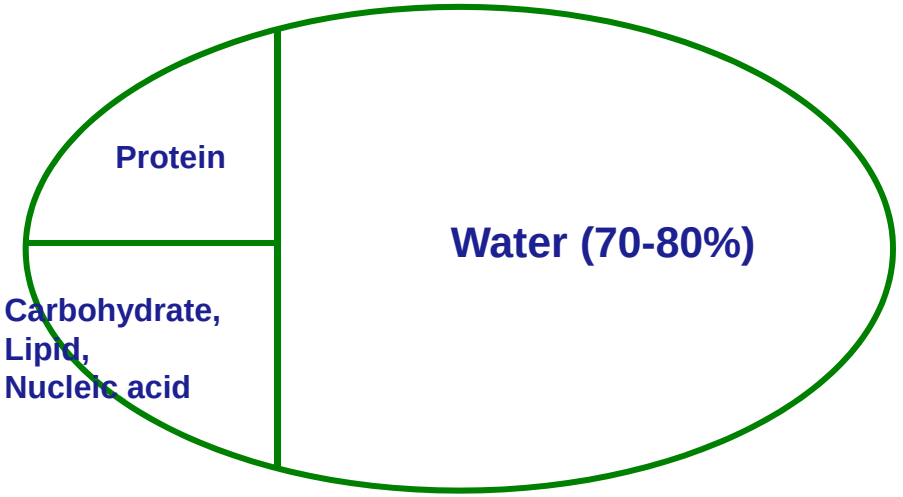
Chapter 3

Molecular Components of Cells

Molecular Components of Cells

- Chemical composition
  - C, H, O, N and small amount of other elements
- Molecular building blocks
  - Lipids
  - Carbohydrates
  - Proteins
  - Nucleic acids
    - DNA
    - RNA



Atoms, Ions, and Molecules

- Atoms
  - Biologically important atoms

    ---- C, H, O, N, S, P, Na, K, Ca, Cl

- Ions
  - Biological importance: electrical impulse, ion balance
    - Ca2+, Na+, K+, Cl-

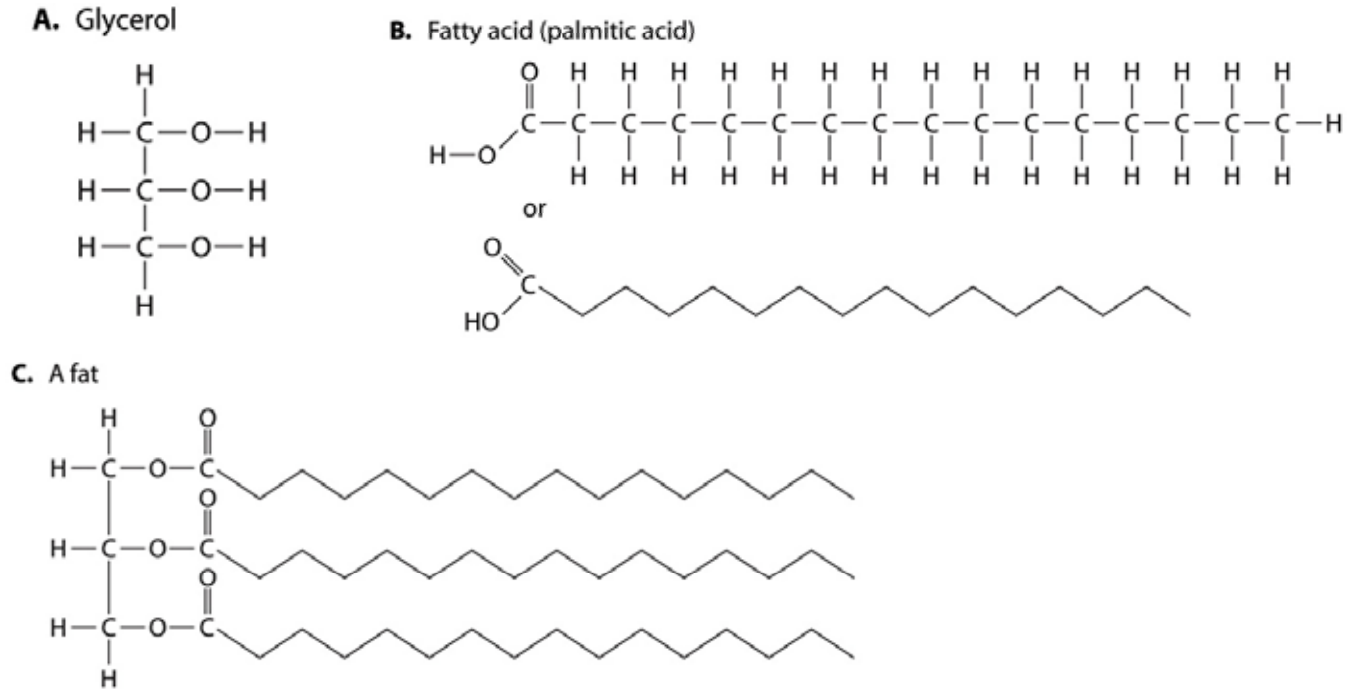
- Molecules
  - Generated from chemical bonding of atoms

