

Biochemistry I

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Progress is the most important!

Biochemistry

Biochemistry

- Chemistry of living matter (stardust)
- What is the living matter?
 1. Metabolism & Energy: Must intake and transform nutrients into energy
 2. Sensation & Response: Must sense and respond to changes in surroundings
 3. Reproduction: Must accurately reproduce

Three Domains of Life

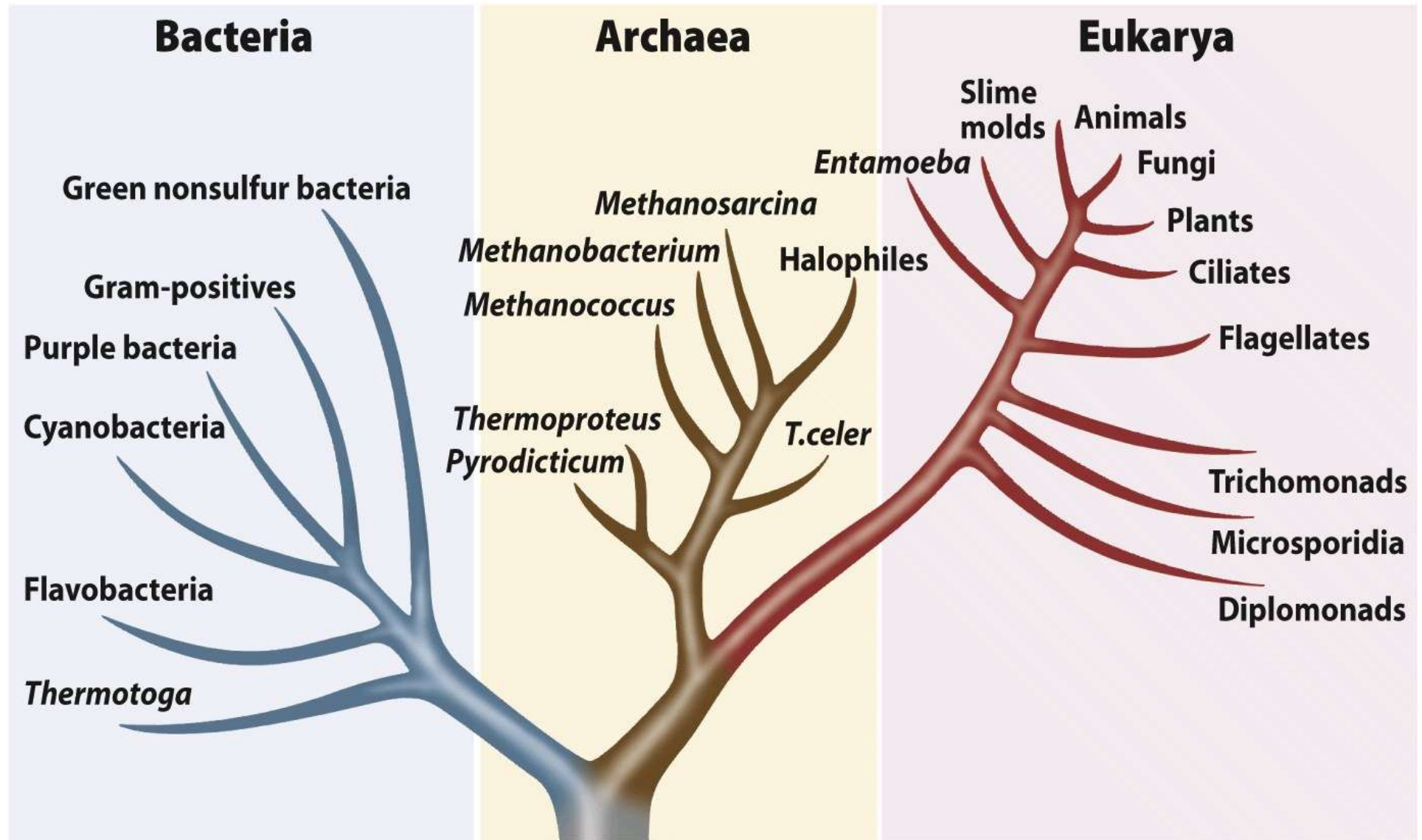


Figure 1-9

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Six Kingdoms of Life

Six kingdoms

Cellular organization

- | | | |
|-------------|---|---------------------------------|
| 1. Archaea | → | Unicellular prokaryote |
| 2. Bacteria | → | Unicellular prokaryote |
| 3. Protista | → | Unicellular eukaryote |
| 4. Fungi | → | Uni- or Multicellular eukaryote |
| 5. Plantae | → | Multicellular eukaryote |
| 6. Animalia | → | Multicellular eukaryote |

Cell: The Universal Building Block

- Living organisms are made of cells.
- The simplest living organisms are unicellular (single-celled).
- Larger organisms are multicellular (many-celled), with different functions for different cells.
- Different cells have common and unique features.

