

Terminology

원어	번역
Macromolecules	고분자
Polymers	중합체
monomers	단위체
Carbohydrates	탄수화물
Lipids	지질
Nucleic acids	핵산
sugar	당
sucrose	설탕
Monosaccharides	단당류
Glucose	포도당
Fructose	과당
hydrophilic	친수성
(un)saturated	(불)포화
Hydrogenation	수소화

Organic compounds


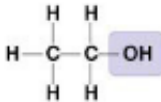
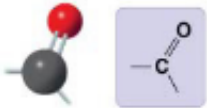
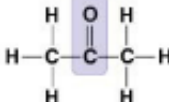
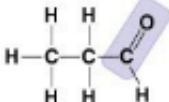
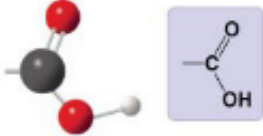
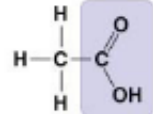
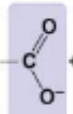

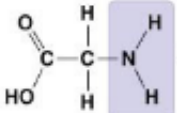
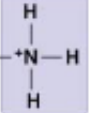
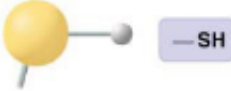
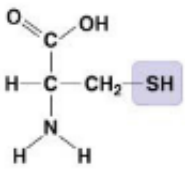
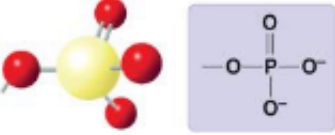
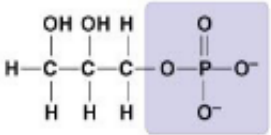
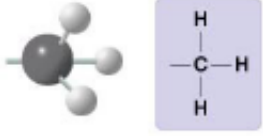
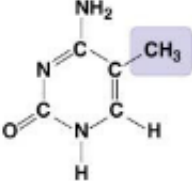
carbon-based molecules

Carbon chemistry

- carbon is a versatile molecule

- carbon can share electrons with other atoms in four covalent bonds.
- it is possible to construct an endless diversity of carbon skeletons varying in size and branching pattern
- unique properties of organic compound depend on
 - its carbon skeleton and
 - the atoms attached to the skeleton
- the groups of atoms directly involved in chemical reactions are called **functional groups**

Functional group

Chemical Group	Compound Name	Examples
Hydroxyl group (—OH) 	Alcohol	 Ethanol
Carbonyl group (>C=O) 	Ketone Aldehyde	 Acetone  Propanal
Carboxyl group (—COOH) 	Carboxylic acid, or organic acid	 Acetic acid \rightleftharpoons  $+ \text{H}^+$
Amino group (—NH_2) 	Amine	 $+ \text{H}^+ \rightleftharpoons$  Glycine
Sulfhydryl group (—SH) 	Thiol	 Cysteine
Phosphate group (—OPO_3^{2-}) 	Organic phosphate	 Glycerol phosphate
Methyl group (—CH_3) 	Methylated compound	 5-Methyl cytosine

- Methyl group을 제외하고 Ionic unbalance 하다.
 - Carbonyl group에 C=O 부분의 위치에 따라 Kethone(가운데), Aldehyde(끝)로 나뉨
 - Carboxyl group은 유기산에 있어 필수 요소임
 - Phosphate group은 강력하게 결합되어 ATP 생성, 큰 물질 결합 시 이용
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Large Biological Molecules

