

Chapter 3

Molecular Components of Cells



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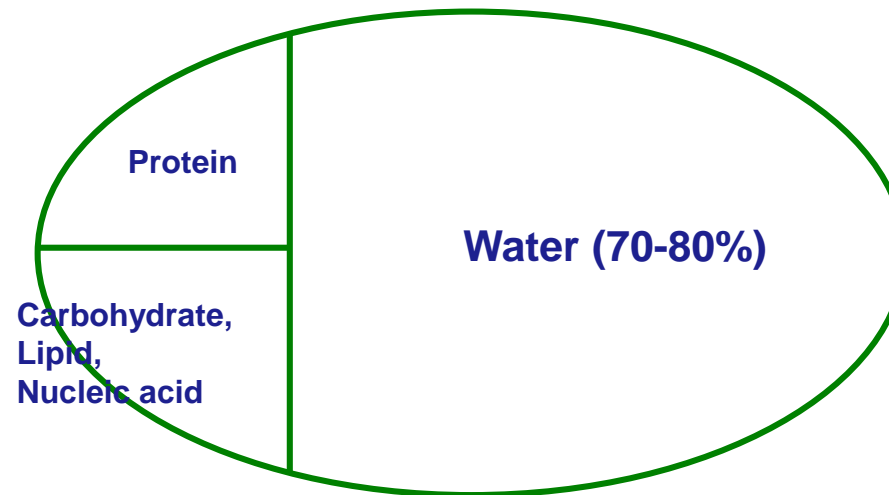
핵 산

1. 세포의 성분



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

- Ca^{2+} , Na^{+} , K^{+} , Cl^{-}

- Molecules

- Generated from chemical bonding of atoms

Subunits of Biological Molecules

Class of Molecules	Examples	Repeating Unit
Lipid	Fats, oils	Glycerol, fatty acid
Carbohydrate	Sugars, starch, cellulose	Simple sugars
Nucleic acid	DNA, RNA	Nucleotide
Proteins	Enzymes	Amino acids

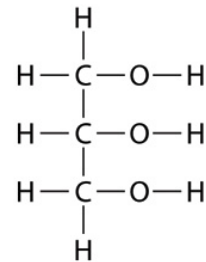
2. 지 질



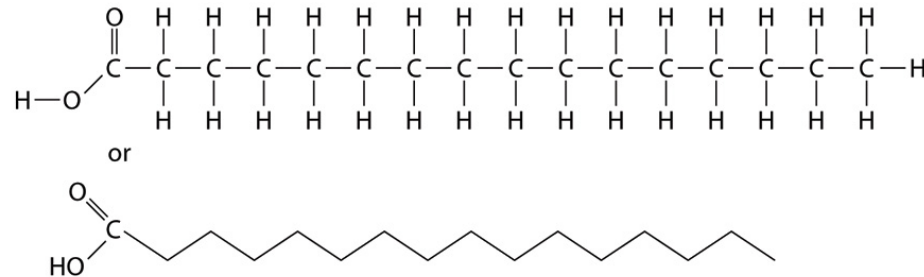
Lipids

- Hydrophobic fats, oils, and cholesterol etc.
- High energy C-H, C-C bonds → good energy storage
- Fats : glycerol + fatty acids

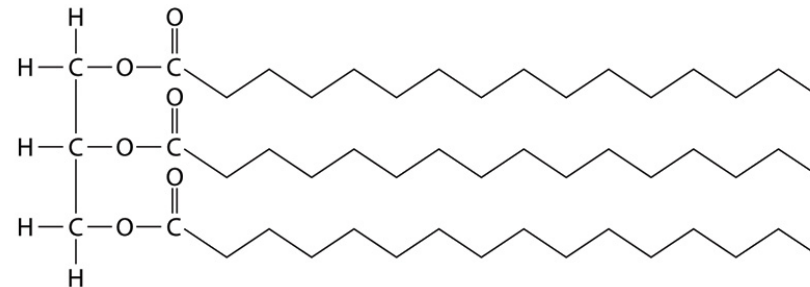
A. Glycerol



B. Fatty acid (palmitic acid)



C. A fat



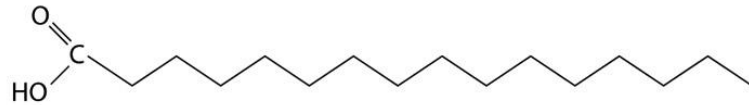
Triglyceride

Lipids

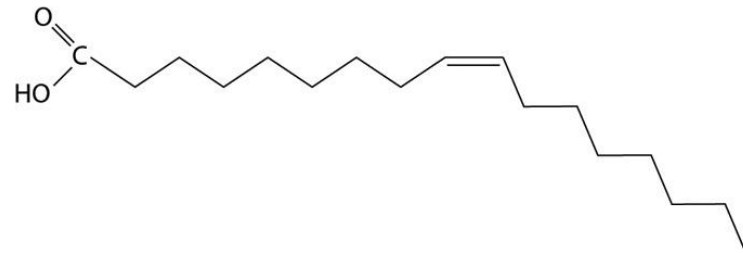
- Fatty acid

- Saturated: tight packing → solid at room temperature
- Unsaturated: more than one cis-double bond → liquid