Prokaryotes vs Eukaryotes

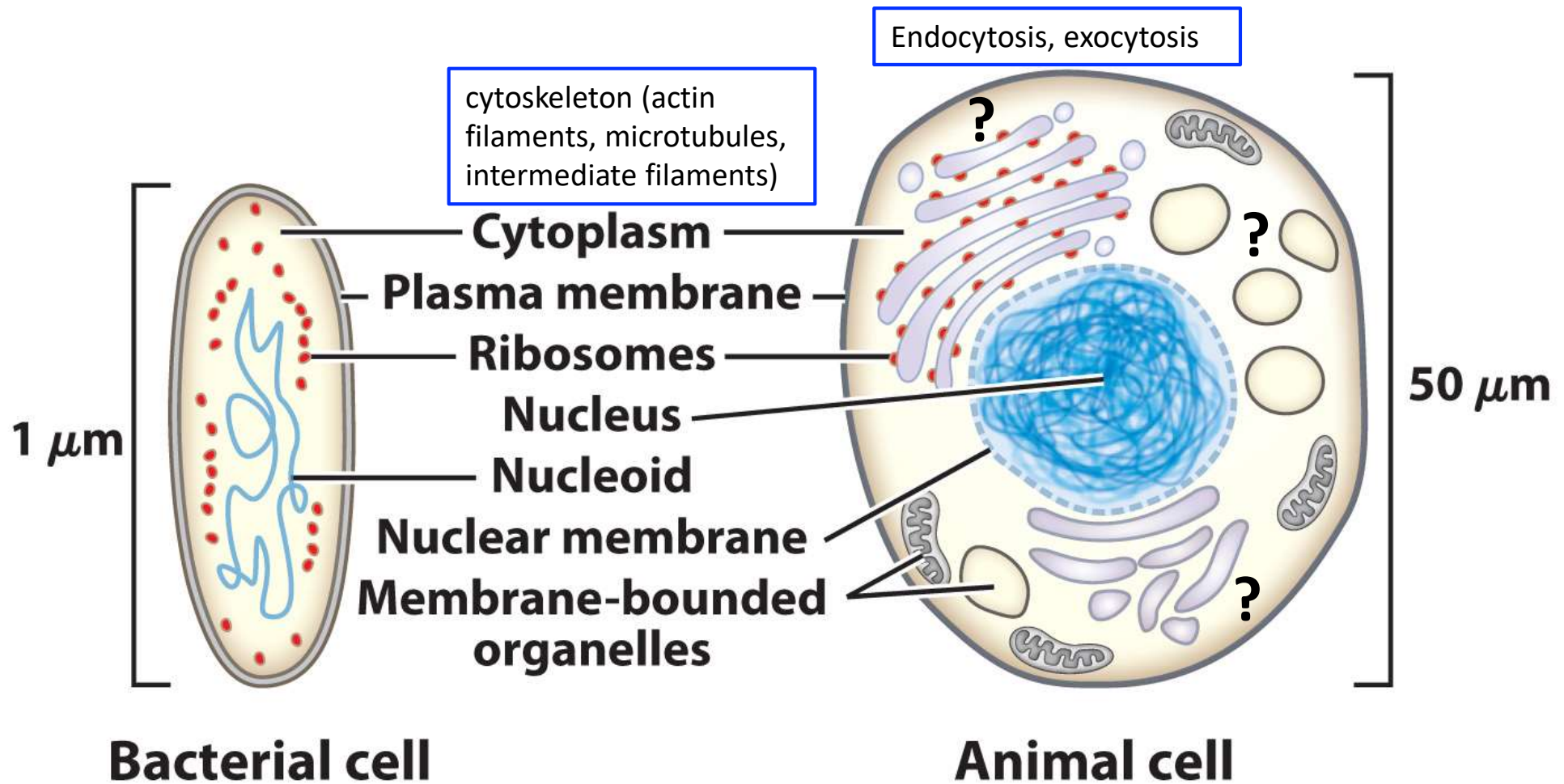


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What limits cell size?