Subunits of Biological Molecules

Class of Molecule	Examples	Smallest Repeating Unit
Lipid		
Carbohydrate		
Nucleic acid		
Proteins		

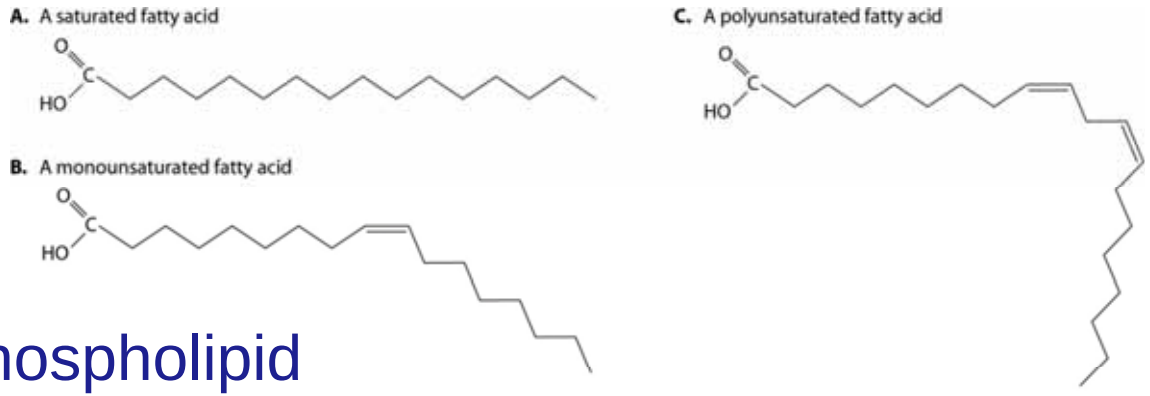
Lipids

- Hydrophobic ..
- High energy .. → good energy storage
- Fats :

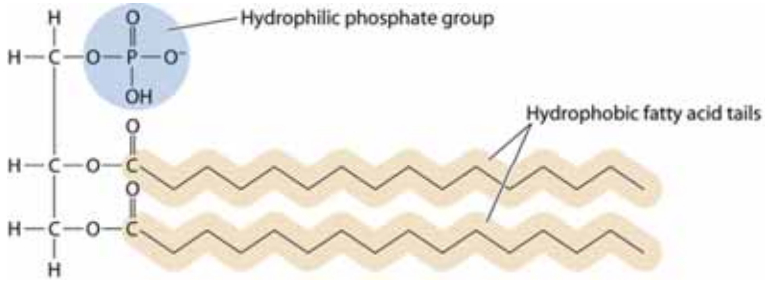


Lipid

- Fatty acid
  - Saturated:
  - Unsaturated:

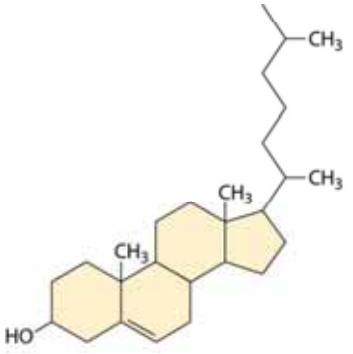


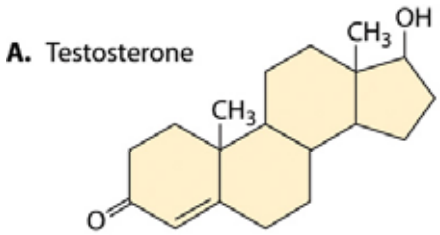
- Phospholipid
  - Glycerol backbone
  - two fatty acids (..)+ phosphate (..)

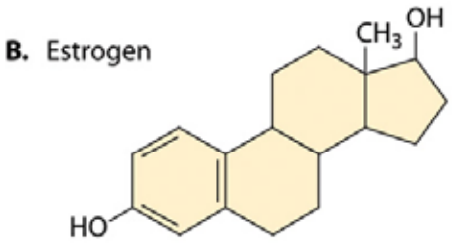


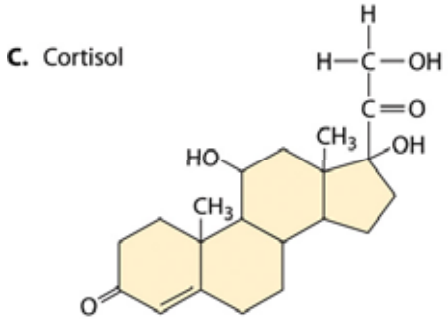
Lipids

- Sterols
  - Cyclic ..
  - Cholesterol
    - Component of ..
      - Increase membrane fluidity
    - Starting material for ..