- There are four categories of large biological molecules found in all living creatures
 1. Carbohydrates
 2. Lipids
 3. Proteins
 4. nucleic acids
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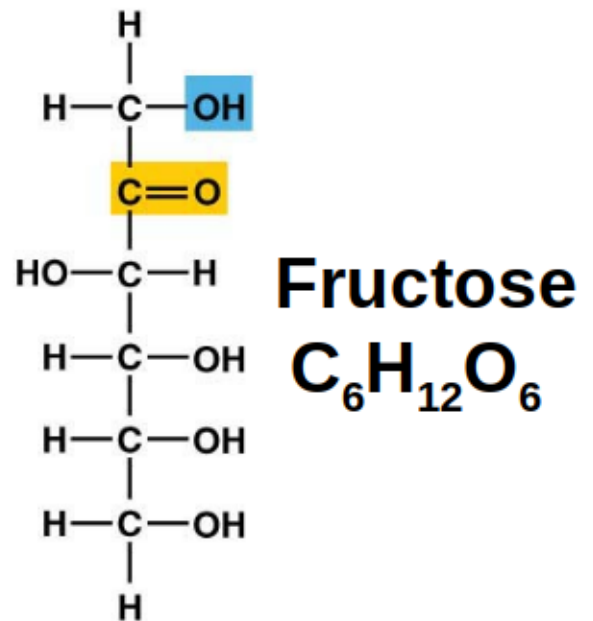
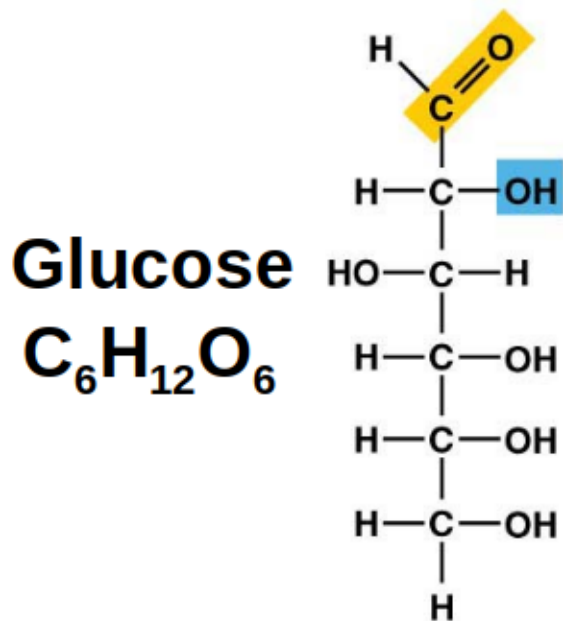
Carbohydrates

- include sugars and polymers of sugar

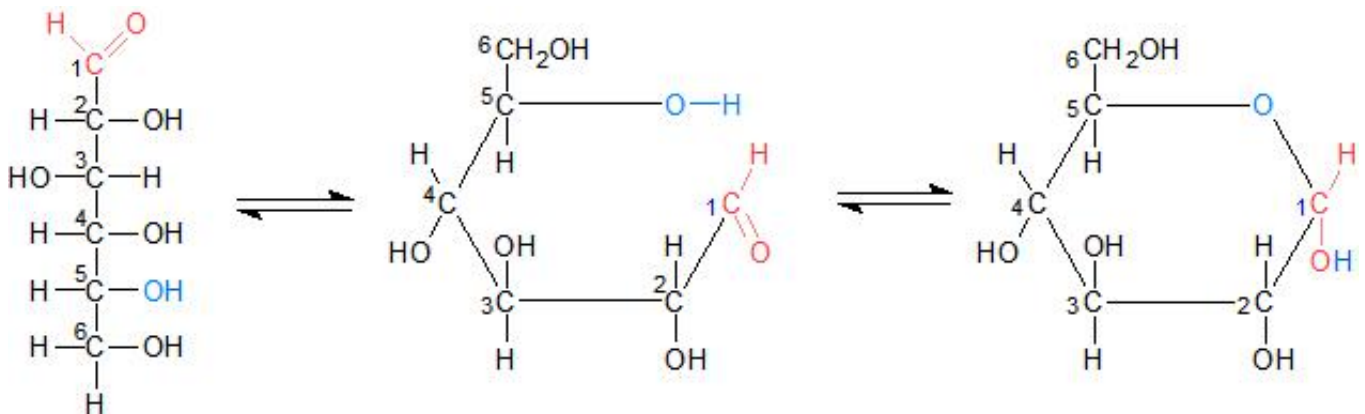
glycosid bond

1. α - 1,4 glycosid bond
2. β - 1,4 glycosid bond
3. branch
 - 6번 탄소 CH_2OH 에 1번 혹은 4번 OH기가 붙어 가지를 형성