The Molecular Hierarchy of Structure

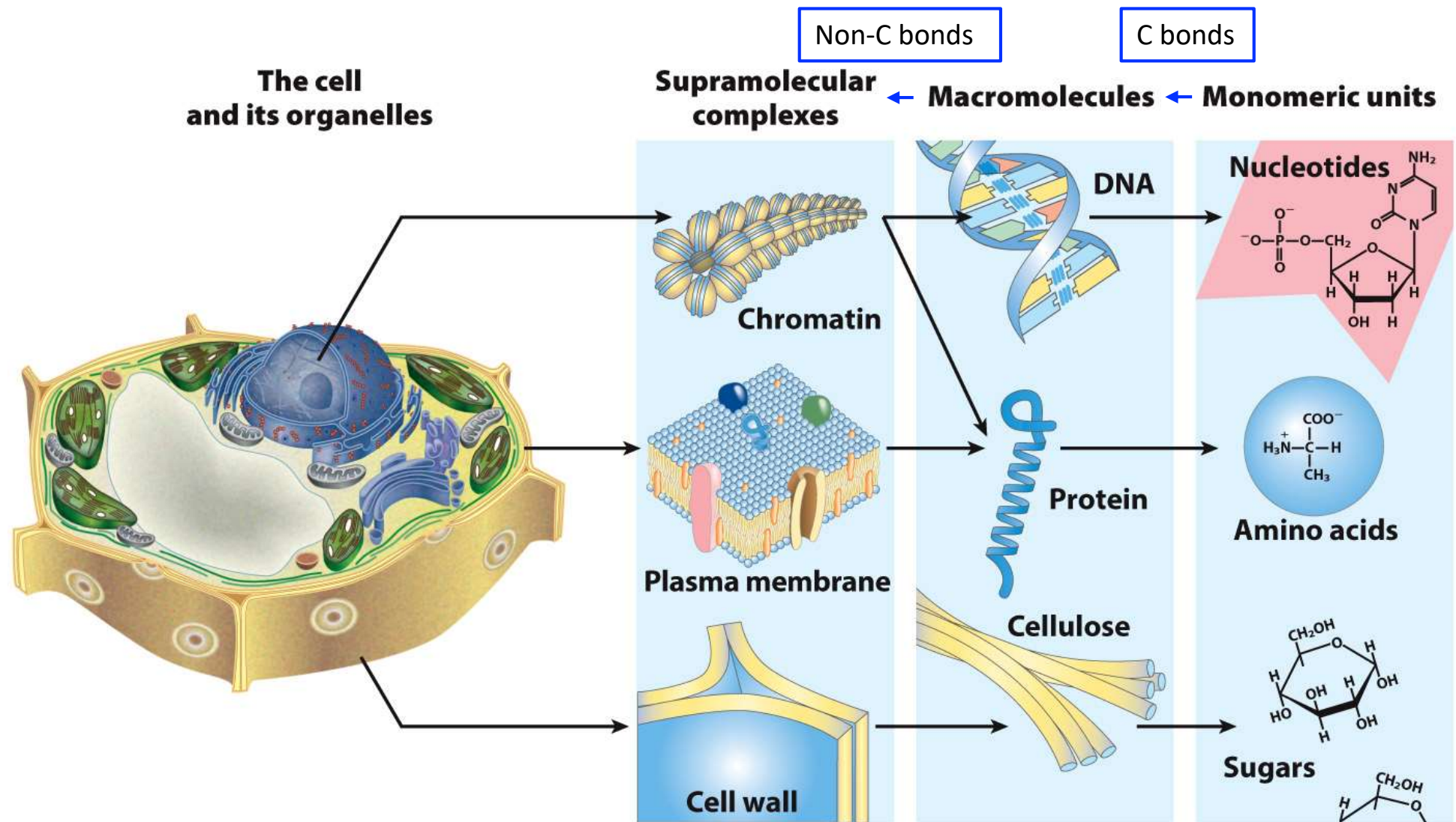


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30 Elements Essential for Life

| | | | | | | | | | | | | | | | | | | |
|-----------------|-----------------|--|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 1 H | | | | | | | | | | | | | | | | | 2 He | |
| 3 Li | 4 Be | | | | | | | | | | | 5 B | 6 C | 7 N | 8 O | 9 F | 10 Ne | |
| 11 Na | 12 Mg | | | | | | | | | | | 13 Al | 14 Si | 15 P | 16 S | 17 Cl | 18 Ar | |
| 19 K | 20 Ca | 21 Sc | 22 Ti | 23 V | 24 Cr | 25 Mn | 26 Fe | 27 Co | 28 Ni | 29 Cu | 30 Zn | 31 Ga | 32 Ge | 33 As | 34 Se | 35 Br | 36 Kr | |
| 37 Rb | 38 Sr | 39 Y | 40 Zr | 41 Nb | 42 Mo | 43 Tc | 44 Ru | 45 Rh | 46 Pd | 47 Ag | 48 Cd | 49 In | 50 Sn | 51 Sb | 52 Te | 53 I | 54 Xe | |
| 55 Cs | 56 Ba | ↙ ↘ Lanthanides Actinides | | 72 Hf | 73 Ta | 74 W | 75 Re | 76 Os | 77 Ir | 78 Pt | 79 Au | 80 Hg | 81 Tl | 82 Pb | 83 Bi | 84 Po | 85 At | 86 Rn |
| 87 Fr | 88 Ra | | | | | | | | | | | | | | | | | |

Bulk elements
 Trace elements

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Carbon!