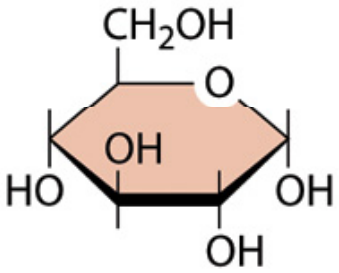
Steroid hormones

Carbohydrates

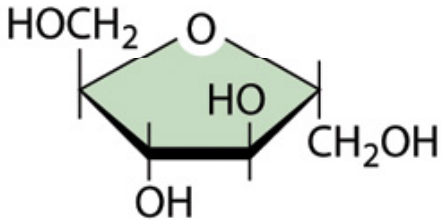
- C : H : O = 1 : 2 : 1
- Simple sugars (monosaccharide)
  - ...
- Disaccharide
  - sucrose (.. + ..)
  - lactose (.. + ..)
- Polysaccharide
  - pectin, starch, cellulose --- from ..
  - agar, carragreenan (thickener for ice cream)

Carbohydrates

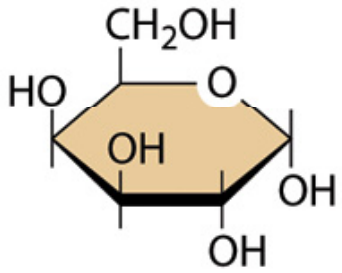
A. Simple sugars



Glucose

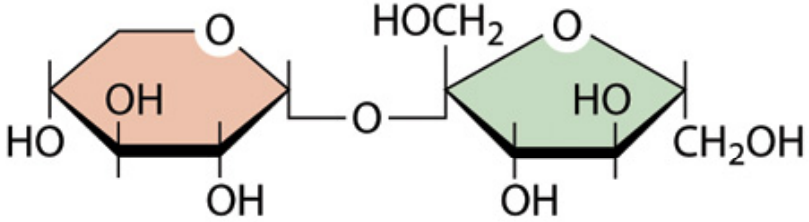


Fructose

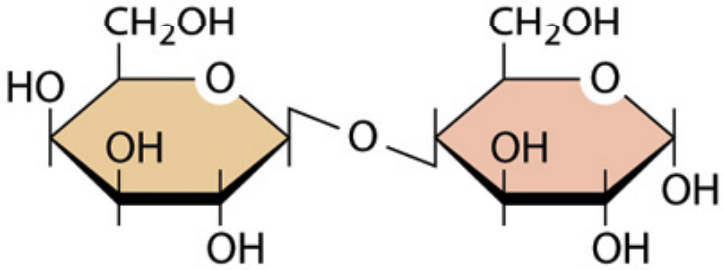


Galactose

B. Complex sugars



Sucrose (table sugar)
Glucose + fructose



Lactose (milk sugar)
Galactose + glucose

Carbohydrates

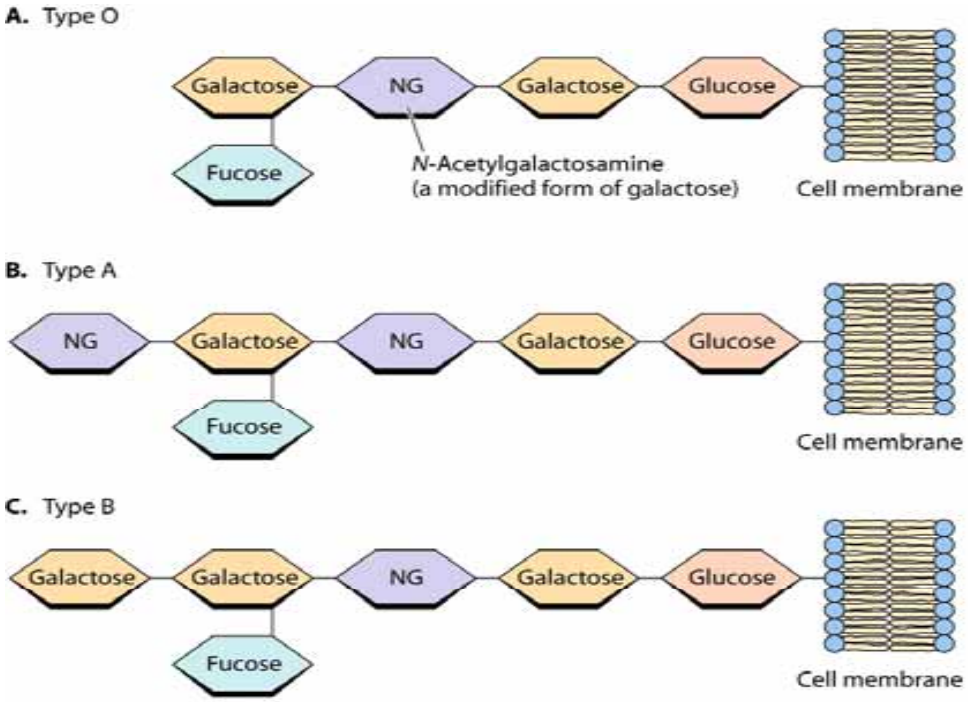
- Carbohydrates in energy metabolism
  - Plant
    - Glucose synthesis by ..