Monosaccharides



- In water, many monosaccharides form rings
 - it is stable form(less interaction)



- 1번 탄소의 OH기가 아래에 있으면 α -glucose, 위에 있으면 β -glucose
- 결합 시 α -glucose는 같은 방향을, β -glucose은 반대 방향을 향함

Disaccharides

- two monosaccharides with glycosidic bond(linkage) by dehydration reaction.

disaccharides	mono1	mono2	bond
lactose	glucose	galactose	glycosidic bonds (1,4)
maltose	glucose	glucose	α -1,4 glycosidic bonds
sucrose	glucose	fructose	glycosidic bonds (1,4)

High-fructose corn syrup(HFCS) : glucose in corn syrup to much sweeter fructose with isomerase

Polysaccharides

- complex carbohydrates
- polymers of monossacharides
- stable -> good for saving energy
- empty space(twisted structure) make glycosidase decompose polysaccharides easily

Starch

- long string of glucose monomers.
- used by plant cell to store energy
- α - 1,4 glycosid bond -> spiral structure
- some of it have branch. **some**

Glycogen

- used by animal to store energy
- break down to release glucose
- α - 1,4 glycosid bond with branch by α - 1,6 glycosid bond (in many case...)

Cellulose

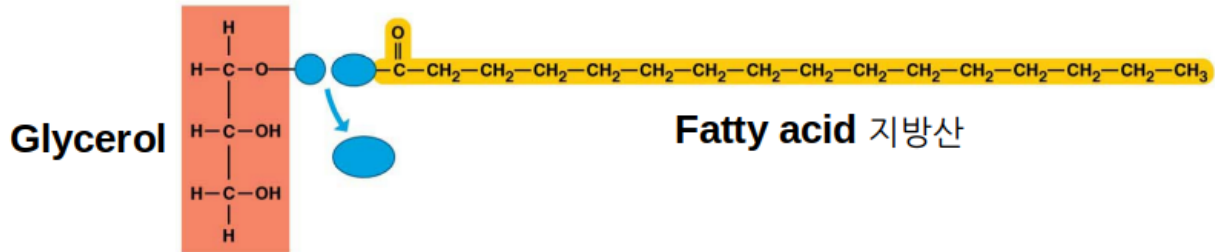
- abundant organic compound on Earth
- cannot be broken by any enzyme produced by animals
- β - 1,4 glycosid bond

Lipids

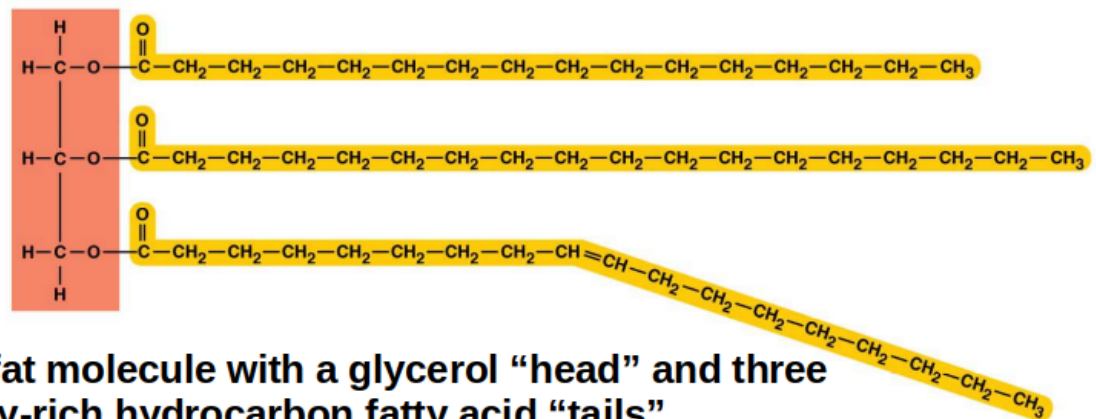
- hydrophobic
- diverse group of molecules made from **diffent molecular building blocks** that are unable to mix with water
- neither huge macromolecules nor necessarily polymers built from repeating monomers.

