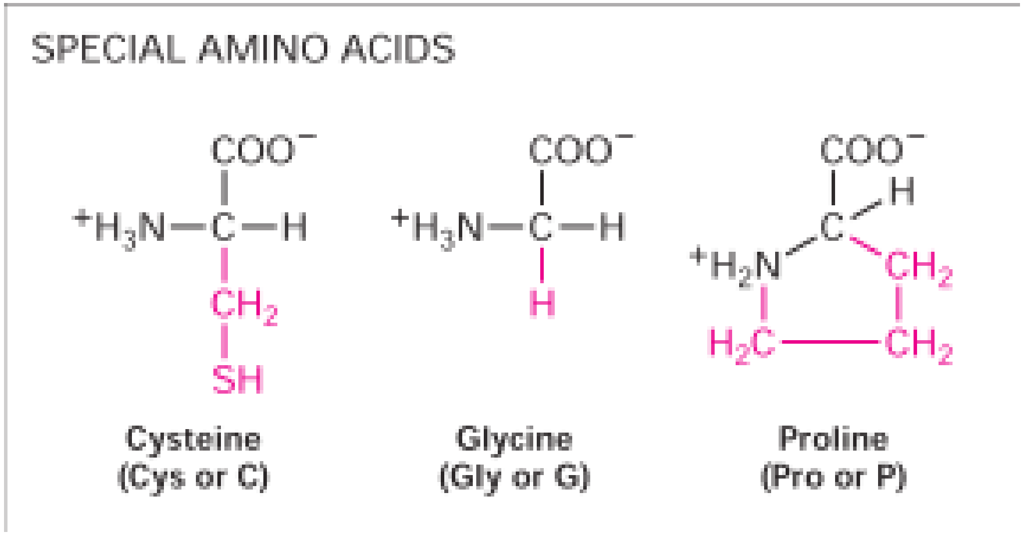


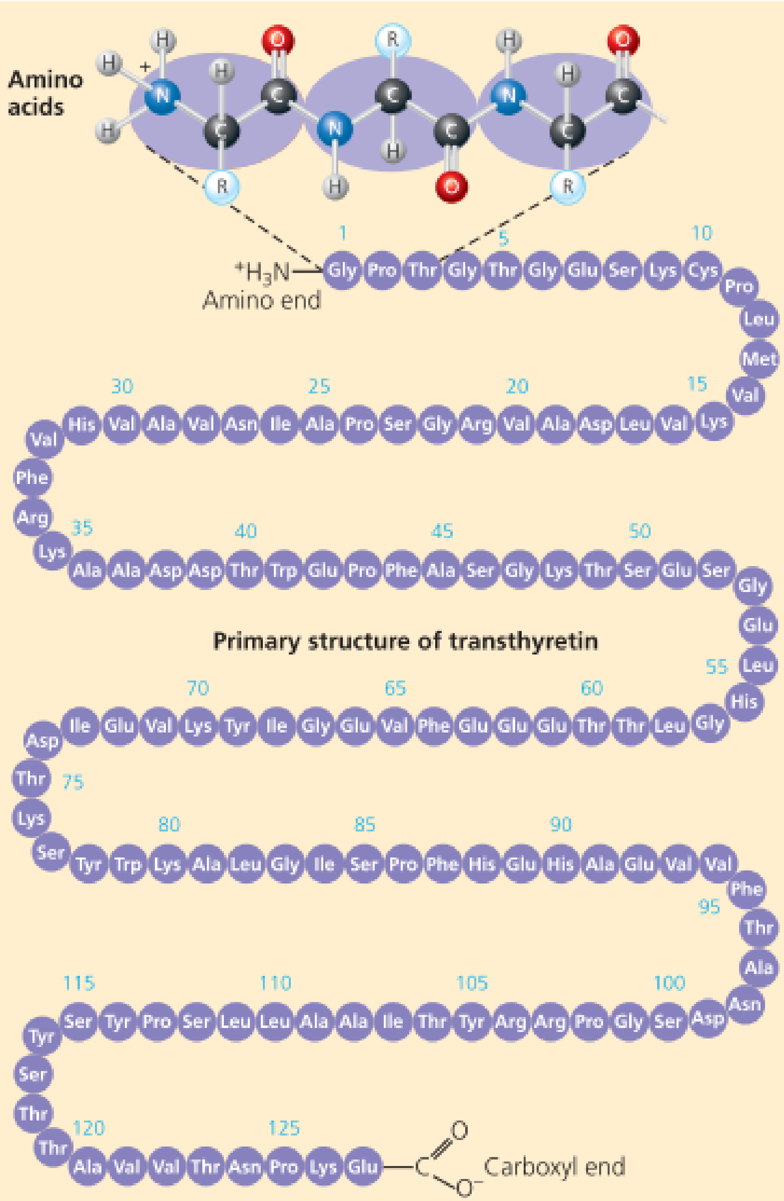
Asam amino

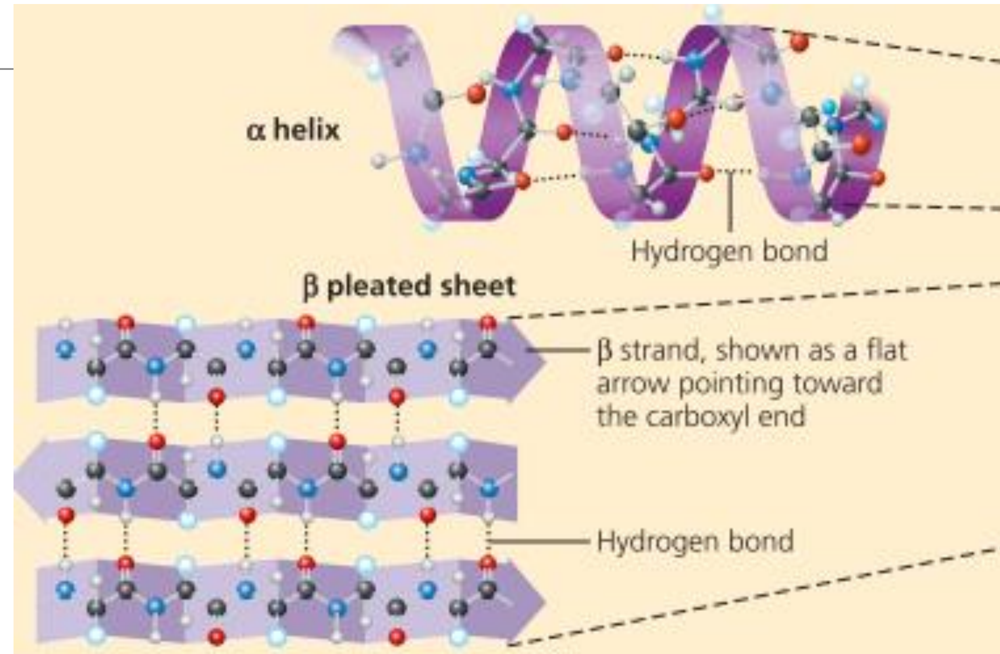

HYDROPHOBIC AMINO ACIDS
Alanine
(Ala or A)
Valine
(Val or V)
Isoleucine
(Ile or I)
Leucine
(Leu or L)
Methionine
(Met or M)
Phenylalanine
(Phe or F)
Tyrosine
(Tyr or Y)
Tryptophan
(Trp or W)