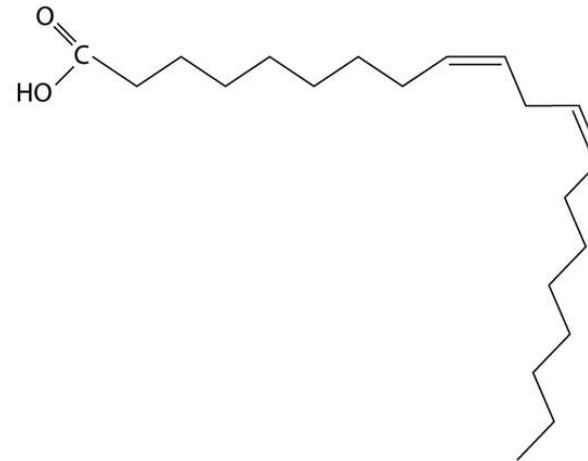
A. A saturated fatty acid



B. A monounsaturated fatty acid

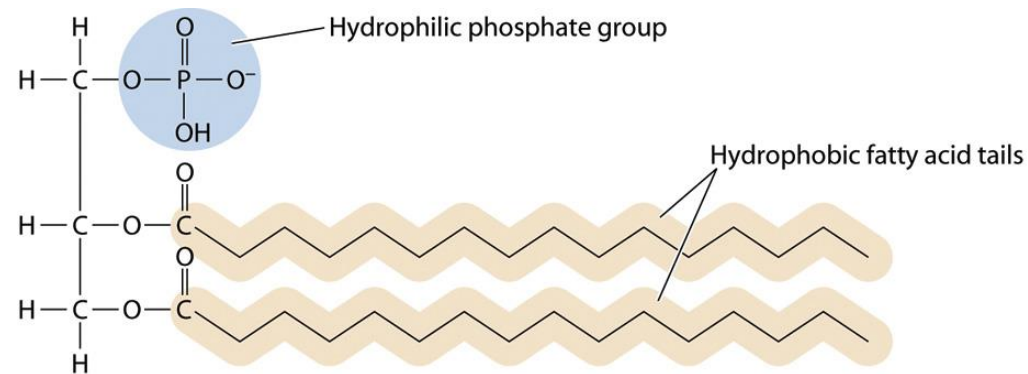


C. A polyunsaturated fatty acid



Lipids

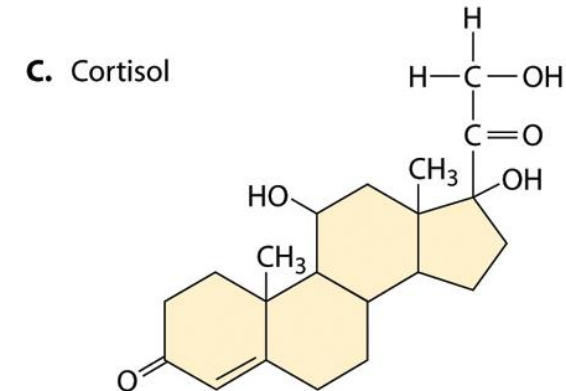
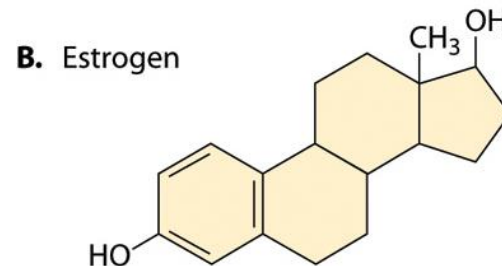
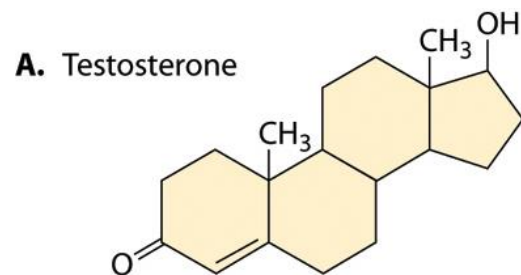
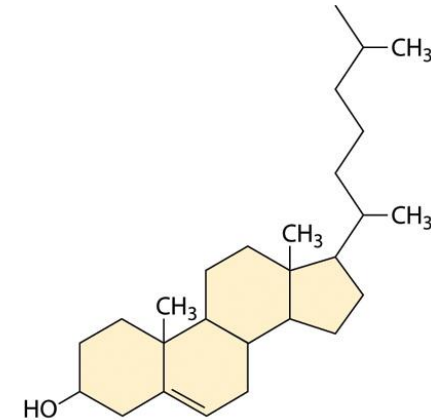
- Phospholipid
 - Major component of cellular membrane
 - Glycerol backbone
 - two fatty acids (hydrophobic)+ phosphate (hydrophilic)



Lipids

- Sterols

- Cyclic hydrocarbon compounds
- Cholesterol
 - Component of animal cell membranes
 - decrease membrane fluidity
 - Starting material for steroid hormones and bile synthesis



3. 탄소화물

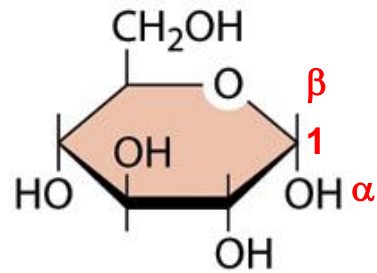


Carbohydrates

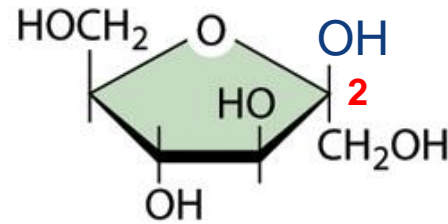
- $C : H : O = 1 : 2 : 1$
- Simple sugars (monosaccharide)
- Disaccharide
 - sucrose (glucose + fructose)
 - lactose (galactose + glucose)
- Polysaccharide
 - pectin, starch, cellulose --- from glucose
 - agar, carrageenan (thickener for ice cream)

Mono- and Disaccharides

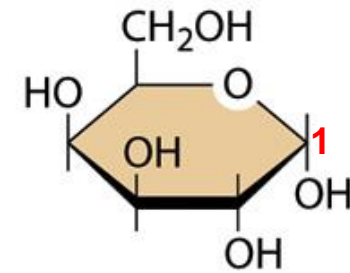
A. Simple sugars



Glucose (α form)

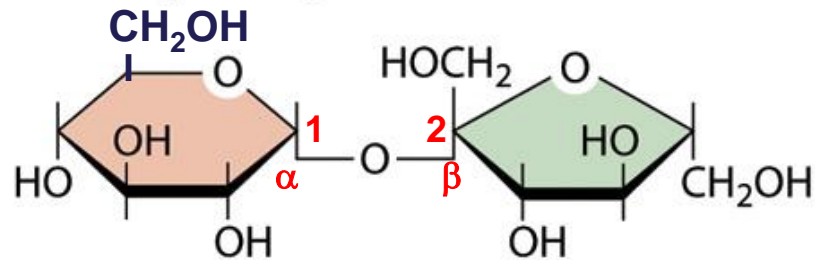


Fructose (β form)

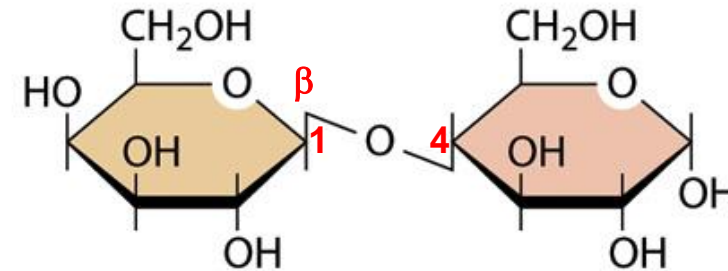


Galactose (α form)

B. Complex sugars



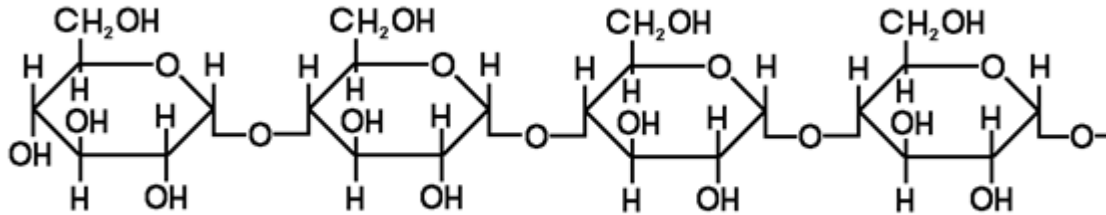
Sucrose (table sugar)
Glucose + fructose