Fats

- triglyceride
- consists of a glycerol molecule joined with three fatty acid molecules via dehydration reaction

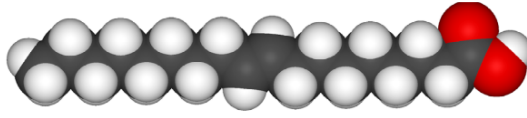
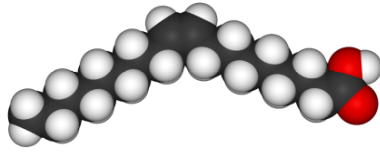


(a) A dehydration reaction linking a fatty acid to glycerol



- perform essential function in the human body
 - energy storage, cushioning and insulation
- If carbon skeleton of fatty acid has fewer than the maximum number of hydrogens at the **double bond**, it is **unsaturated**
 - by its double bond, its structure is fixed. so it has density and easy to be melted (good for Poikilotherm (변온동물) and plant)
- saturated fat has all three of its fatty acid saturated.
- Most animal fats
 - relatively high portion of saturated fatty acids
 - easily stack, tending to be solid at room temperature.
- **Hydrogenation**
 - adds hydrogen
 - converts unsaturated fats to saturated fats
 - makes liquid fats solid at room temperature.
 - creates **trans fats**. its fatty acid has double bond. -> unsaturated fat

Cis (Oleic acid)



Trans (Elaidic acid)

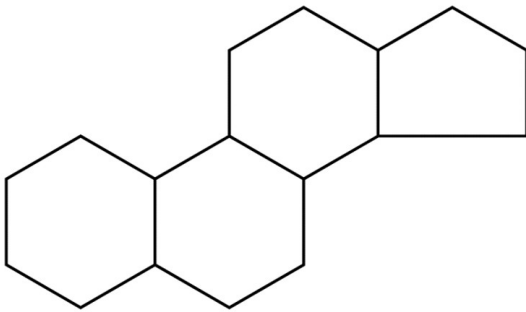
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diglyceride

- two fatty acids
- 인지질은 glycerol에 P(인)이 붙어 있음

Steroids

- The carbon skeleton has four fused rings
- Steroids vary in the functional groups attached to this set of rings, and these chemical variations their function.



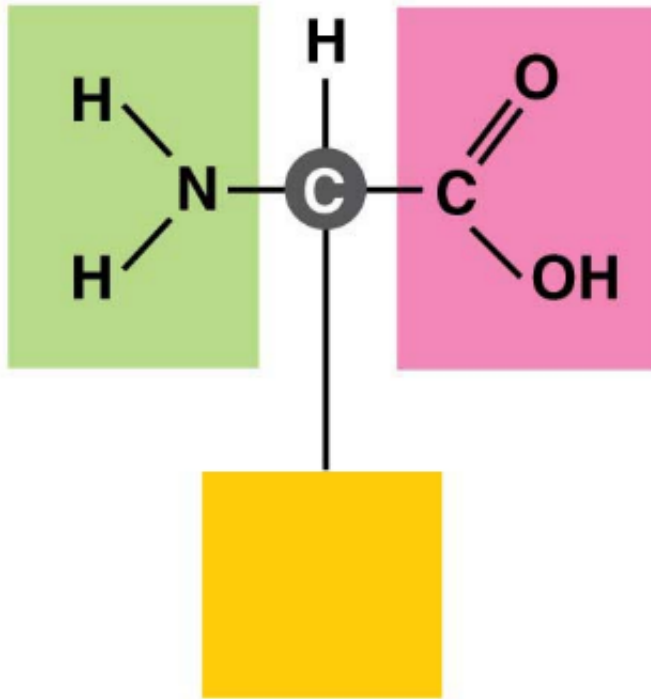
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- **Cholesterol**
 - o key component of cell membranes
 - o the base steroid from which body produces other steroids such as estrogen and testosterone