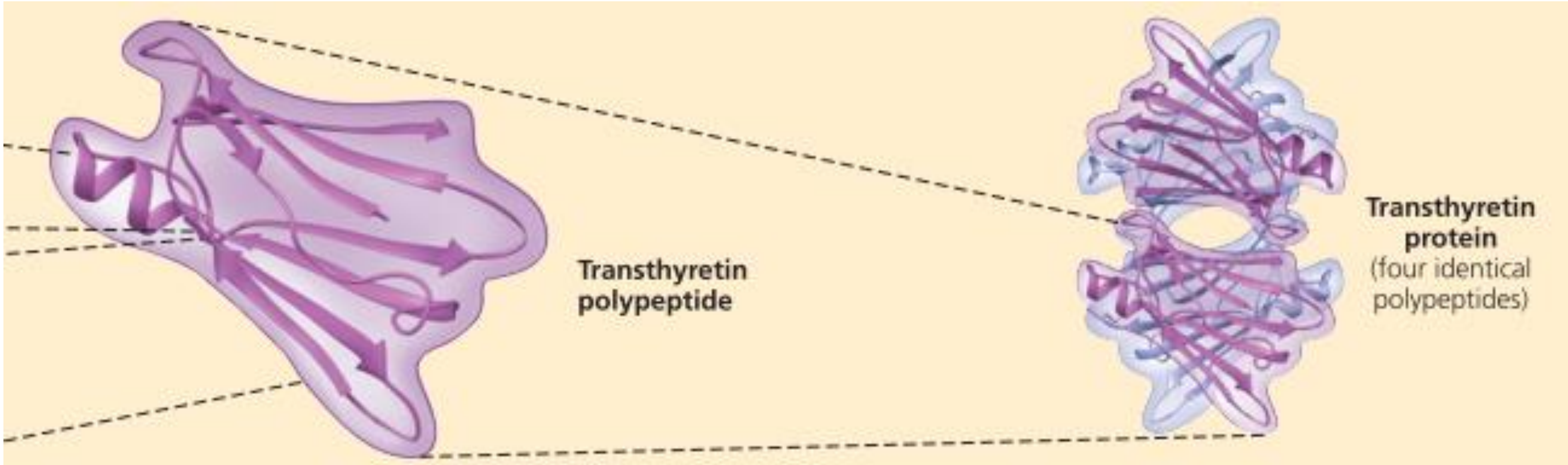


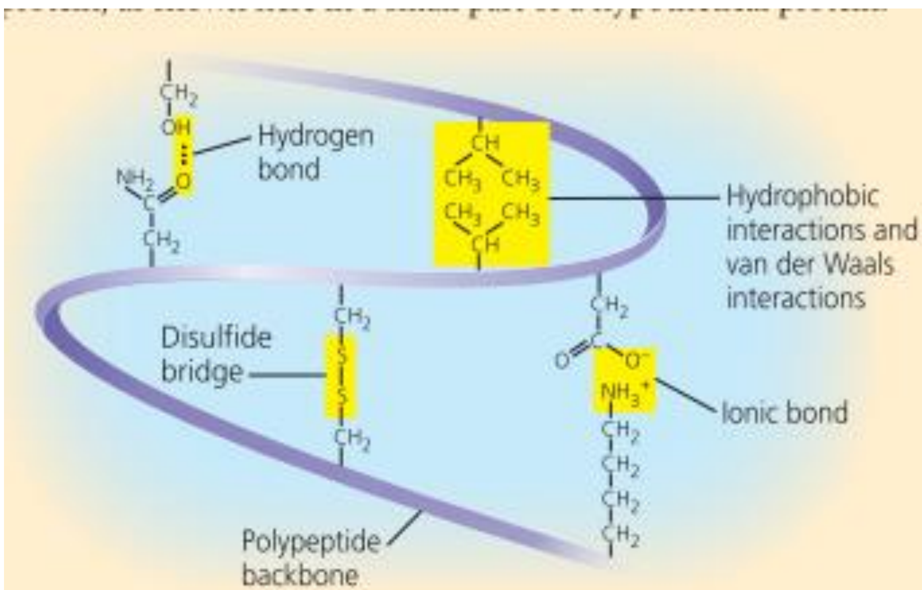
HYDROPHILIC AMINO ACIDS
Basic amino acids
Lysine
(Lys or K)
Arginine
(Arg or R)
Histidine
(His or H)
Acidic amino acids
Aspartate
(Asp or D)
Glutamate
(Glu or E)
Polar amino acids with uncharged R groups
Serine
(Ser or S)
Threonine
(Thr or T)
Asparagine
(Asn or N)
Glutamine
(Gln or Q)