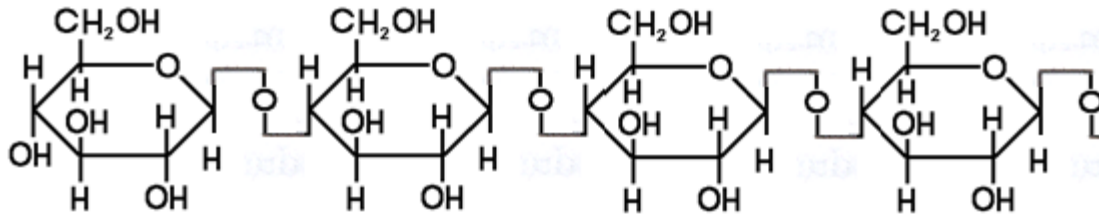
Lactose (milk sugar)
Galactose + glucose

Polysaccharides

- Amylose: α -1,4-Glycosidic linkage

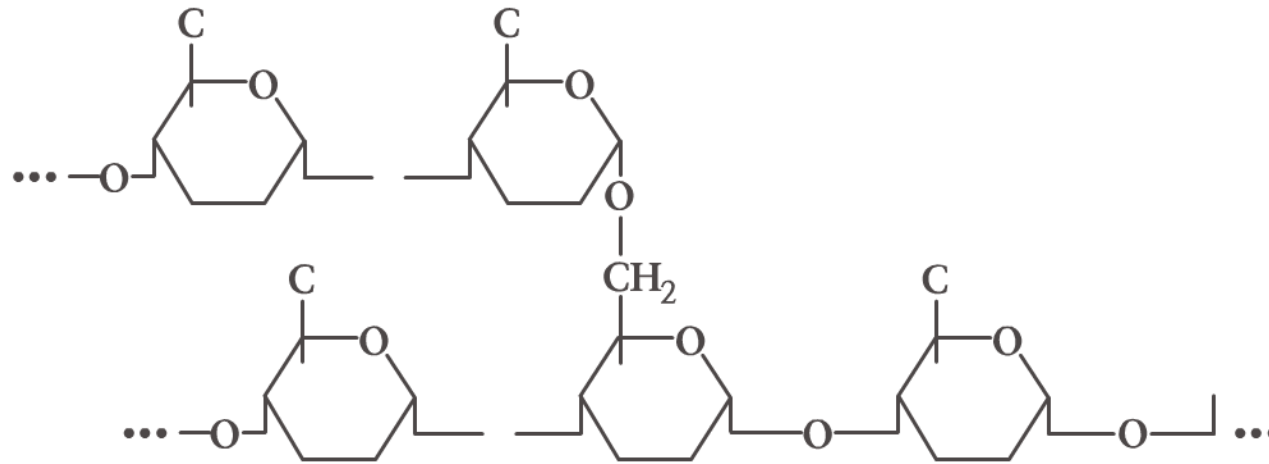


- Cellulose: β -1,4-Glycosidic linkage



Polysaccharides

- Amylopectin: α -1,6-Glycosidic linkage



- Starch: Amylose (20-25%) + Amylopectin (75-80%)

Roles of Carbohydrates I

■ Carbohydrates in energy metabolism

■ Plant

- Glucose synthesis by photosynthesis
$$6\text{CO}_2 + 6\text{H}_2\text{O} + \text{energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$$
- Starch for energy storage
- cellulose for structural compound

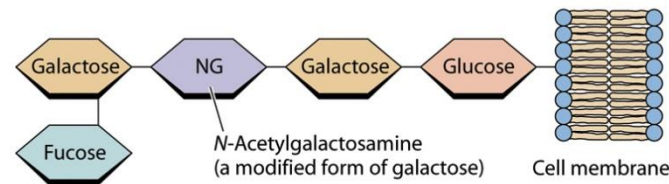
■ Animals

- Intake glucose from food
- Glycogen for energy storage

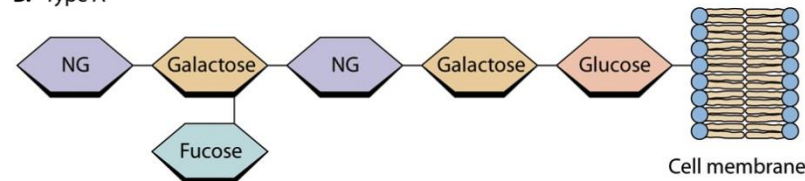
Roles of Carbohydrates II

- Carbohydrates in molecular recognition
 - Often found connected to other molecules on the outsides of cells --- cellular recognition, cell signaling, cell adhesion
 - e.g. blood typing : sugar chains in the membrane of RBC