Protein

- polymers of amino acid monomers
- account for more than 50% of the dry weight of most cells
- instrumental in almost everything cells do
 - o structural, storage, contractile, transport, enzymes

Amino Acids : Monomers of Proteins

- central carbon atom bonded to four covalent partners
 - carboxyl group (-COOH)
 - amino group (-NH₂)
 - hydrogen atom
 - side chain giving amino acid its special chemical properties (R₂)



twenty-one amino acid

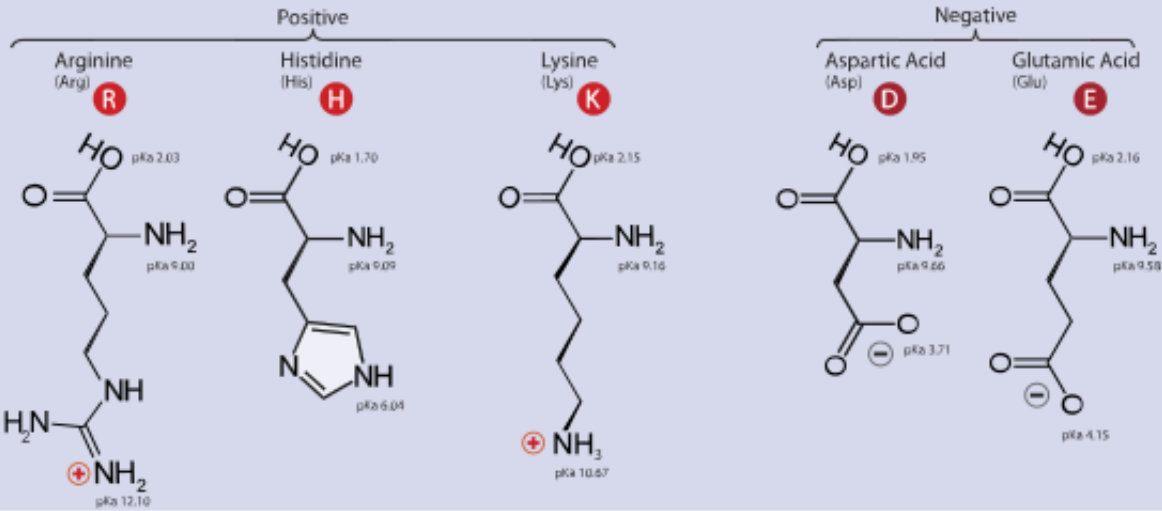
Twenty-One Amino Acids

⊕ Positive

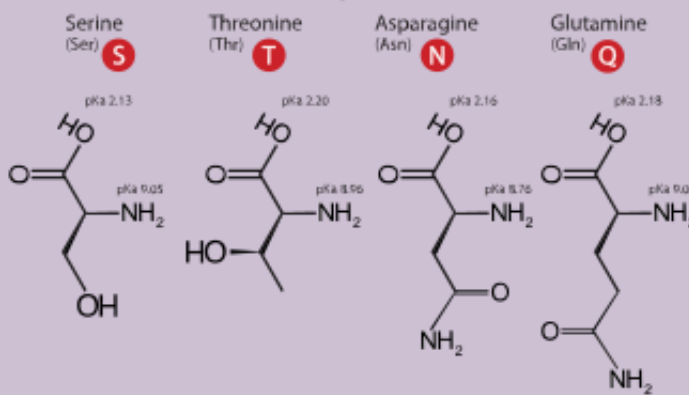
⊖ Negative

• Side chain charge at physiological pH 7.4

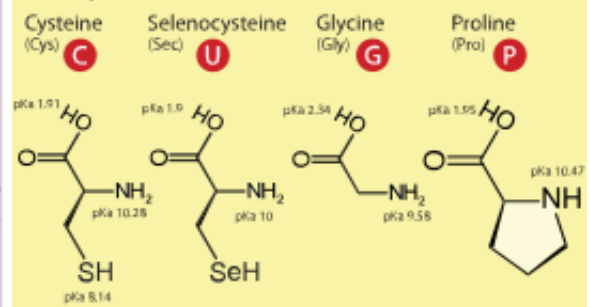
A. Amino Acids with Electrically Charged Side Chains



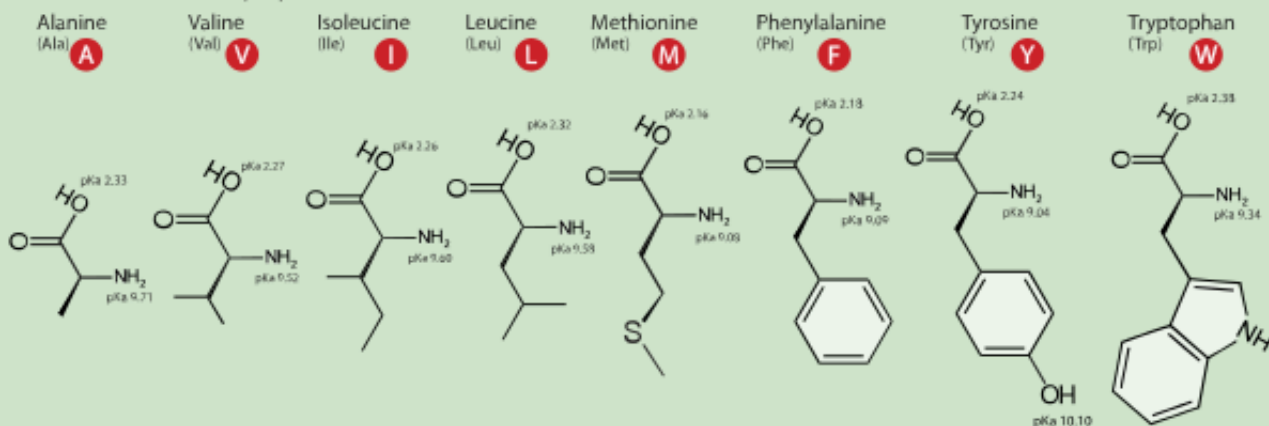
B. Amino Acids with Polar Uncharged Side Chains