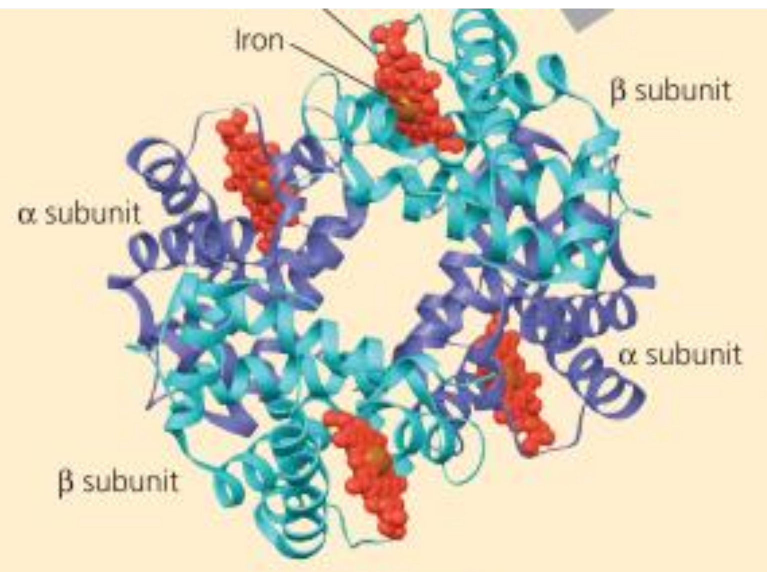

SPECIAL AMINO ACIDS
COO⁻
+H3N—C—H
CH2
SH
H
+H2N
H2C
CH2
Cysteine
(Cys or C)
Glycine
(Gly or G)
Proline
(Pro or P)


Amino acids
H
N
C
O
R
+H3N
Amino end
1 5 10
Gly Pro Thr Gly Thr Gly Glu Ser Lys Cys Pro Leu Met Val
30 25 20 15
Val His Val Ala Val Asn Ile Ala Pro Ser Gly Arg Val Ala Asp Leu Val Lys
Phe Arg Lys
35 40 45 50
Ala Ala Asp Asp Thr Trp Glu Pro Phe Ala Ser Gly Lys Thr Ser Glu Ser Gly Glu Leu His
Primary structure of transthyretin
70 65 60 55
Asp Ile Glu Val Lys Tyr Ile Gly Glu Val Phe Glu Glu Glu Thr Thr Leu Gly
Thr Lys
75
80 85 90
Ser Tyr Trp Lys Ala Leu Gly Ile Ser Pro Phe His Glu His Ala Glu Val Val Phe Thr Ala Asn
95
115 110 105 100
Tyr Ser Tyr Pro Ser Leu Leu Ala Ala Ile Thr Tyr Arg Arg Pro Gly Ser Asp
Ser Thr Thr
120 125
Ala Val Val Thr Asn Pro Lys Glu
Carboxyl end


α helix
Hydrogen bond
β pleated sheet
β strand, shown as a flat arrow pointing toward the carboxyl end
Hydrogen bond


Transthyretin polypeptide
Transthyretin protein
(four identical polypeptides)

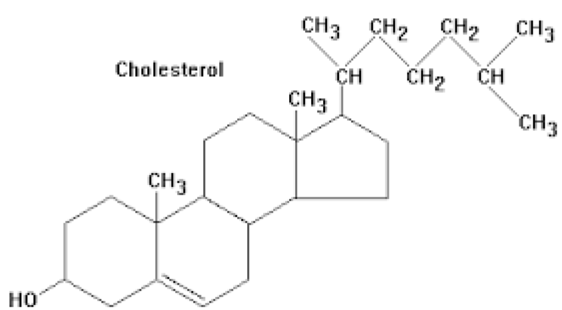

Hydrogen bond
Hydrophobic interactions and van der Waals interactions
Disulfide bridge
Ionic bond
Polypeptide backbone

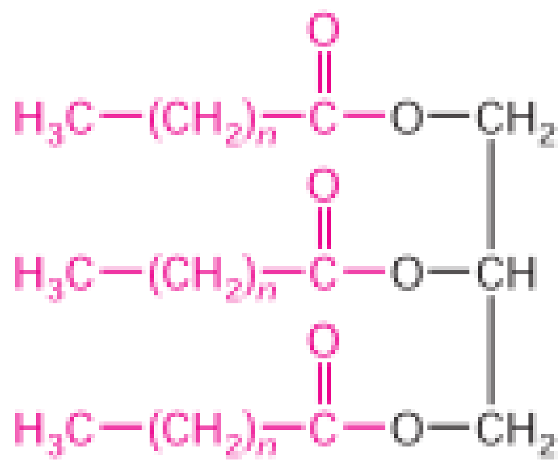

Iron
β subunit
α subunit
α subunit
β subunit

Hemoglobin

Lipid

- Biomolekul hidrokarbon yang tidak larut dalam air
- Dapat disaponifikasi
- Terdiri dari:
  - Lipid sederhana → trigliserida
  - Lipid kompleks → fosfolipid
  - Turunan lipid / steroid → kolesterol