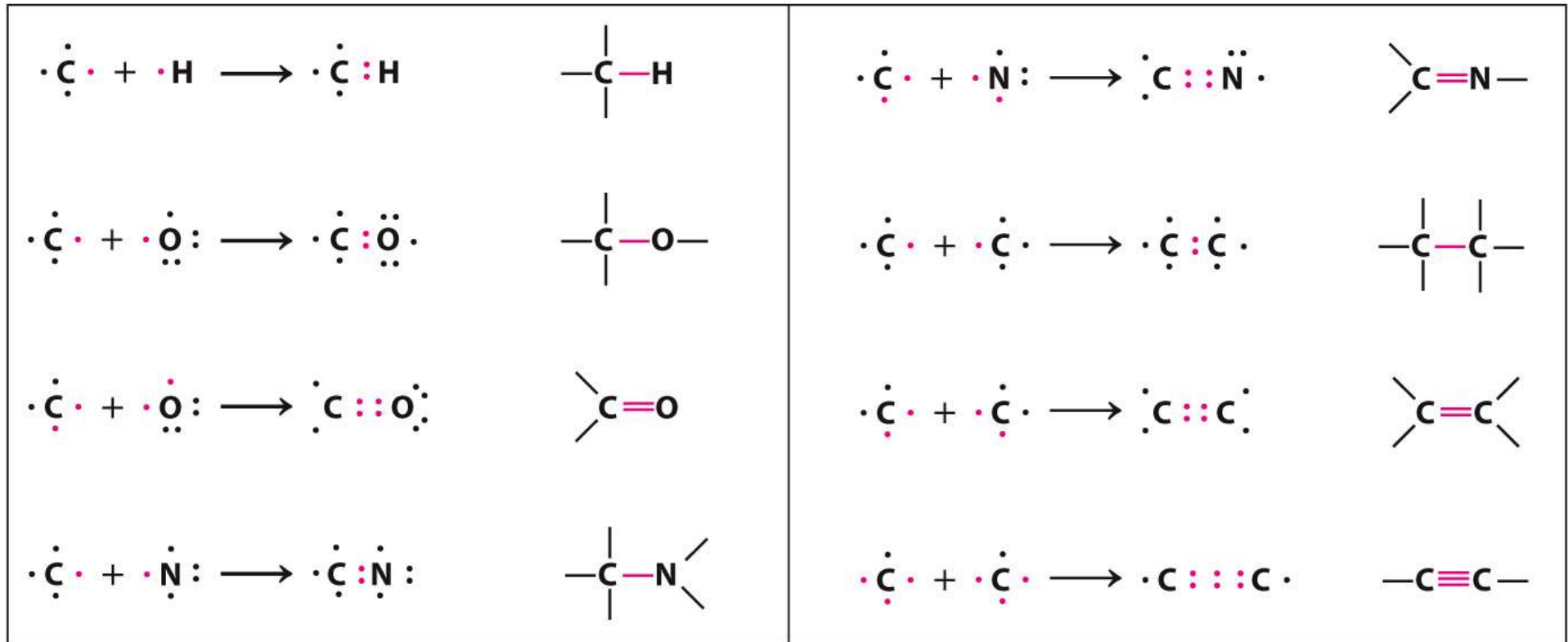
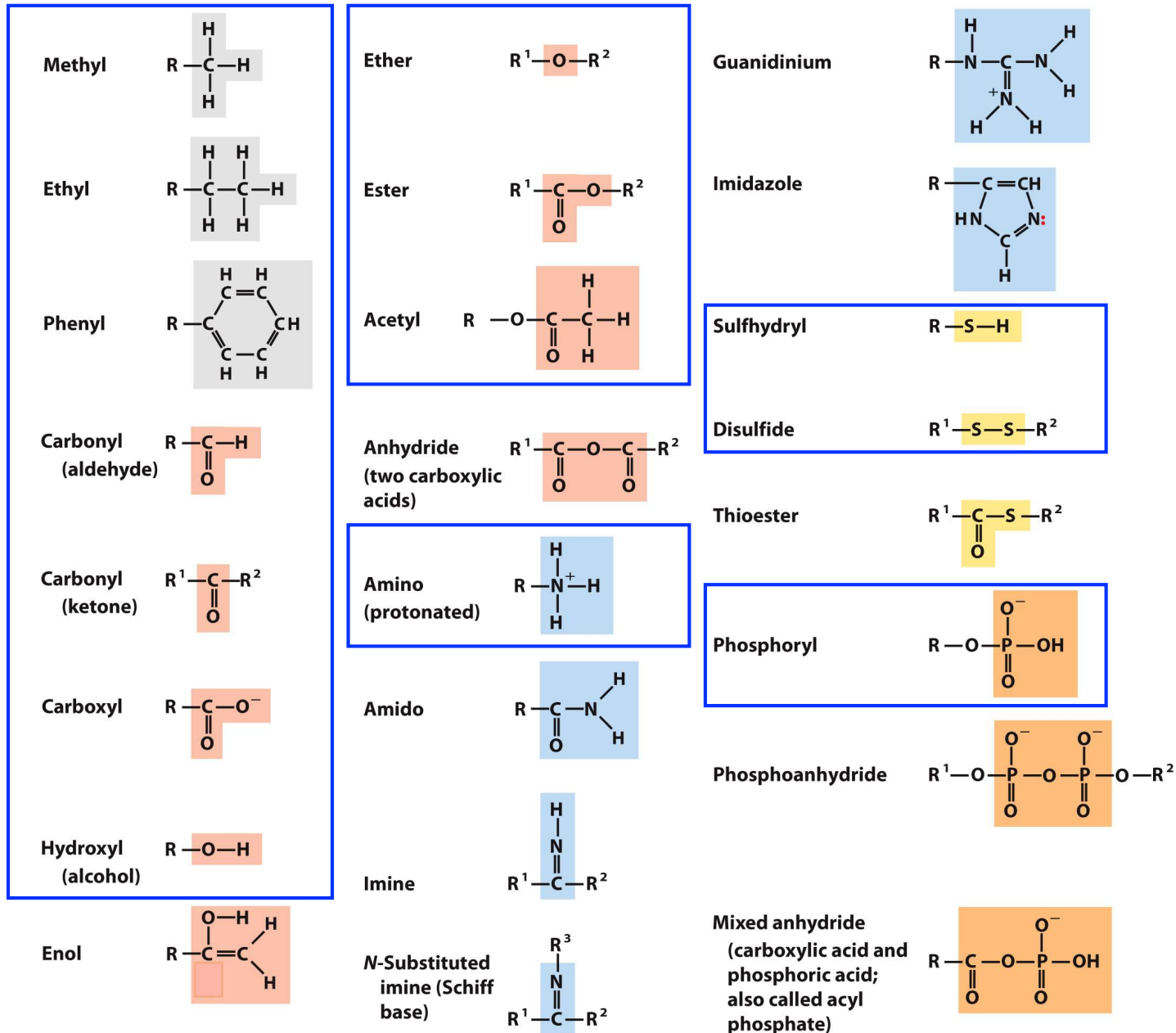