      $6CO_2 + 6H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + 6O_2$
    - Starch for ..
    - cellulose for ..
  - Animals
    - Intake ...
    - Glycogen for ..

Carbohydrates

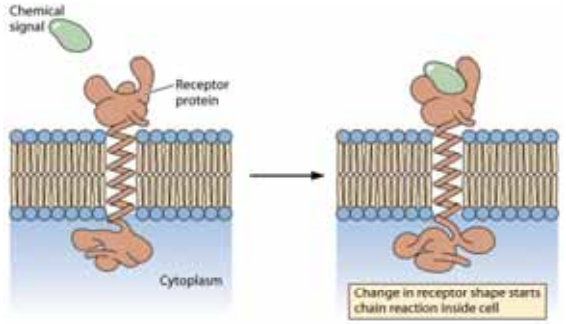
- Carbohydrates in molecular recognition
  - Often found connected to other molecules on the outsides of cells

    ----
  - e.g. blood typing :



Proteins

- Roles of proteins: most of the cellular functions



  - Enzymes :
  - Receptors :
  - Antibody :

    ..
  - Transporters :
  - Structural proteins :

- Diversity of organism
  - Due to ..

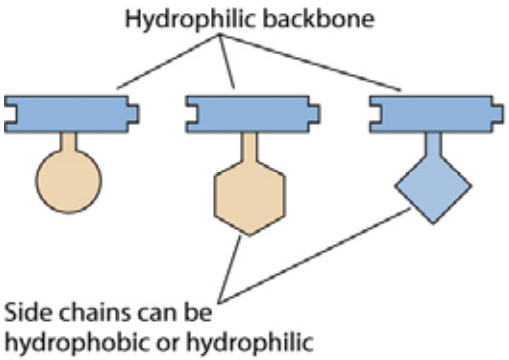
    --- particularly ..

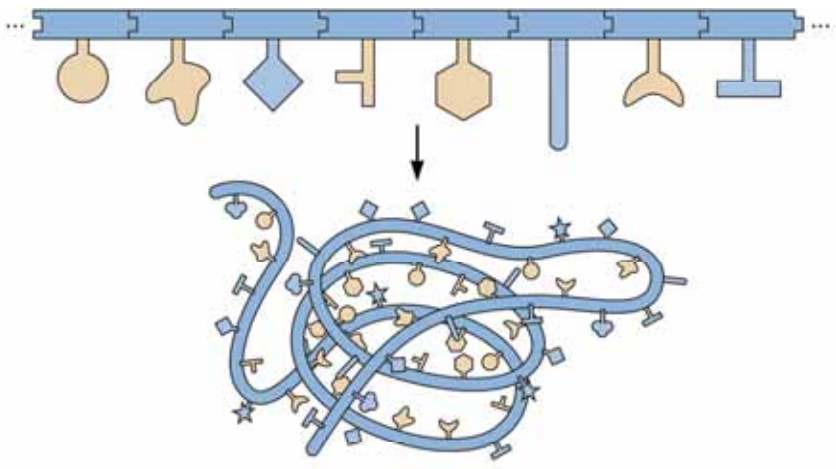
Proteins

- Amino acids
  - Building blocks of ..
  - Hydrophilic ..

    + ..
- Polypeptide
  - Amino acid chains linked by ..
- Tree-dimensional structure
  - Determines ..
  - Determined by ..

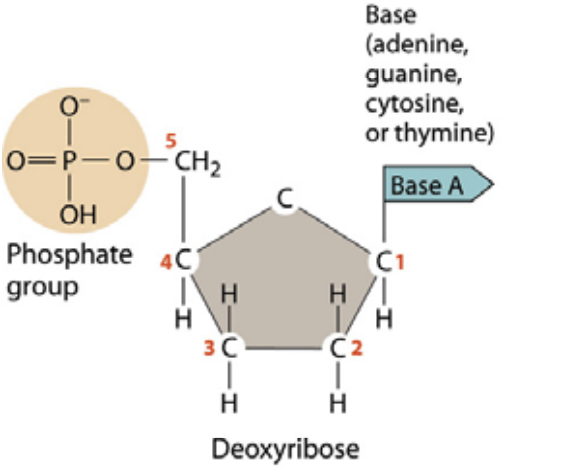
    ..