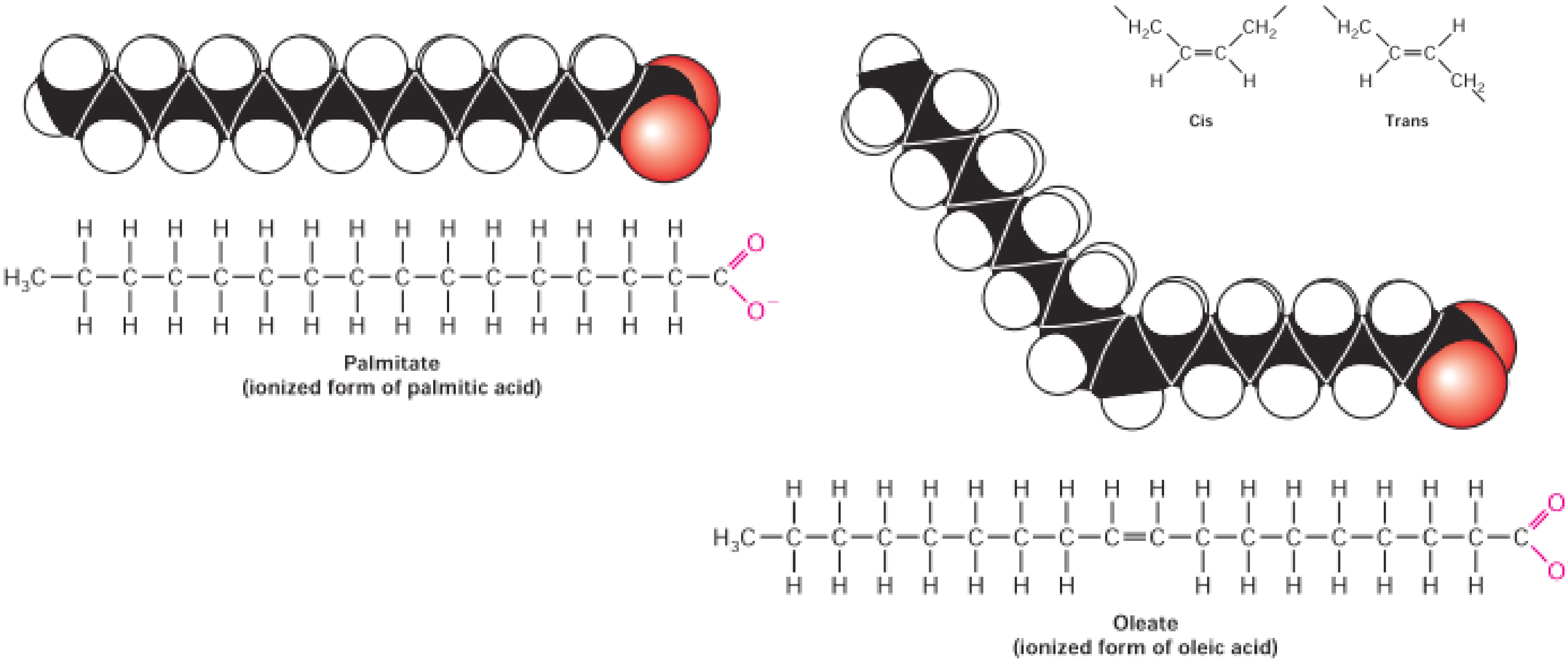


Triacylglycerol

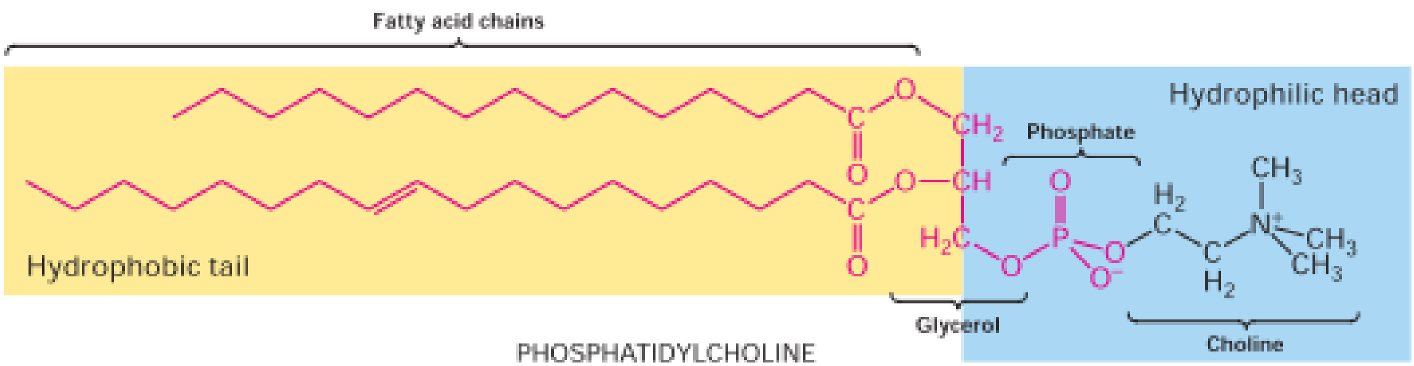
Asam lemak

TABLE 2-3 Fatty Acids That Predominate in Phospholipids

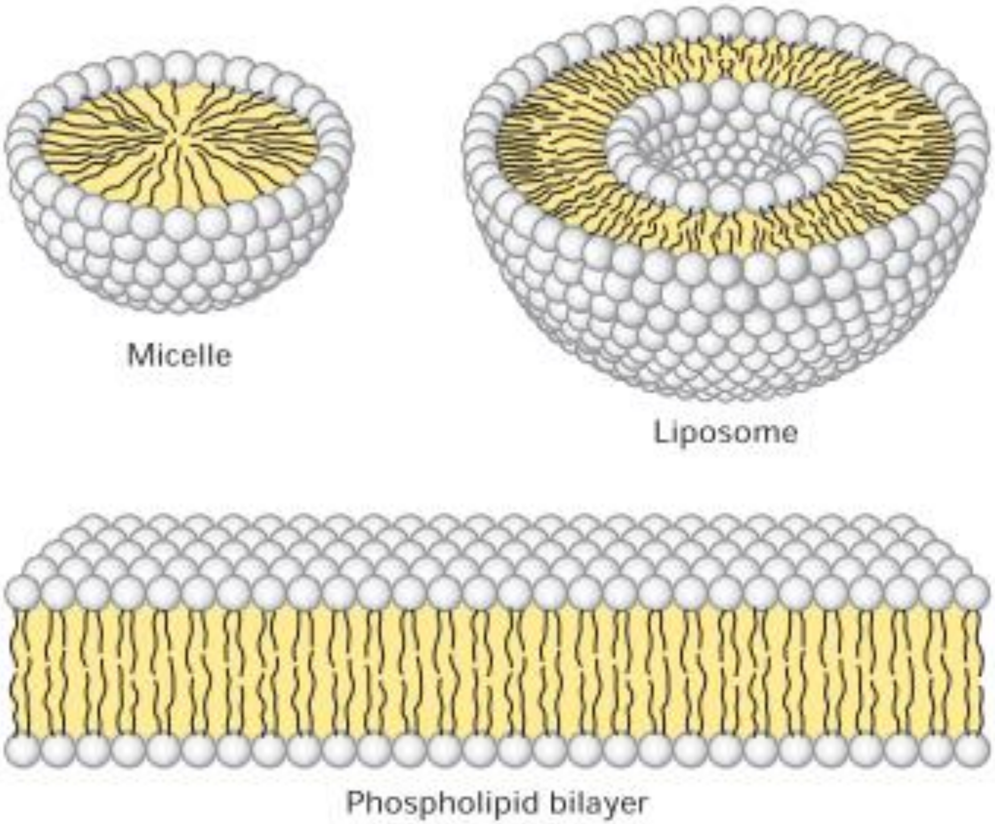
Common Name of Acid (Ionized Form in Parentheses)	Abbreviation	Chemical Formula
SATURATED FATTY ACIDS		
Myristic (myristate)	C14:0	$CH_3(CH_2)_{12}COOH$
Palmitic (palmitate)	C16:0	$CH_3(CH_2)_{14}COOH$
Stearic (stearate)	C18:0	$CH_3(CH_2)_{16}COOH$
UNSATURATED FATTY ACIDS		
Oleic (oleate)	C18:1	$CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$
Linoleic (linoleate)	C18:2	$CH_3(CH_2)_4CH{=}CHCH_2CH{=}CH(CH_2)_7COOH$
Arachidonic (arachidonate)	C20:4	$CH_3(CH_2)_4(CH{=}CHCH_2)_3CH{=}CH(CH_2)_3COOH$