Figure 1-15

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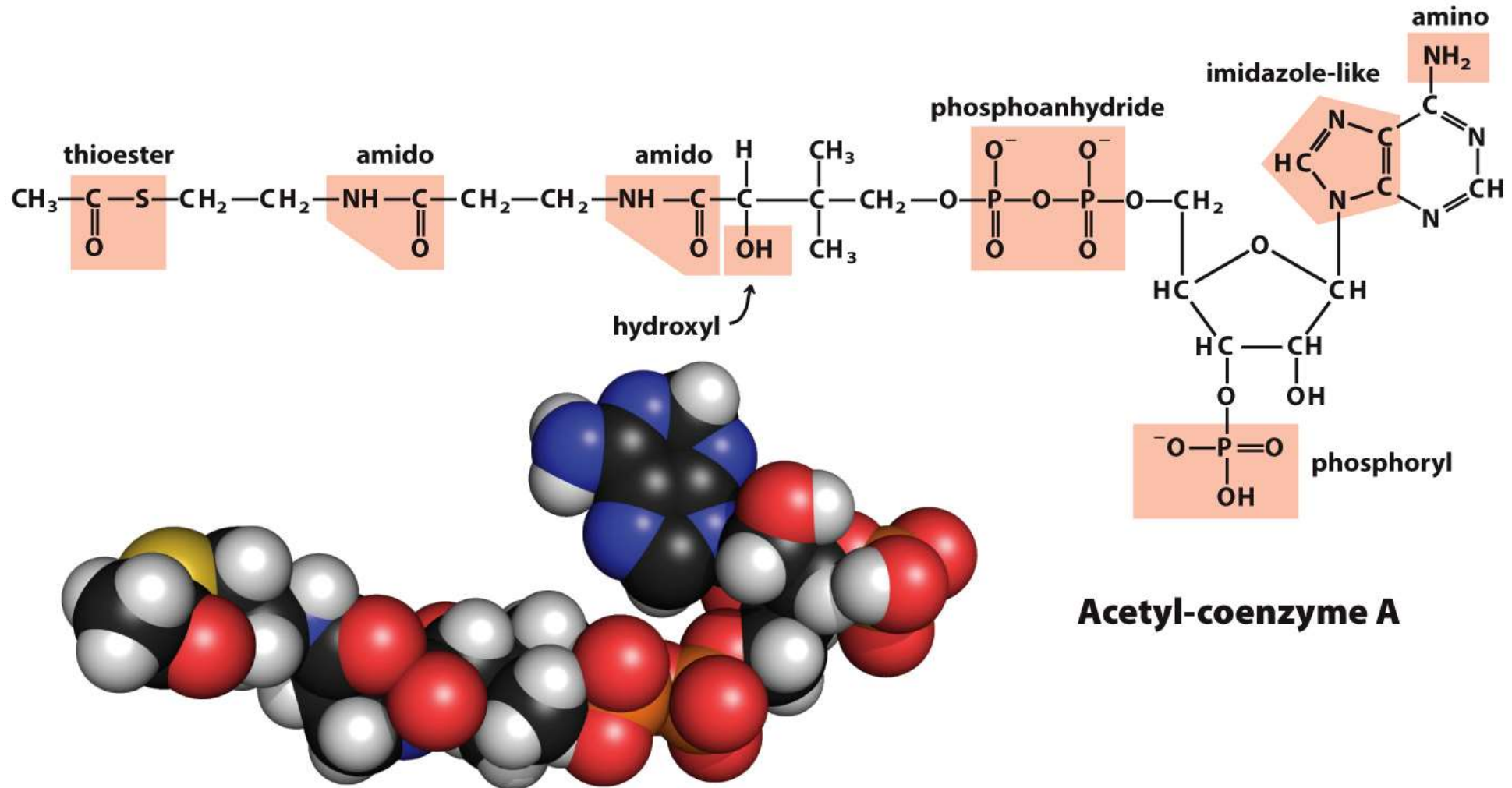
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Common Functional Groups of Biological Molecules