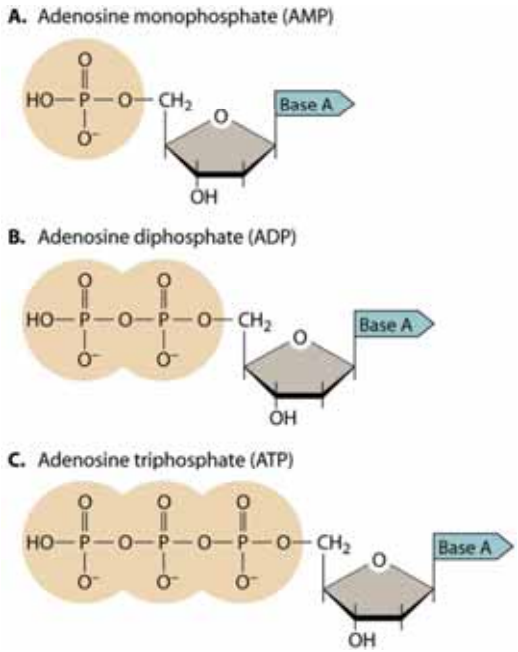




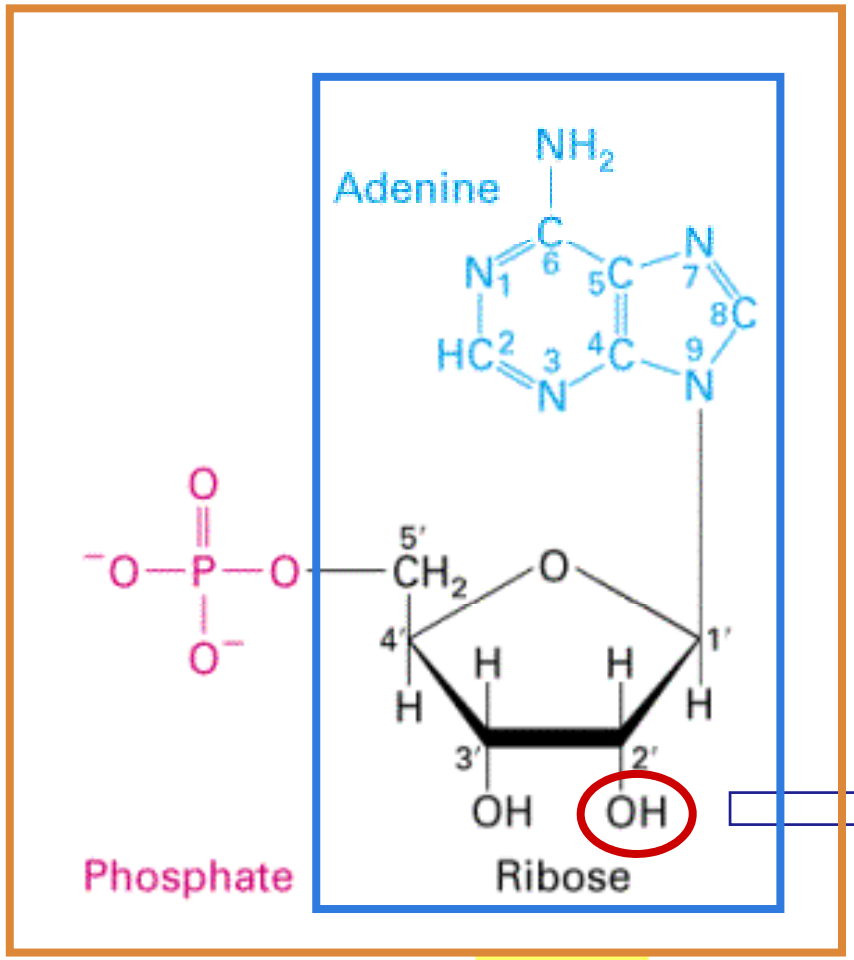
Nucleic acids

- Nucleotides
  - Building blocks of ..
  - (deoxy)ribose + phosphate group + 4 bases
  - Bases: adenine (A), guanine (G), cytosine (C), thymine (T)
- Terminology
  - Base
  - Nucleoside :
  - Nucleotide :





Primary Structure : Nucleotides



Base	Nucleoside	Nucleotide
Adenine	Adenosine	Adenylate
Guanine	Guanosine	Guanylate
Cytosine	Cytidine	Cytidylate
Thymine (D)	Thymidine	Thymidylate
Uracil (R)	Uridine	Uridylate

Purine

Pyrimidine

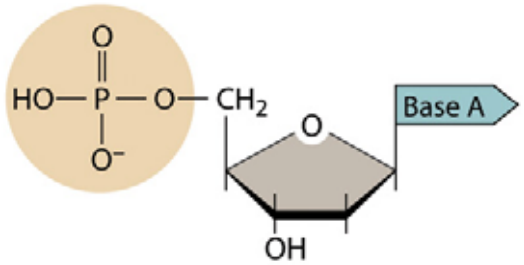
H

RNA

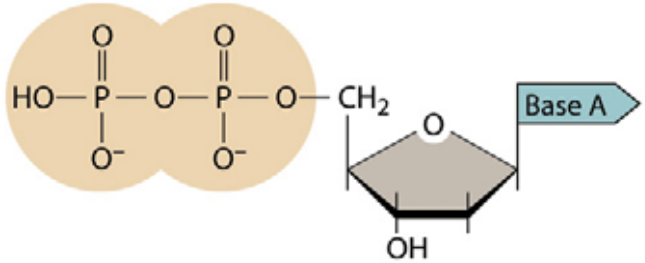
DNA

AMP, ADP, ATP

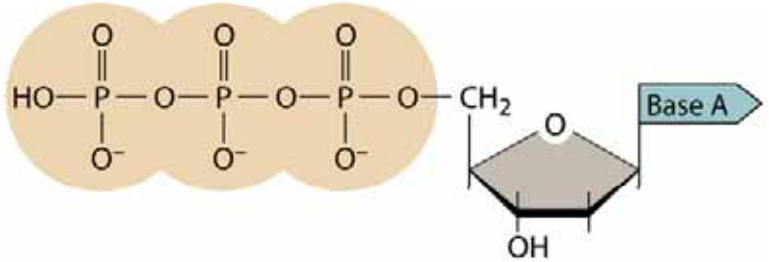
A. Adenosine monophosphate (AMP)