▲ FIGURE 2-18 The effect of a double bond on the shape of fatty acids. Shown are space-filling models and chemical structures of the ionized form of palmitic acid, a saturated fatty acid with 16 C atoms, and oleic acid, an unsaturated one with 18 C atoms. In saturated fatty acids, the hydrocarbon chain is often linear; the cis double bond in oleate creates a rigid kink in the hydrocarbon chain. [After L. Stryer, 1994, *Biochemistry,* 4th ed., W. H. Freeman and Company, p. 265.]



▲ FIGURE 2-19 Phosphatidylcholine, a typical phosphoglyceride. All phosphoglycerides are amphipathic, having a hydrophobic tail (yellow) and a hydrophilic head (blue) in which glycerol is linked via a phosphate group to an alcohol. Either of or both the fatty acyl side chains in a phosphoglyceride may be saturated or unsaturated. In phosphatidic acid (red), the simplest phospholipid, the phosphate is not linked to an alcohol.

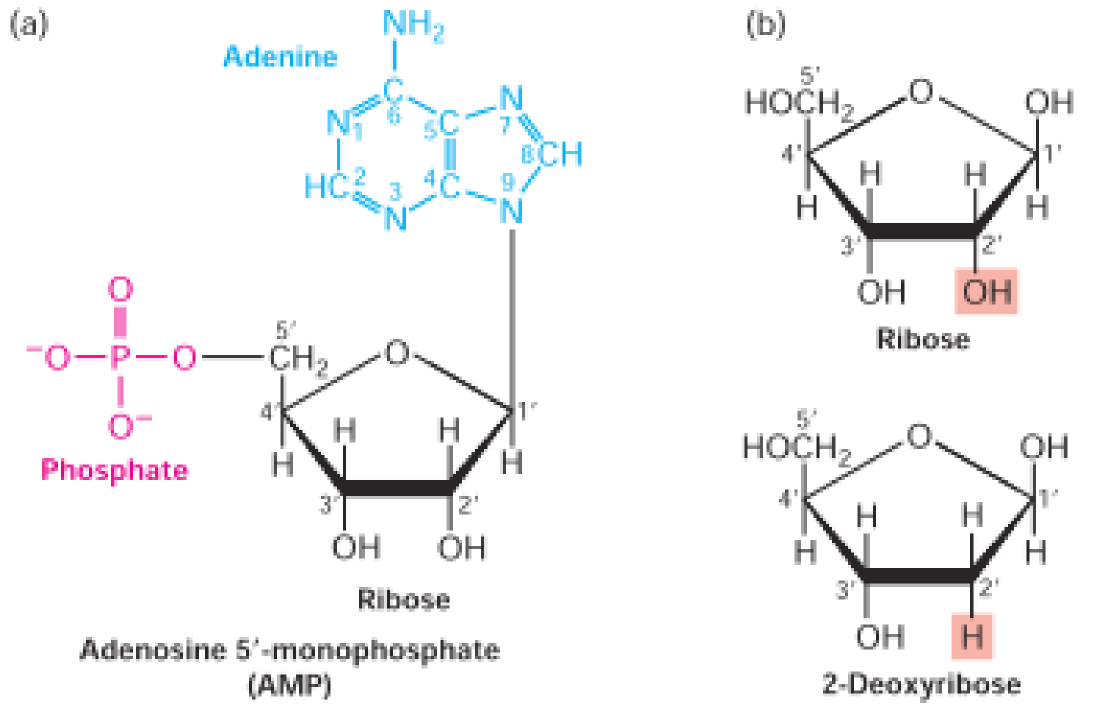


▲ **FIGURE 2-20 Cross-sectional views of the three structures formed by phospholipids in aqueous solutions.** The white spheres depict the hydrophilic heads of the phospholipids, and the squiggly black lines (in the yellow regions) represent the hydrophobic tails. Shown are a spherical micelle with a hydrophobic interior composed entirely of fatty acyl chains; a spherical liposome, which has two phospholipid layers and an aqueous center; and a two-molecule-thick sheet of phospholipids, or bilayer, the basic structural unit of biomembranes.