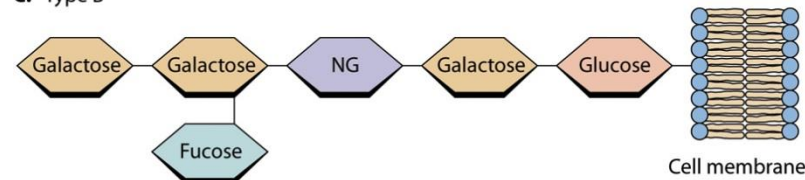
A. Type O



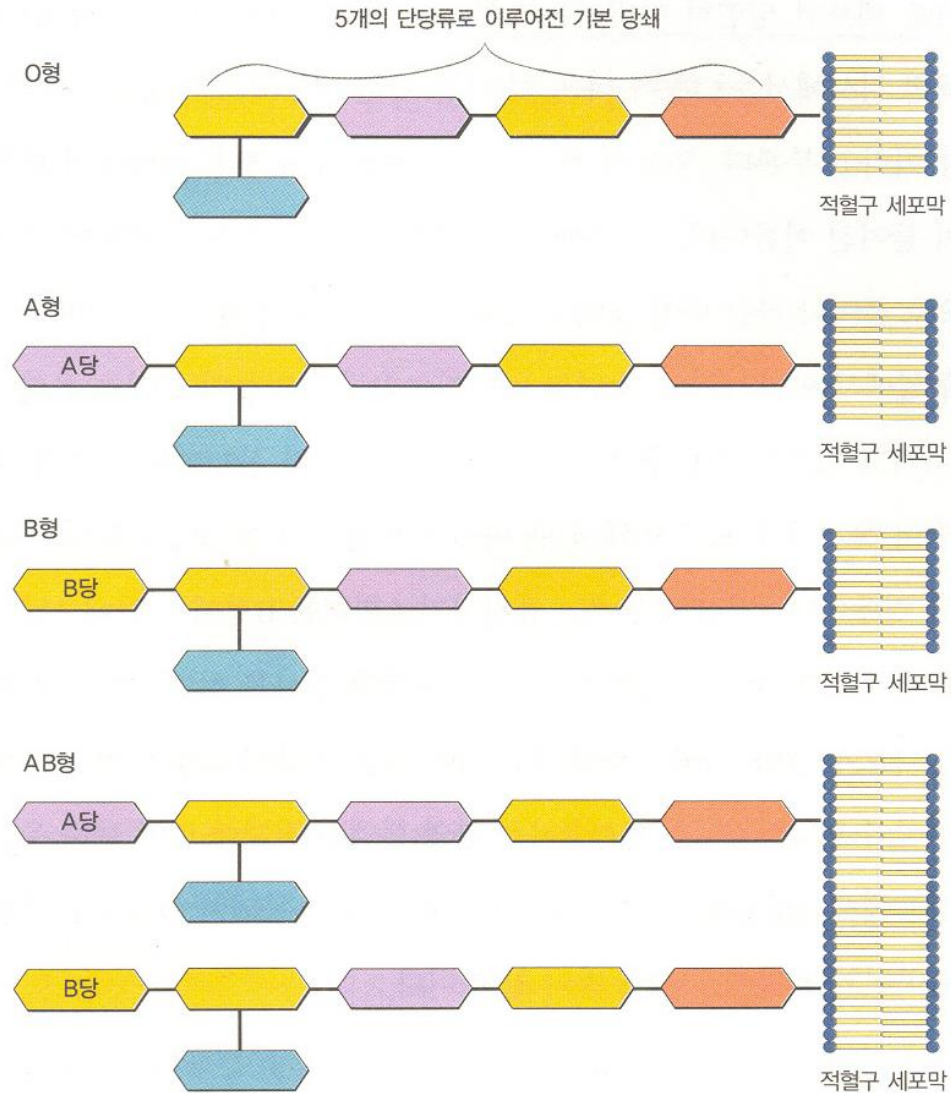
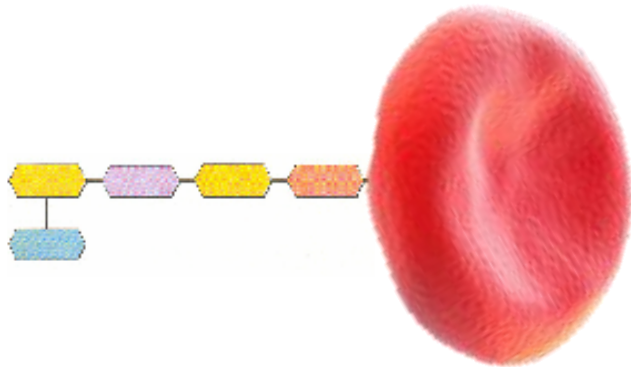
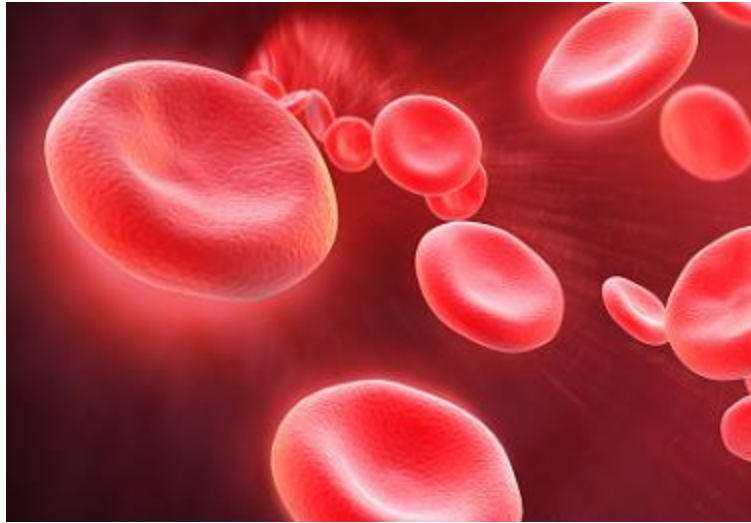
B. Type A



C. Type B



Blood Type (혈액형)

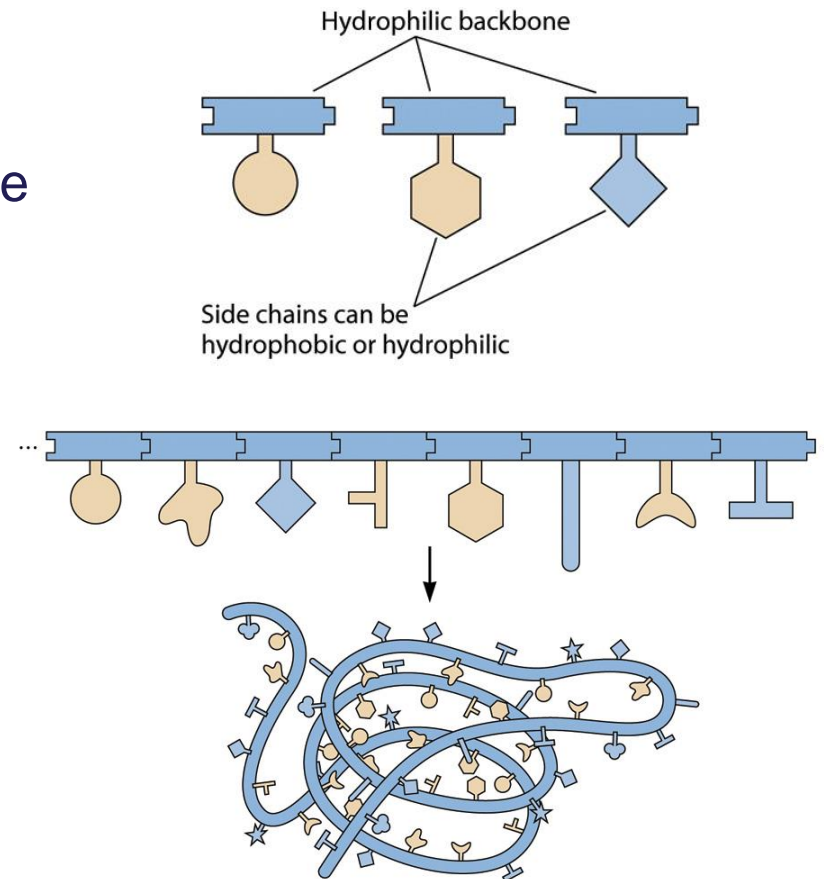


4. 단백질



Proteins

- **Amino acids**
 - Building blocks of proteins
 - Hydrophilic backbone + 20 side chains
- **Polypeptide**
 - Amino acid chains linked by peptide bond
- **Three-dimensional structure**
 - Determines protein function
 - Determined by amino acid sequence