B. Adenosine diphosphate (ADP)



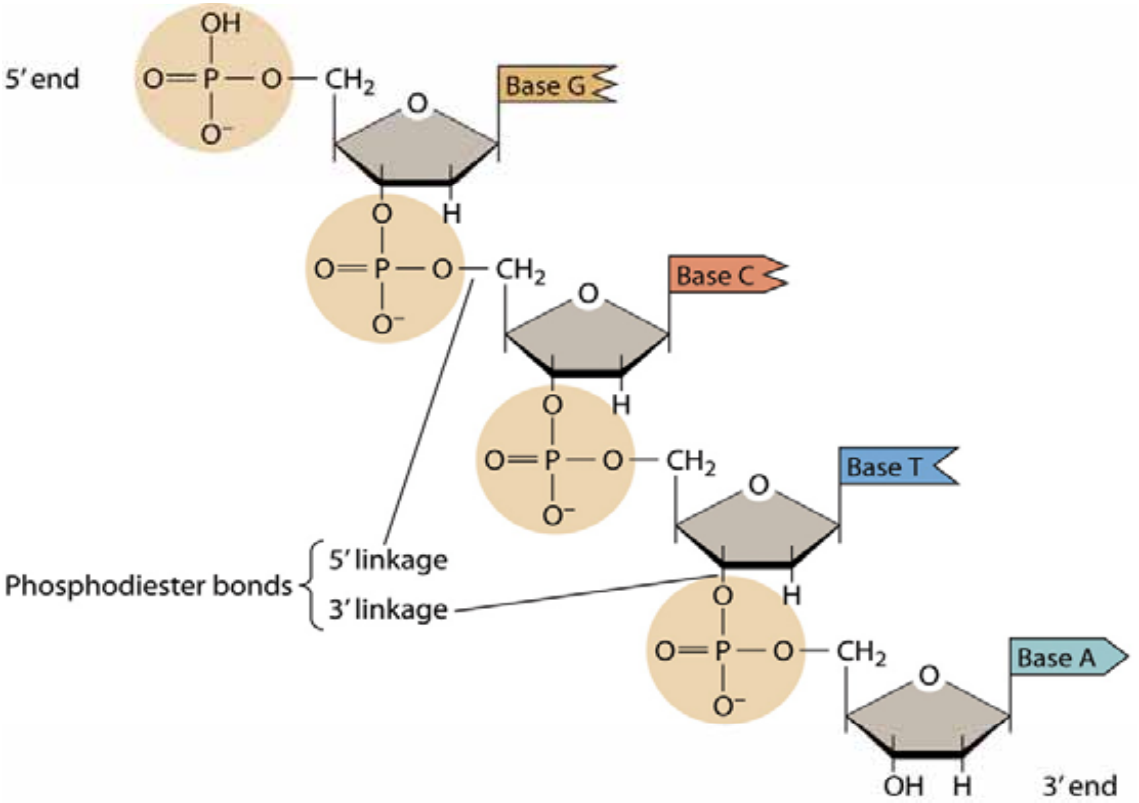
C. Adenosine triphosphate (ATP)