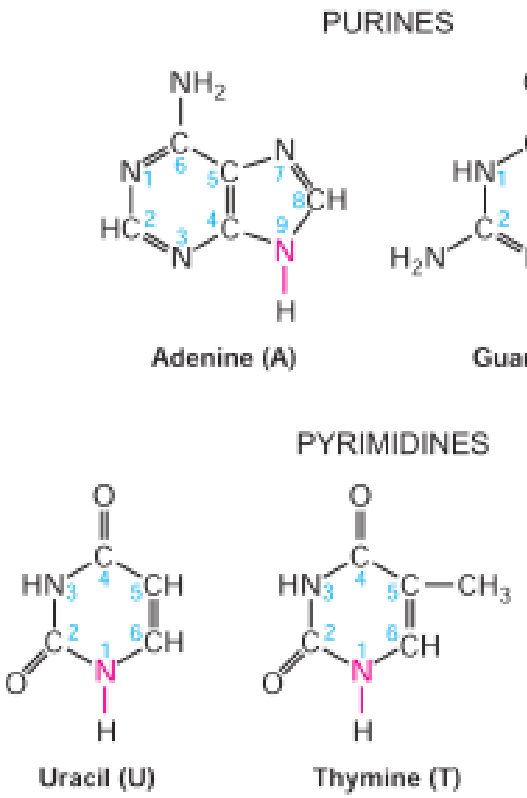
Asam Nukleat

Polimer yang disusun

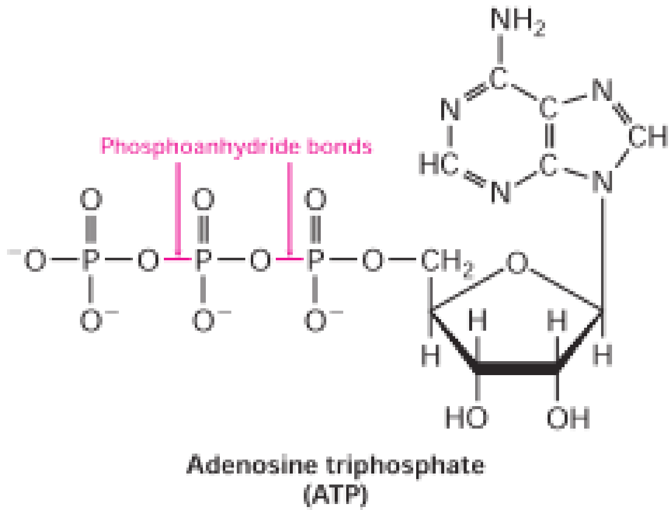
Atas nukleotida



▲ FIGURE 2-14 Common structure of nucleotides. (a) Adenosine 5′-monophosphate (AMP), a nucleotide present in RNA. By convention, the carbon atoms of the pentose sugar in nucleotides are numbered with primes. In natural nucleotides, the 1′ carbon is joined by a β linkage to the base (in this case adenine); both the base (blue) and the phosphate on the 5′ hydroxyl (red) extend above the plane of the furanose ring. (b) Ribose and deoxyribose, the pentoses in RNA and DNA, respectively.



▲ FIGURE 2-15 Chemical structures of the principal bases in nucleic acids. In nucleic acids and nucleotides, nitrogen 9 of purines and nitrogen 1 of pyrimidines (red) are bonded to the 1′ carbon of ribose or deoxyribose. U is only in RNA, and T is only in DNA. Both RNA and DNA contain A, G, and C.



▲ **FIGURE 2-24 Adenosine triphosphate (ATP).** The two phosphoanhydride bonds (red) in ATP, which link the three phosphate groups, each has a $\Delta G^{\circ\prime}$ of −7.3 kcal/mol for hydrolysis. Hydrolysis of these bonds, especially the terminal one, drives many energy-requiring reactions in biological systems.