** handout typo!

Biological Molecules Typically Have Several Functional Groups



Acetyl-coenzyme A

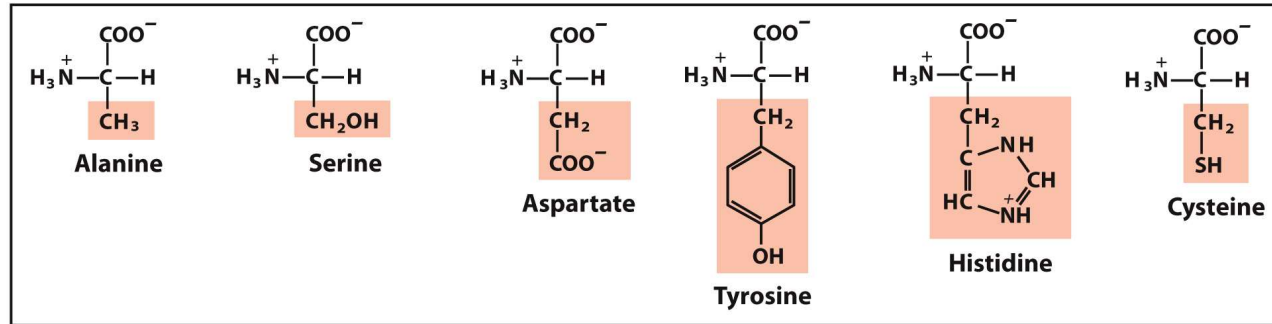
Figure 1-18

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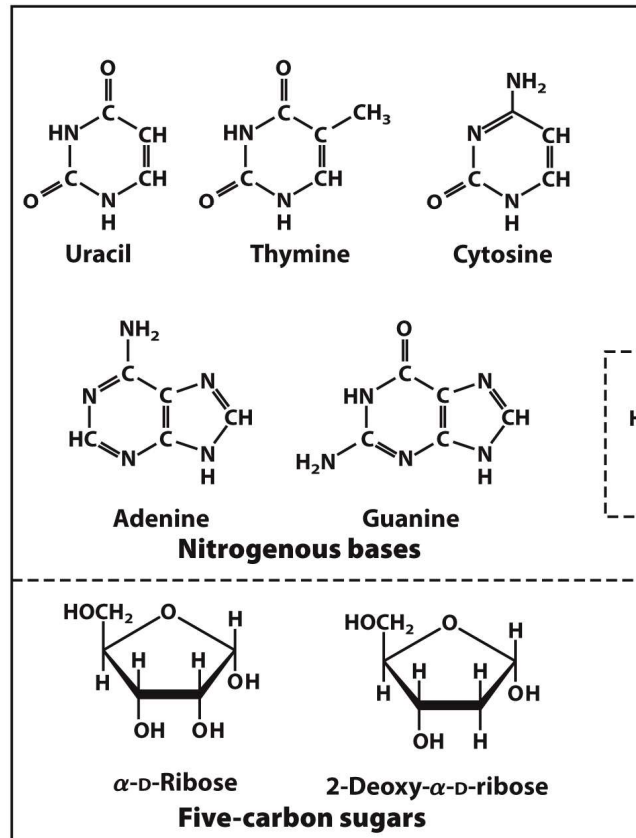
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The ABCs of Life

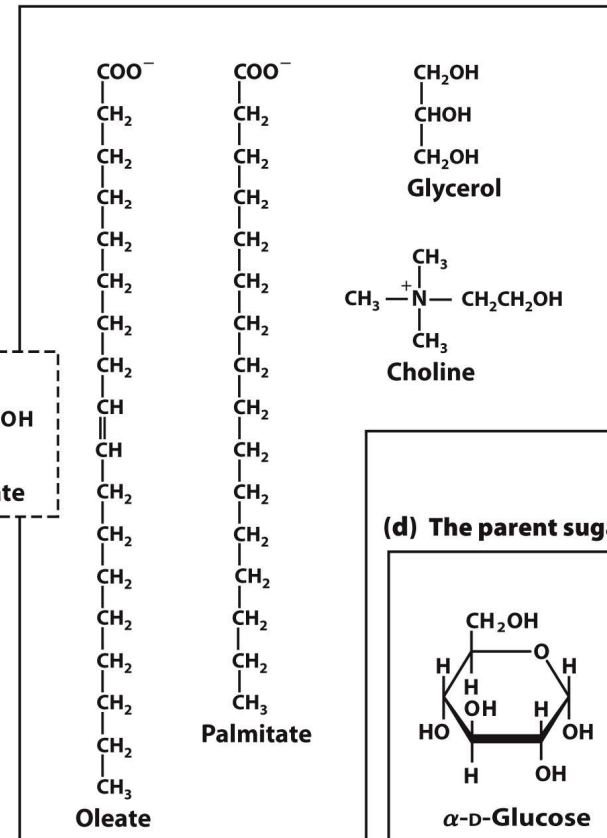
(a) Some of the amino acids of proteins



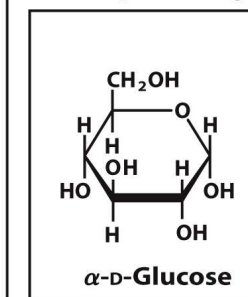
(b) The components of nucleic acids



(c) Some components of lipids



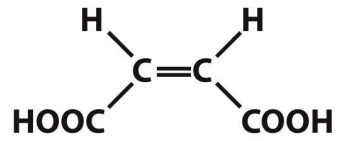
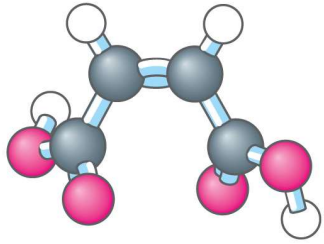
(d) The parent sugar