AMP = Adenylate

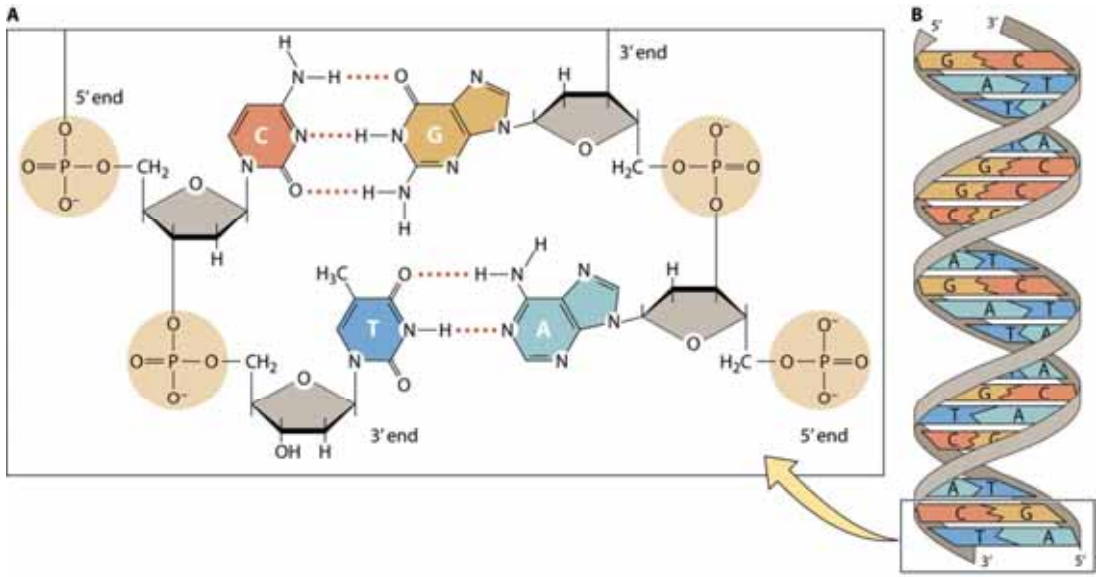
Nucleotide Chains

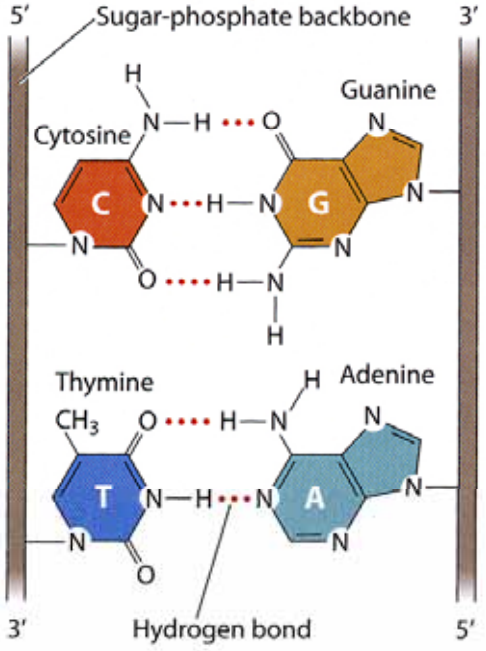
- Linkage of 5’ carbon to 3’ carbon through phosphodiester bond

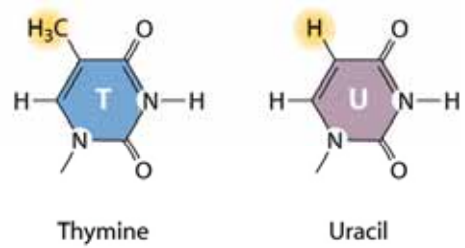


Nucleotide Chains

- Base pairing
  - C≡G, T=A : ..
  - Complementary base pairs
  - Antipararallel strand in DNA molecule