Proteins

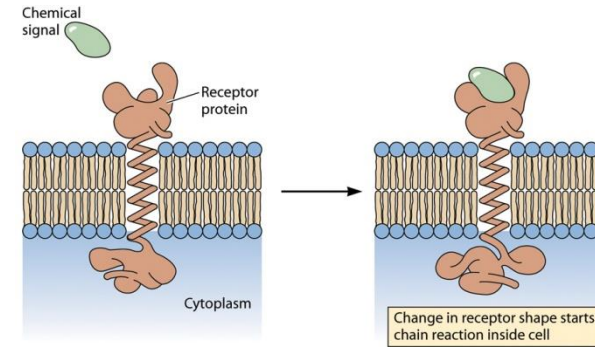
■ Roles of proteins

■ Most of the cellular functions

- Enzymes : chemical reactions
- Receptors : signal transduction
- Antibody : recognition of foreign molecules and trigger immune responses
- Transporters : e.g. hemoglobin for oxygen
- Structural proteins : keratin (hair and nails), actin and myosin (muscle)

■ Diversity of organism

- Due to the organization of proteins within an organism
 - particularly structural proteins and those that synthesize additional structural body components



5. 핵 산



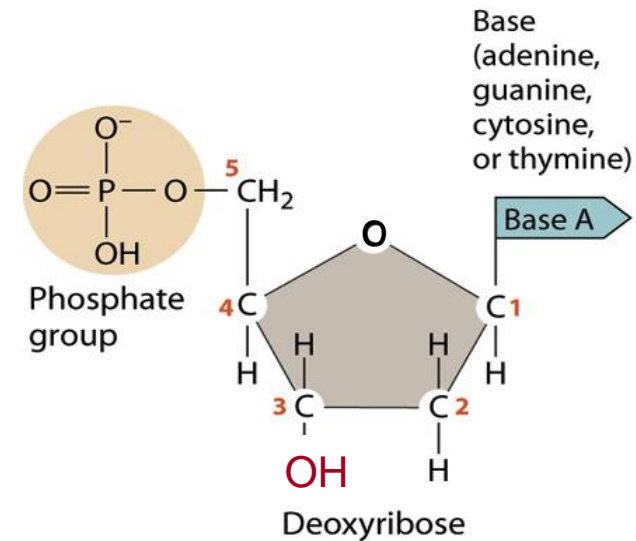
Nucleic acids

■ Nucleotides

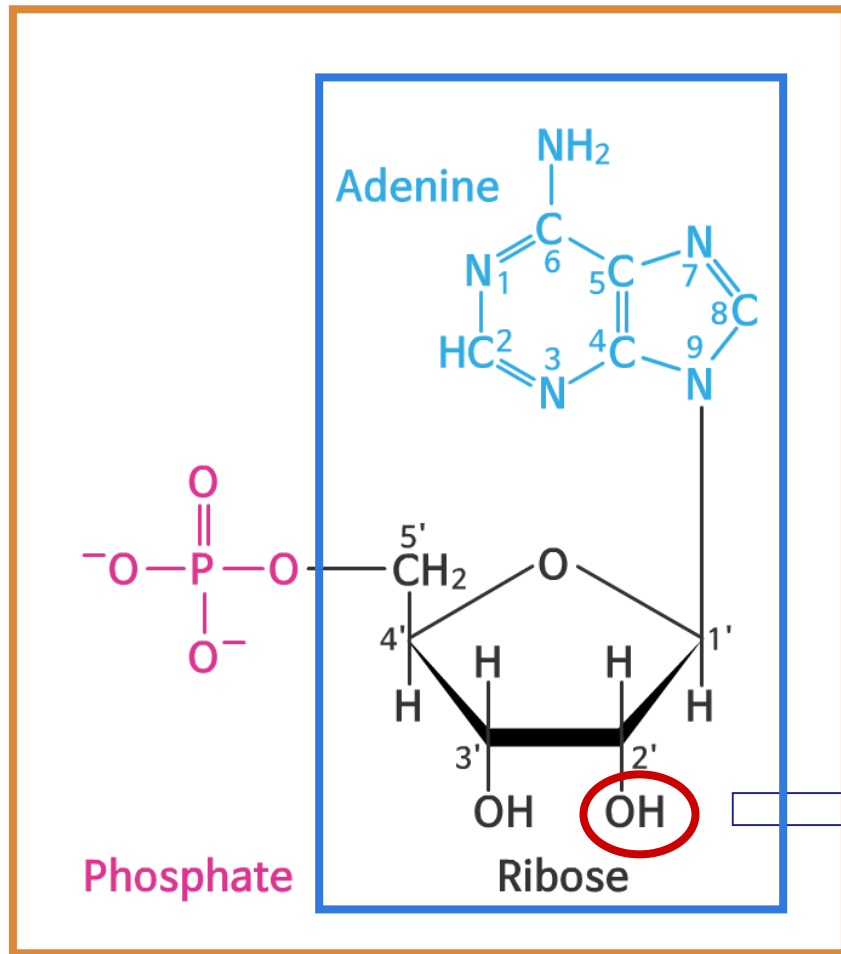
- Building blocks of nucleic acids
- (deoxy)ribose + phosphate group + 4 bases
- Bases: adenine (A), guanine (G), cytosine (C), thymine (T)

■ Terminology

- Base
- Nucleoside : sugar + base
- Nucleotide : sugar + base + phosphate



Nucleotides



RNA

Base

Adenine

Guanine

Cytosine

Thymine (D)

Uracil (R)

Nucleoside

Adenosine

Guanosine

Cytidine

Thymidine

Uridine

Nucleotide

Adenylate

Guanylate

Cytidylate

Thymidylate

Uridylate

Purine
Pyrimidine

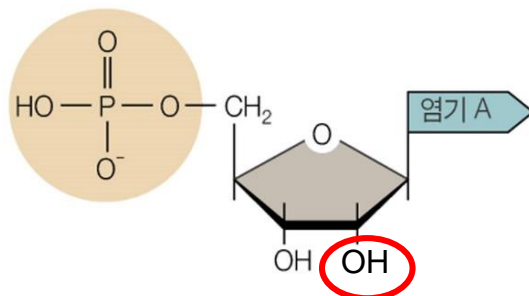
H

DNA

AMP, ADP, ATP

Adenosine
Monophosphate
(AMP)