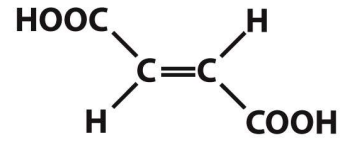
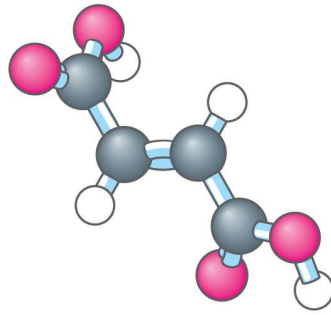
Function of Molecules Depends on 3D Structure

- Stereoisomers
 - have different physical properties
- Geometric isomers (cis vs. trans)
 - have different physical and chemical properties
- Enantiomers (mirror images)
 - have identical physical properties (except with regard to polarized light) and react identically with achiral reagents
- Diastereomers
 - have different physical and chemical properties

Cis vs. Trans

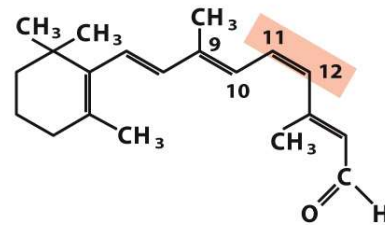
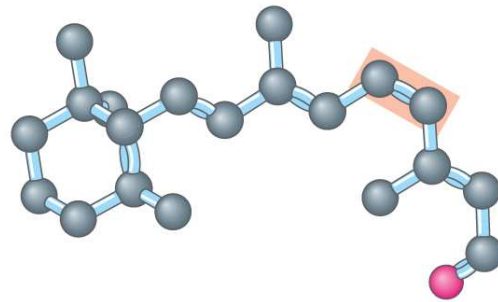


Maleic acid (cis)



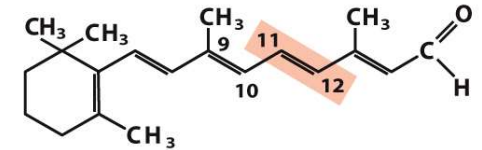
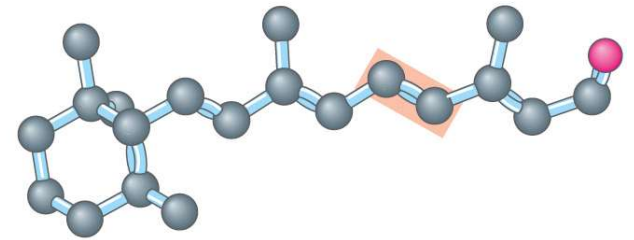
Fumaric acid (trans)

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11-cis-Retinal

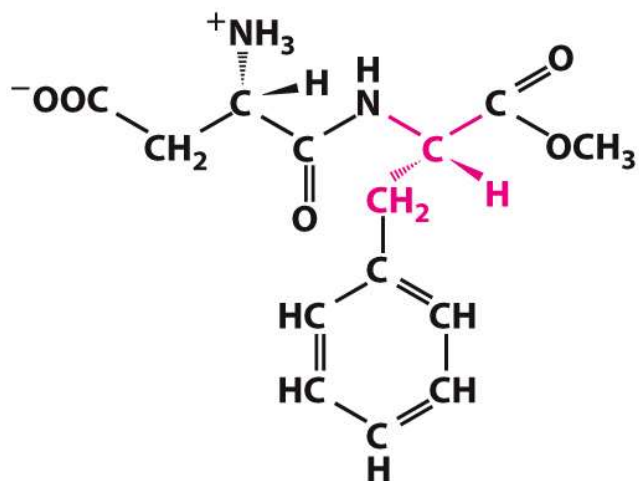
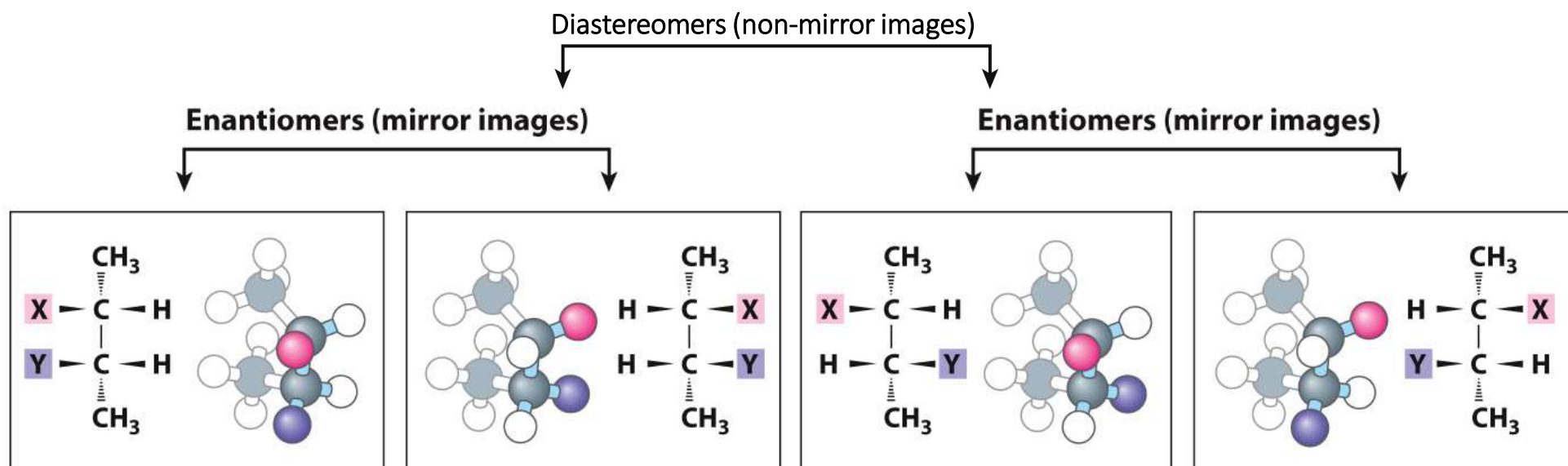
light
↘