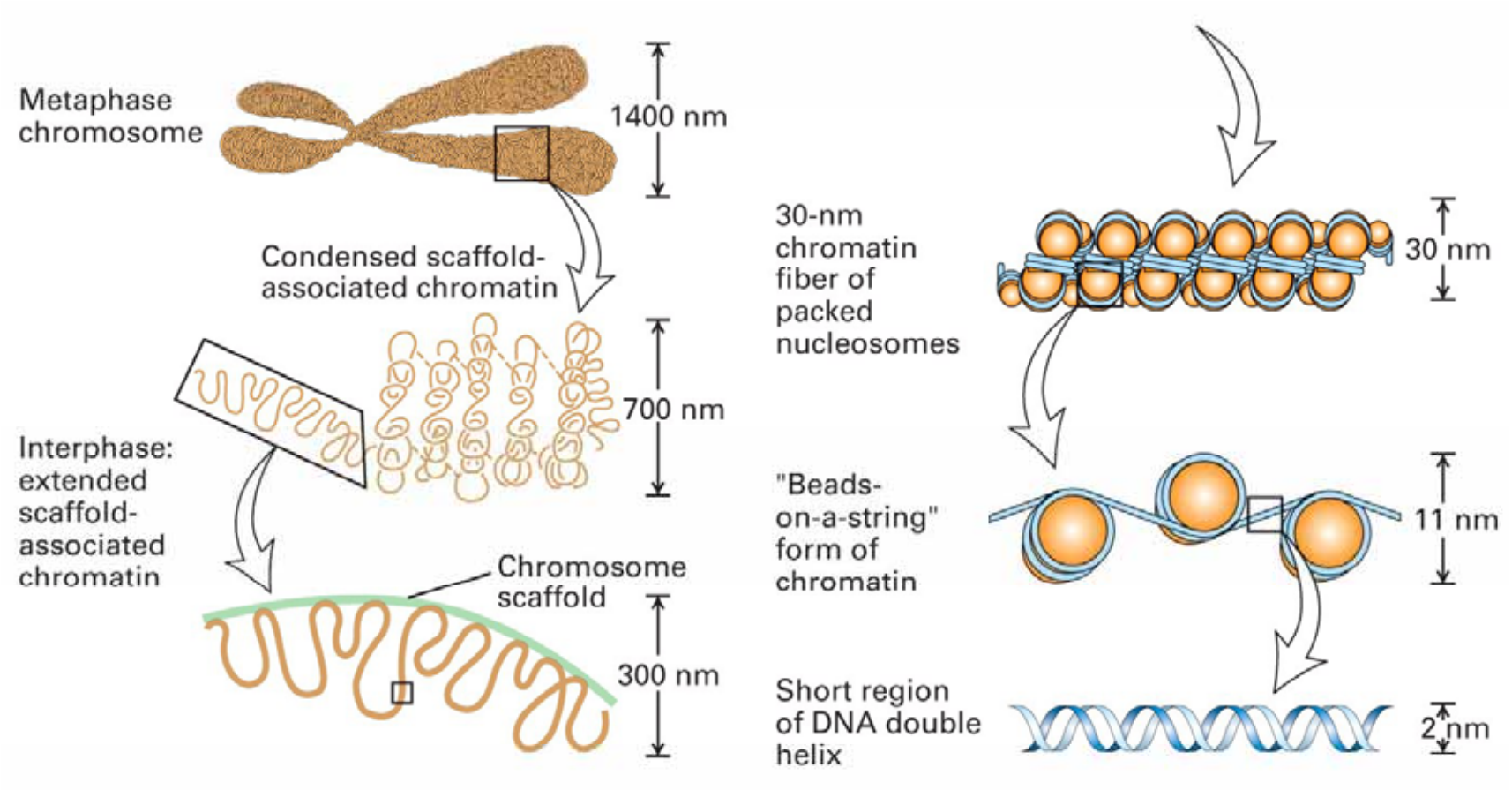






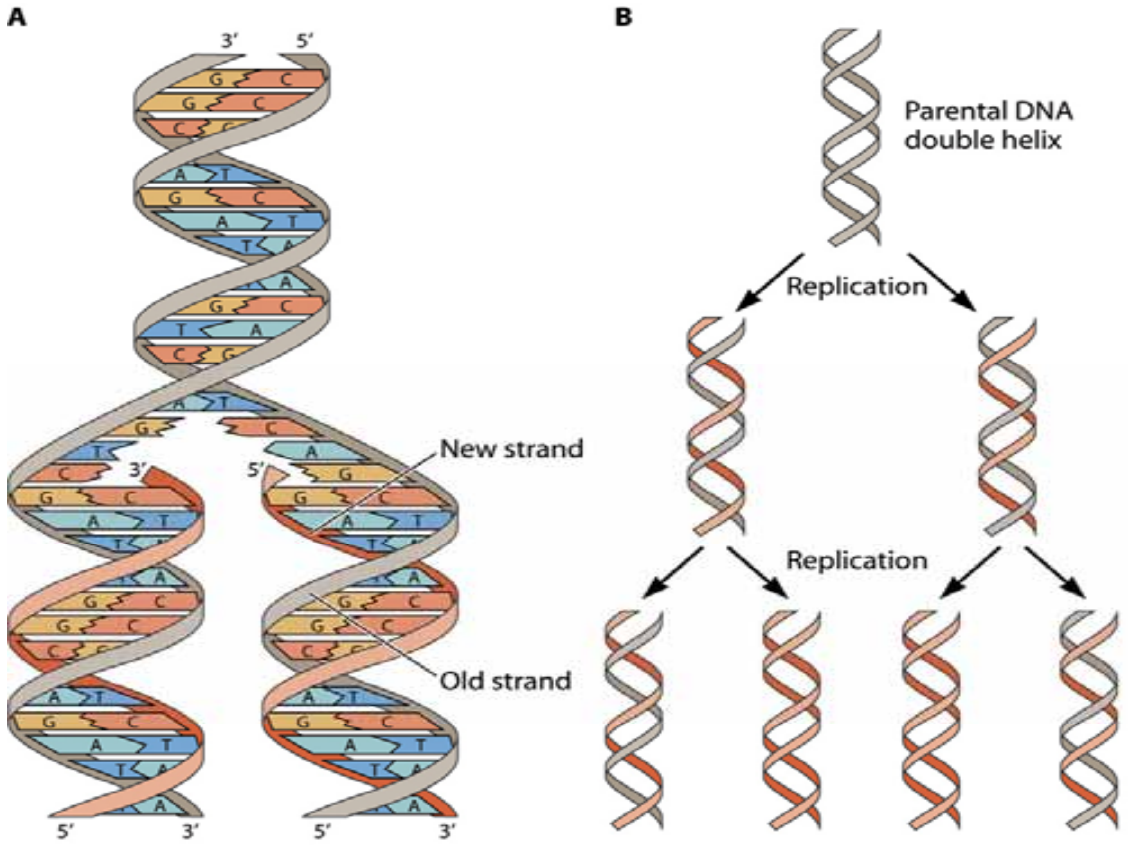
Chromosome

- Tightly packed complex of DNA and histone proteins



DNA Replication

- Synthesis of a complementary strand using the other strand as a template
- DNA polymerase



Expression of Genetic Information