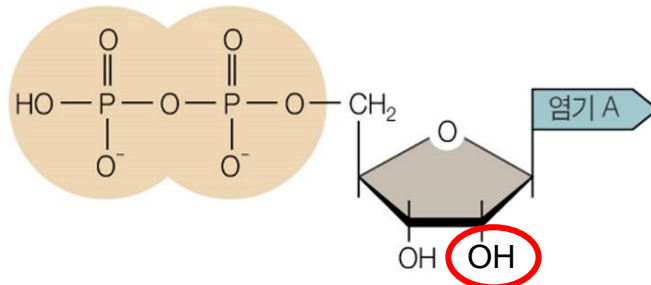
A. 아데노신 1인산(AMP)



AMP = Adenylate
(cf. dAMP)

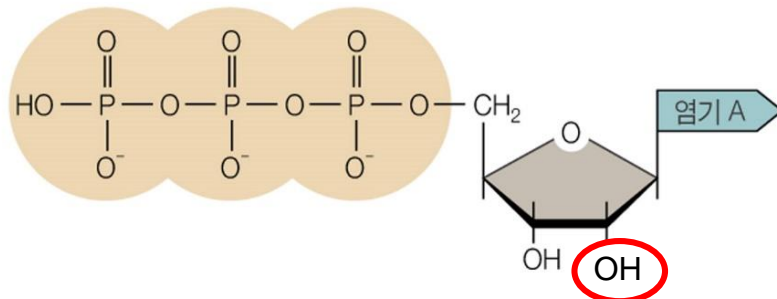
Adenosine
diphosphate
(ADP)

B. 아데노신 2인산(ADP)



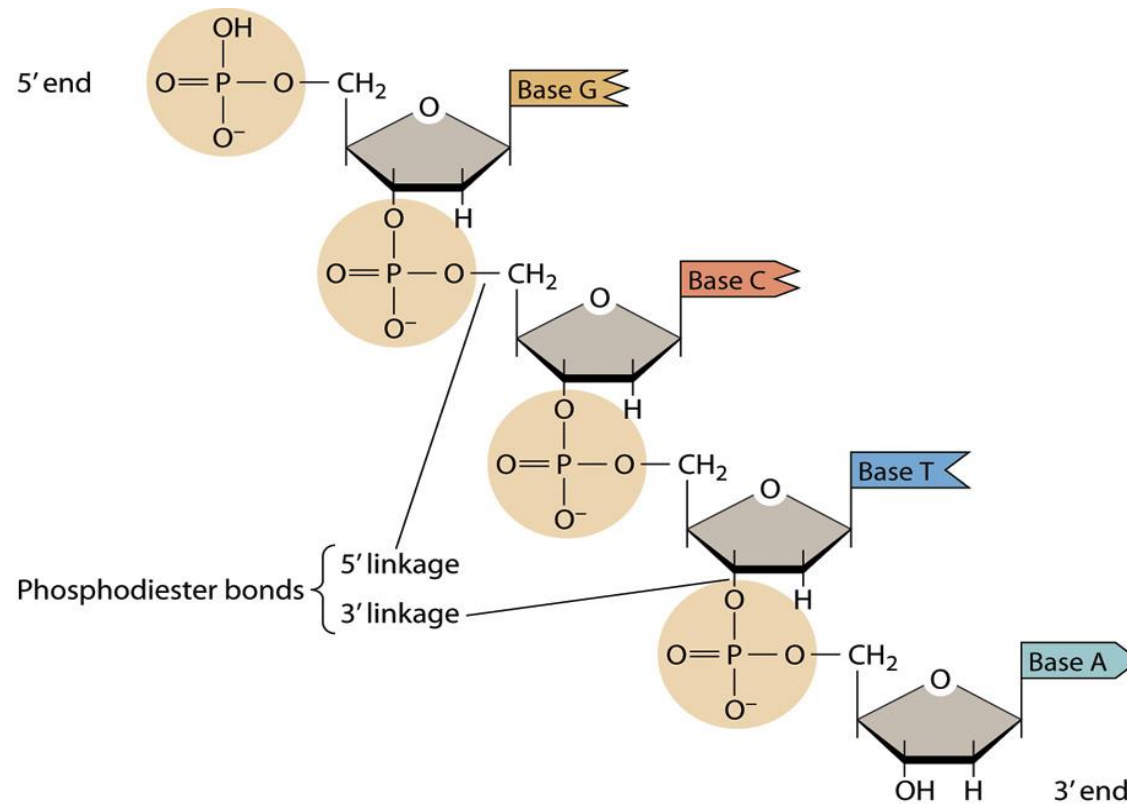
Adenosine
triphosphate
(ATP)

C. 아데노신 3인산(ATP)



Nucleotide Chains

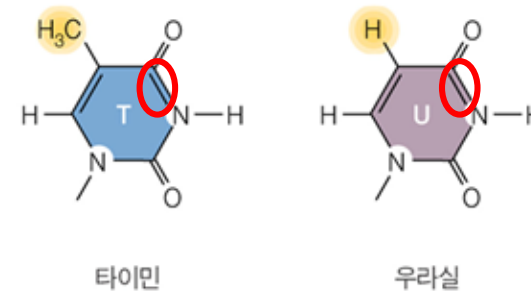
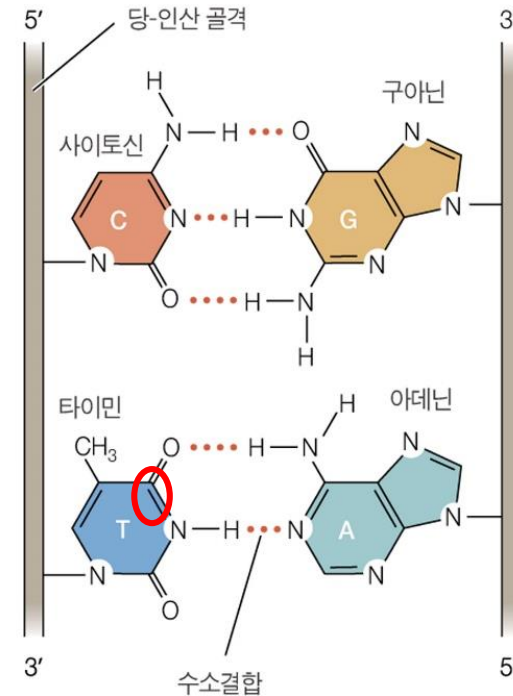
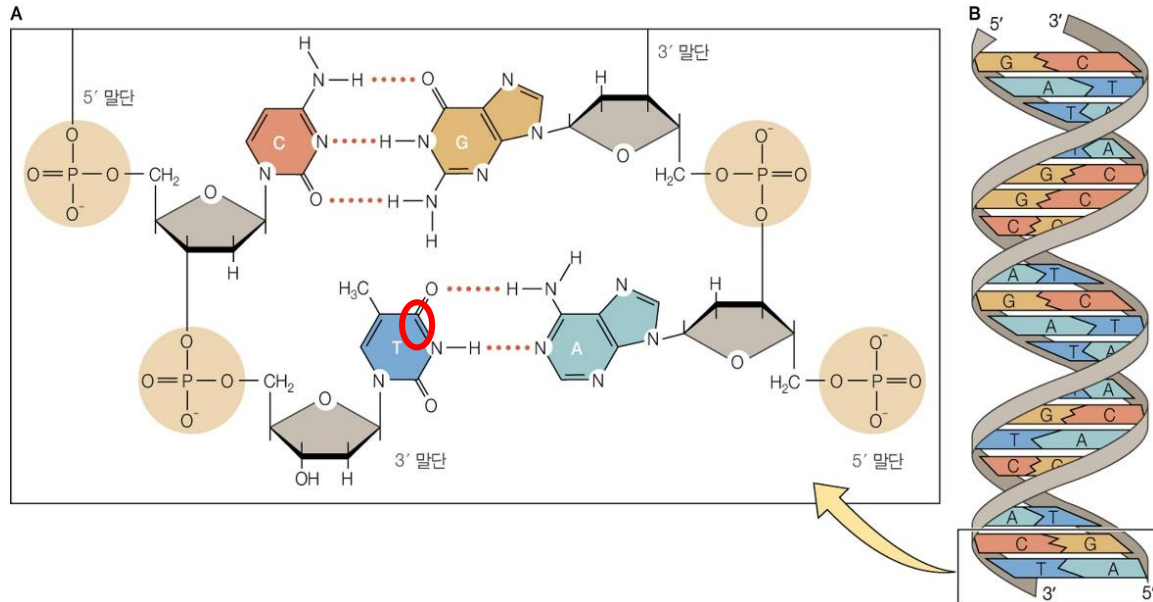
- Linkage of 5' carbon to 3' carbon through phosphodiester bond