C. Special Cases

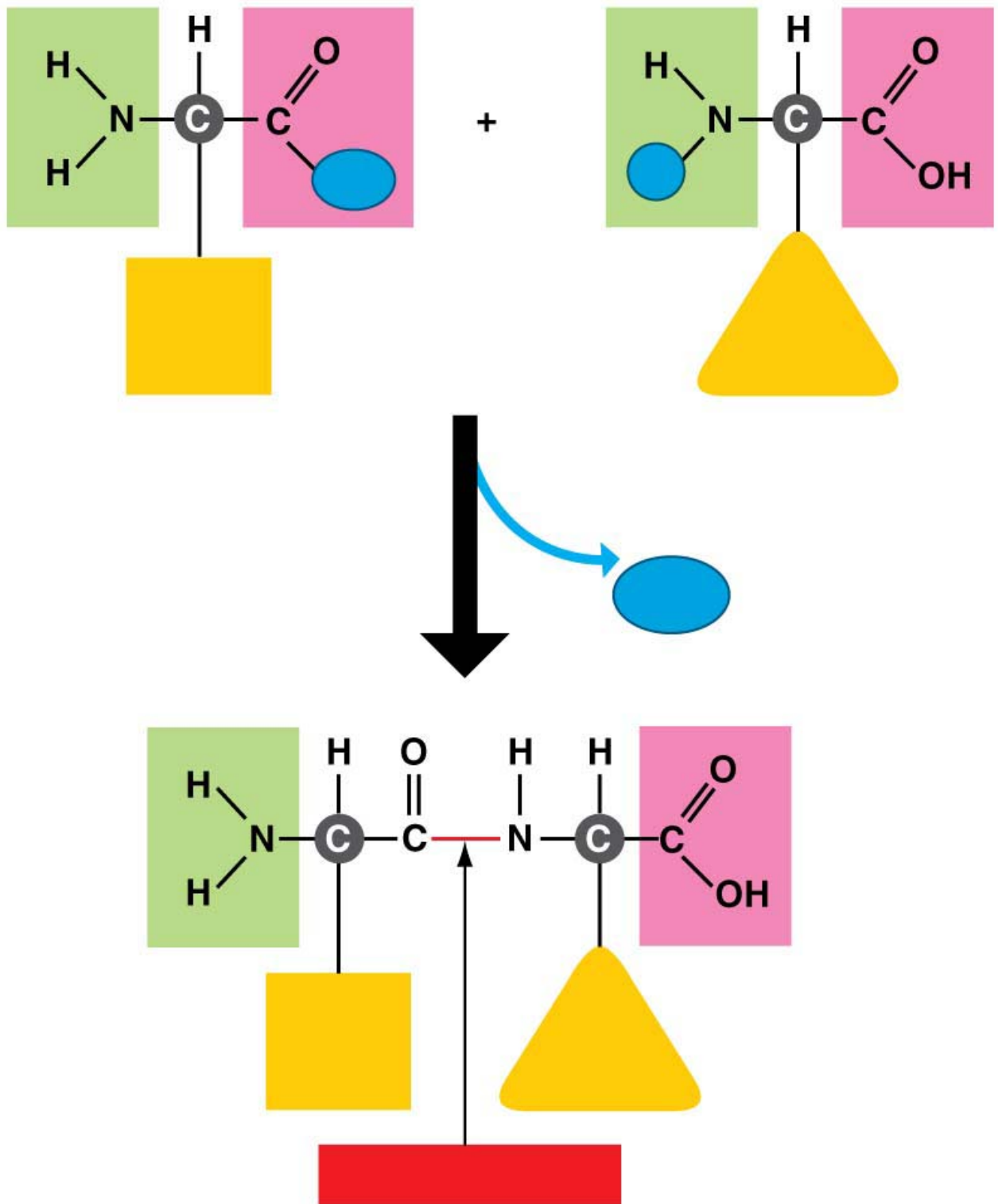


D. Amino Acids with Hydrophobic Side Chain



Peptide bonds

- cells link amino acids together by dehydration reaction with enzyme's help, forming **peptide bonds** and creating long chains of amino acids called, **polypeptides**



-
- peptide → polypeptide
- polypeptide → 변형과정으로 기능함 → protein
- protein's structure
 1. 1차 구조
 - polypeptide 내에서 아미노산이 순서대로 배열된 상태
 2. 2차 구조
 - polypeptide의 일부가 뒤틀린 구조
 - α-helix : peptide bond에서 N-H기와 C=O기 혹은 4 자리 이전에 위치한 아미노

산의 R기와 수소 결합 발생해 나선 모양을 이루는 구조

- β -strand : peptide bond에서 N-H기와 C=O기에서 수소 결합이 발생해 R기의 방향이 위, 아래를 반복하면서 이어짐
- β -sheet : β -strand 구조가 여러 개 이어지면서 그 사이에서 최소 2~3개의 수소 결합을 형성해 병풍 구조를 이룸

3. 3차 구조

- R기 간 상호작용으로 연결되어 형성되며 compact함.