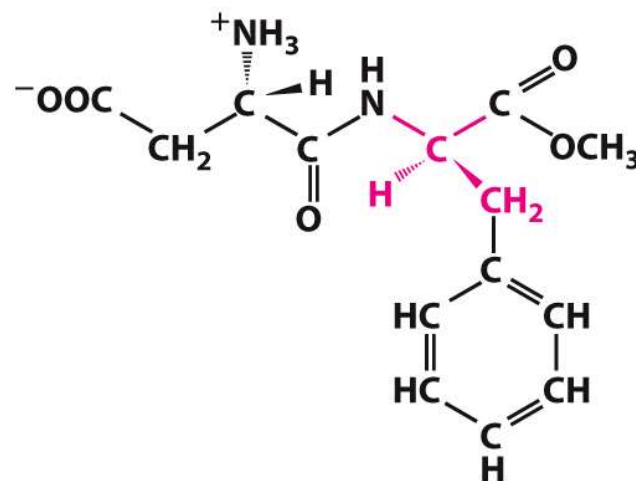
All-trans-Retinal

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Enantiomers and Diastereomers



L-Aspartyl-L-phenylalanine methyl ester
(aspartame) (sweet)



L-Aspartyl-D-phenylalanine methyl ester
(bitter)

Specific Interactions between Biomolecules

- Macromolecules fold into 3D structures with unique binding pockets.
- Only certain molecules fit in well and can bind.
- Binding of chiral biomolecules is stereospecific.

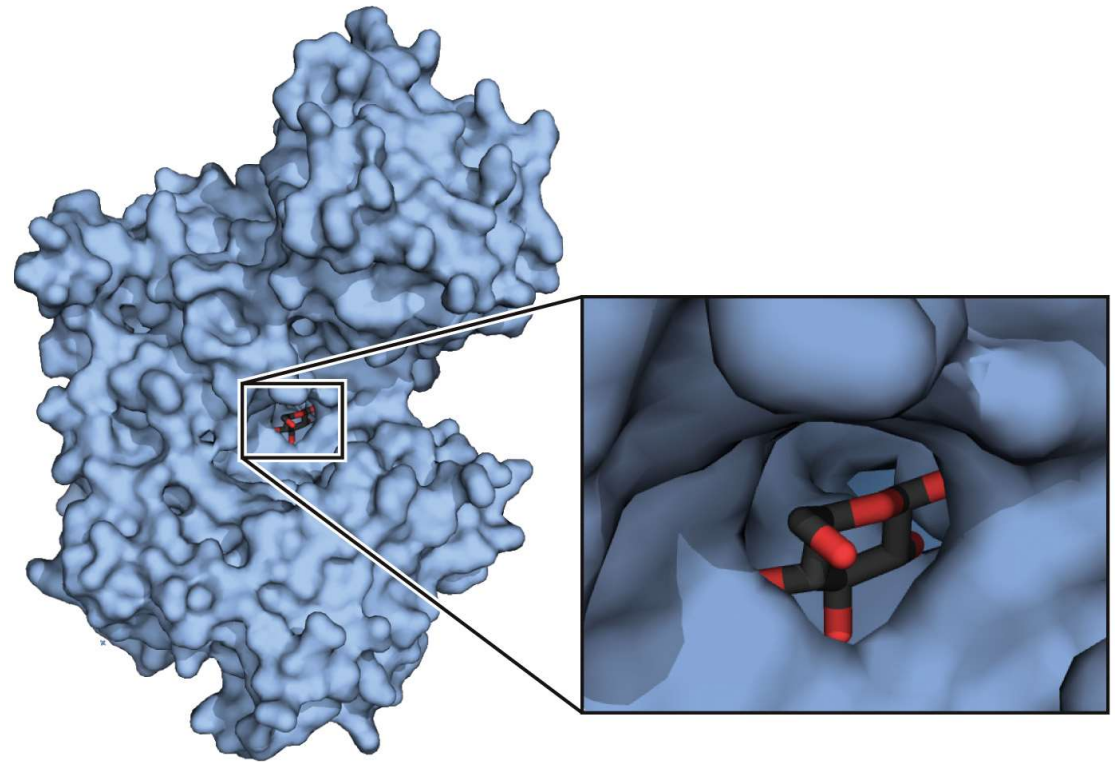


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Chapter 1: Summary

- Living organisms (domains, kingdoms, definition?)
- Structure and function of the cell (2 types)
- Biomolecules and building blocks

Next week: Energy and metabolism, thermodynamics