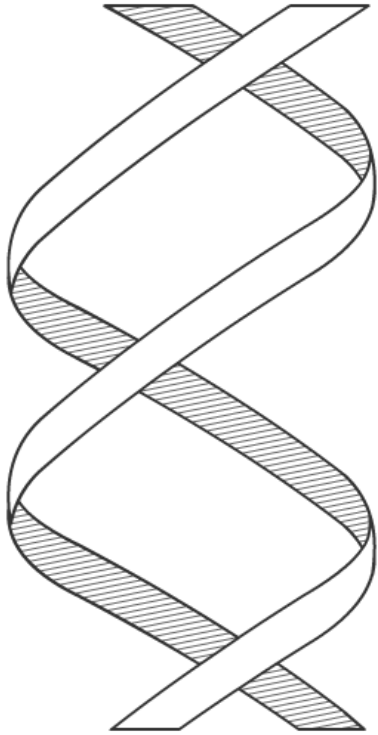
Nucleotide Chains

■ Base pairing

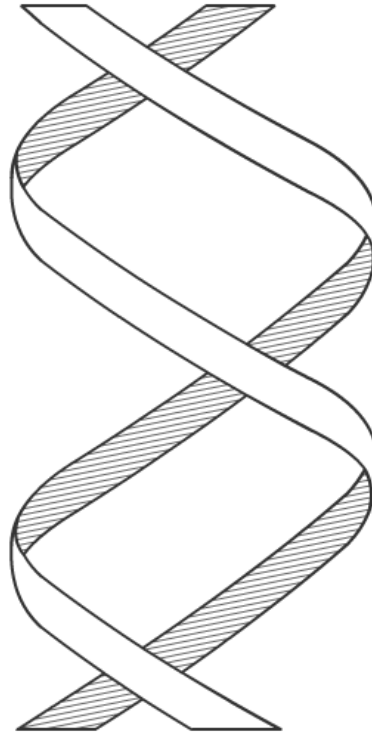
- C≡G, T=A : hydrogen bonding
- Complementary base pairs
- Antiparallel strand in DNA molecule



DNA 나선 방향



B-DNA (오른방향 나선)



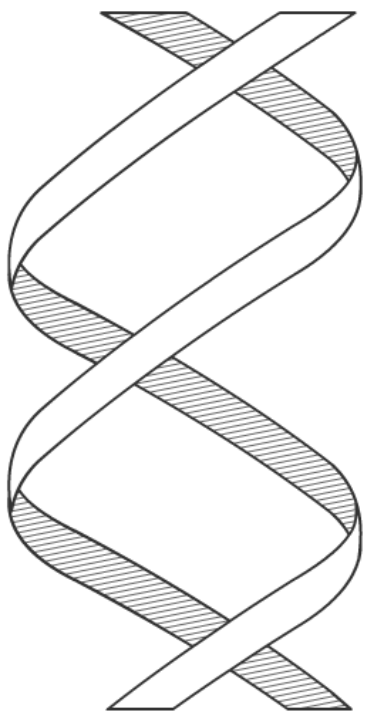
Z-DNA (왼방향 나선)

갈 등

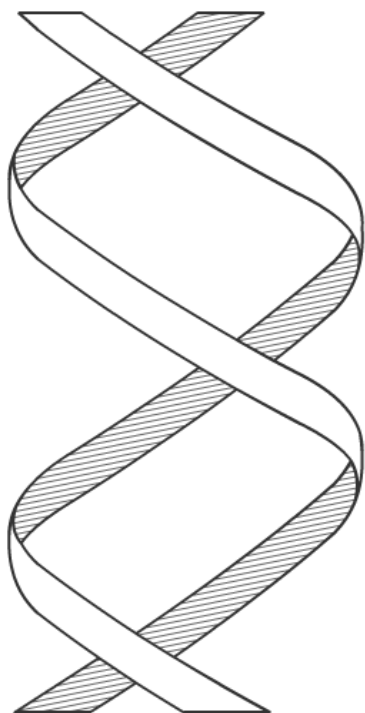
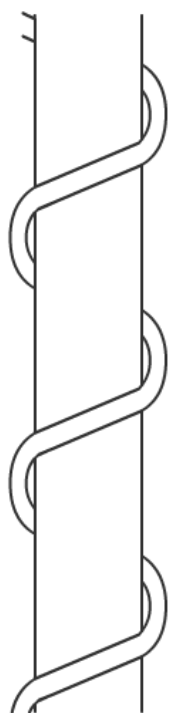
葛(갈): 칩