4. 4차 구조 : 2개 이상의 3차 구조 polypeptide가 이루는 구조. 각각의 polypeptide도 단백질임.

degradation vs denaturation

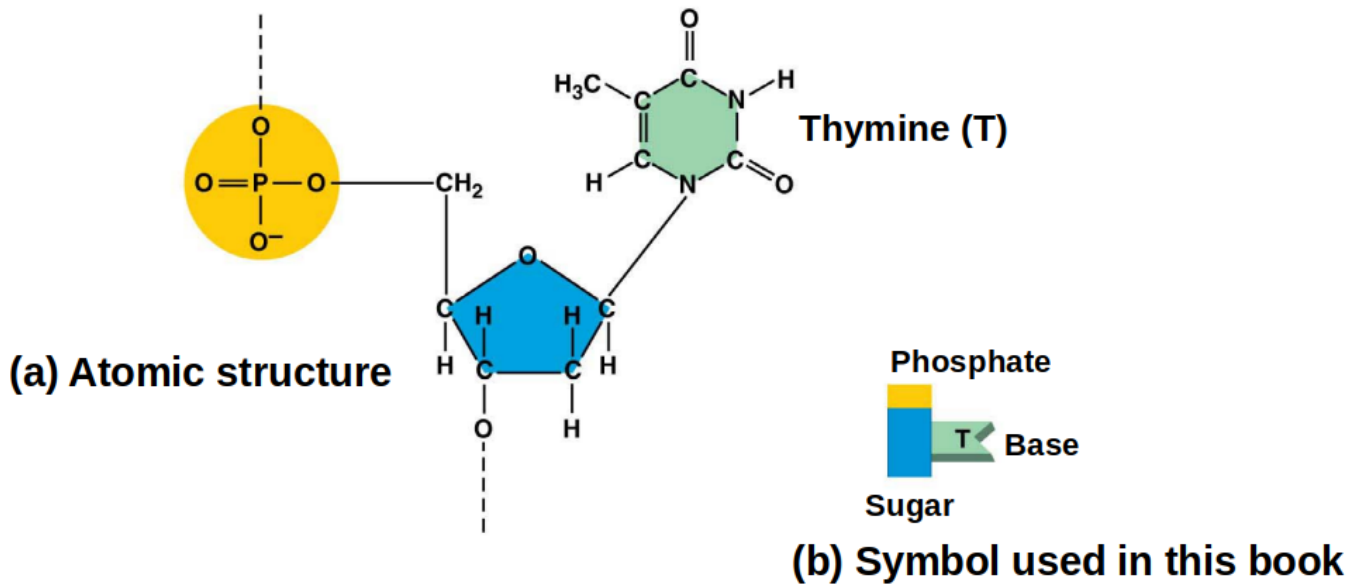
- degradation 분해 : 1차 구조가 깨짐. 강한 에너지에 의한 것
- denaturation 변성 : 2,3,4차 구조가 변형됨. 구조를 형성하는 interaction이 약해서 일어남. 높은 온도, pH 변화 등에 의해서 일어남
 - ex) denaturation of normal protein by prion protein

Nucleic Acids

- store information
- provide the instruction for building protein
- two types
 1. DNA, deoxyribonucleic acid => stable. no functional group in ribose
 2. RNA, ribonucleic acid => unstable. hydroxyl(-OH) group connected to 2' Carbon in ribose
- polymers made from monomers called nucleotides
- 동식물의 가장 큰 기본 구성 물질. nucleotide가 억 단위로 붙으니...

structure of nucleotide

1. a five-carbon sugar
2. a phosphate group
3. a nitrogen-containing base
 - adenine
 - guanine
 - thymine or uracil
 - cytosine



phosphodiester bond

- dehydration reaction
- covalent bond
- dotted line describe this bond in last picture.