藤(등): 등나무

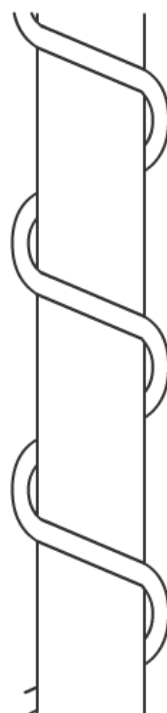
DNA와 갈등



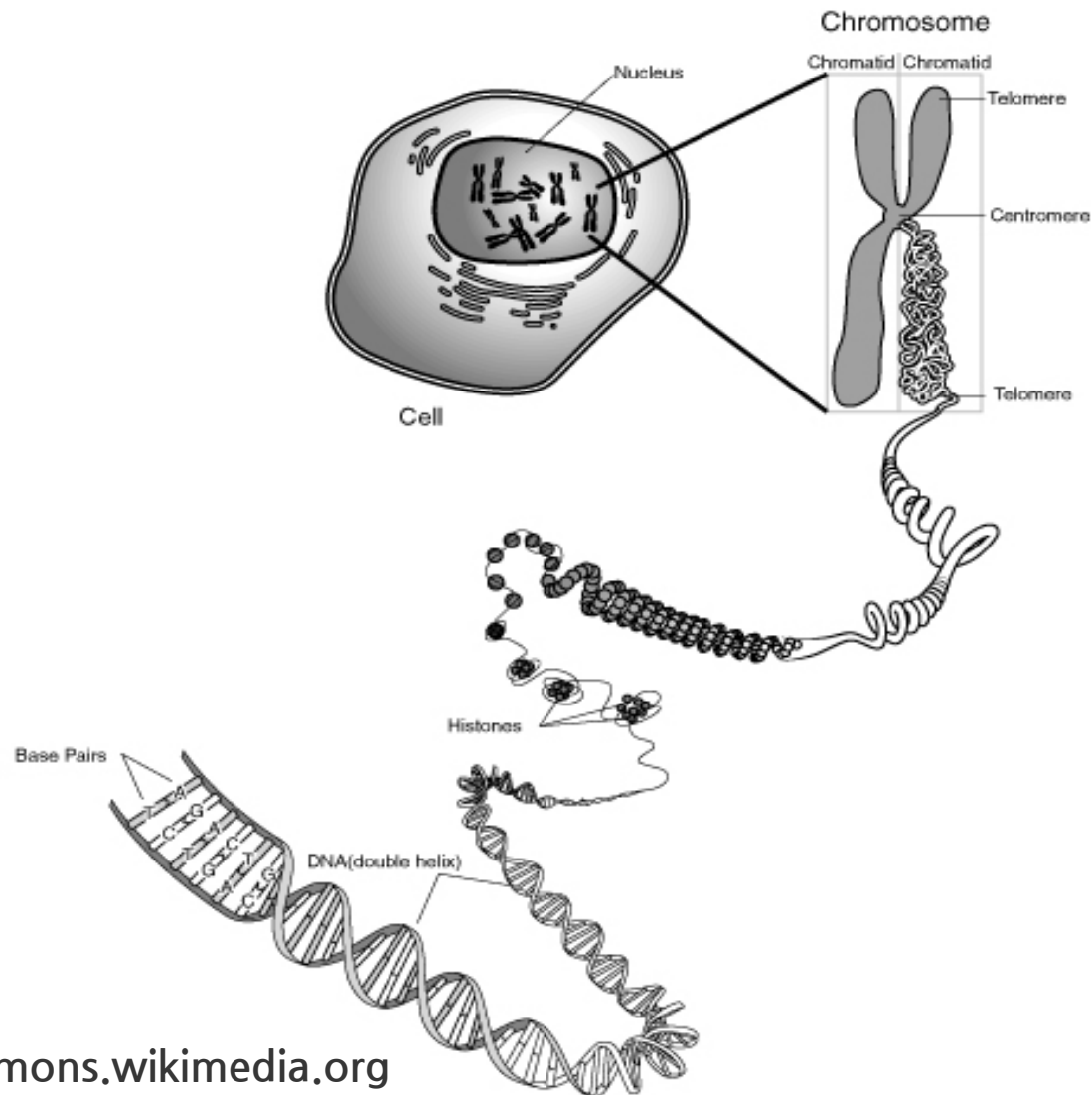
B-DNA
(오른방향 나선) **최덩굴**
(왼쪽 감기)



Z-DNA
(왼방향 나선) **등덩굴**
(오른쪽 감기)

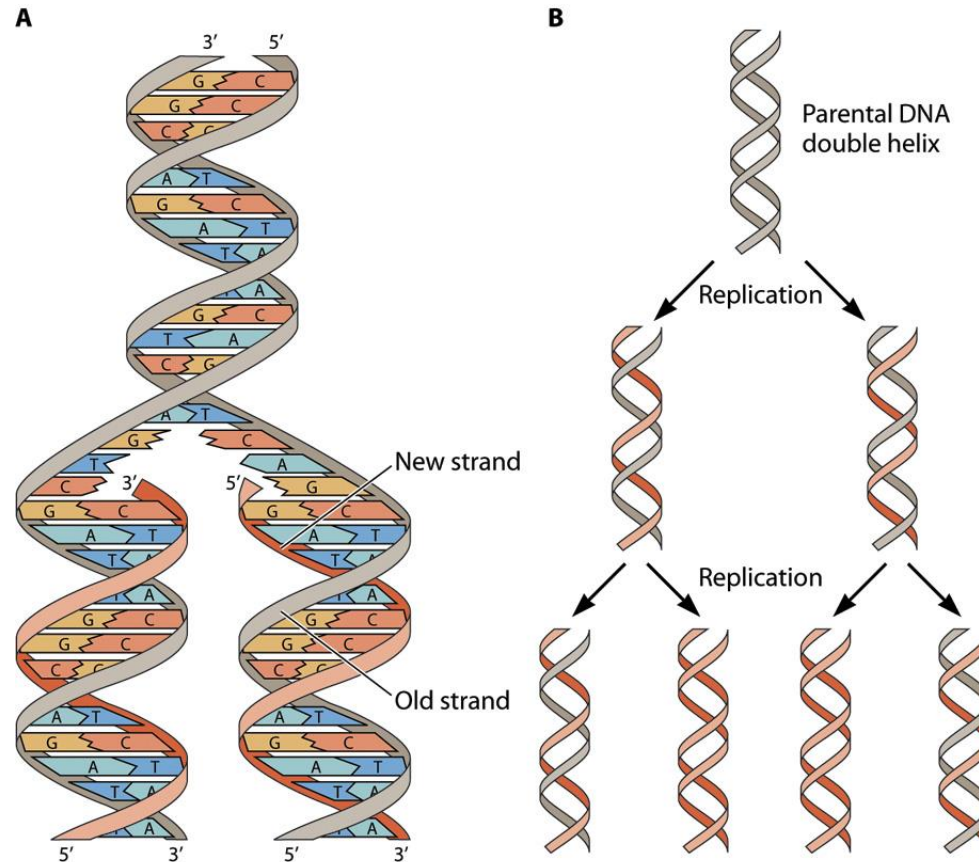


염색체 (Chromosome)와 DNA



DNA Replication

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



Expression of Genetic Information

