Carbon and the Molecular Diversity of Life

70 - 95% of cell is water

the rest = carbon-based compounds

other elements = H, O, N, S and P

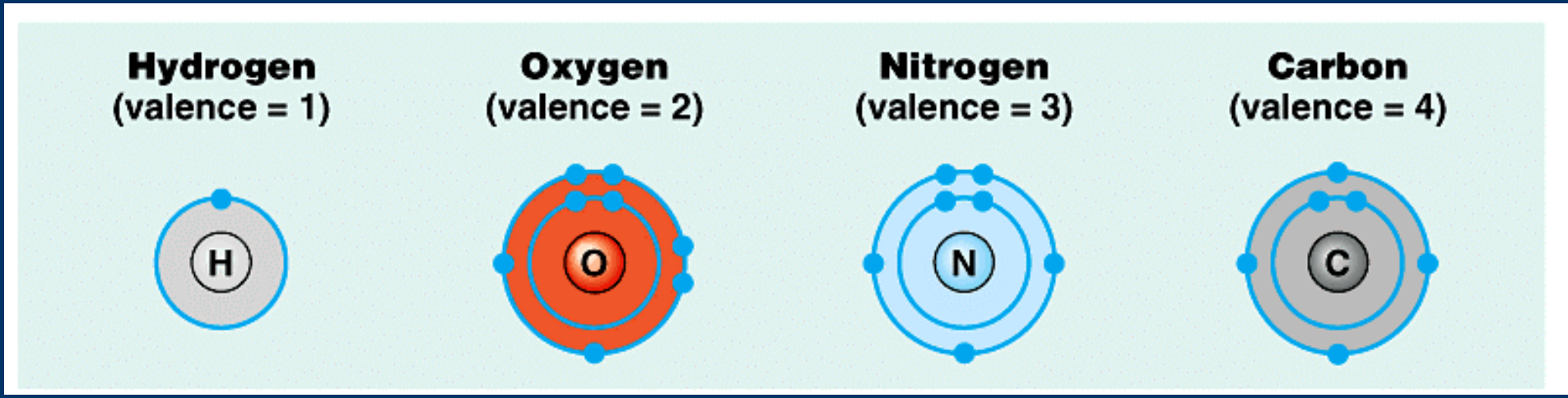
e.g. carbohydrates, proteins, nucleic acids, lipids

Carbon atom: the most versatile building block of molecule

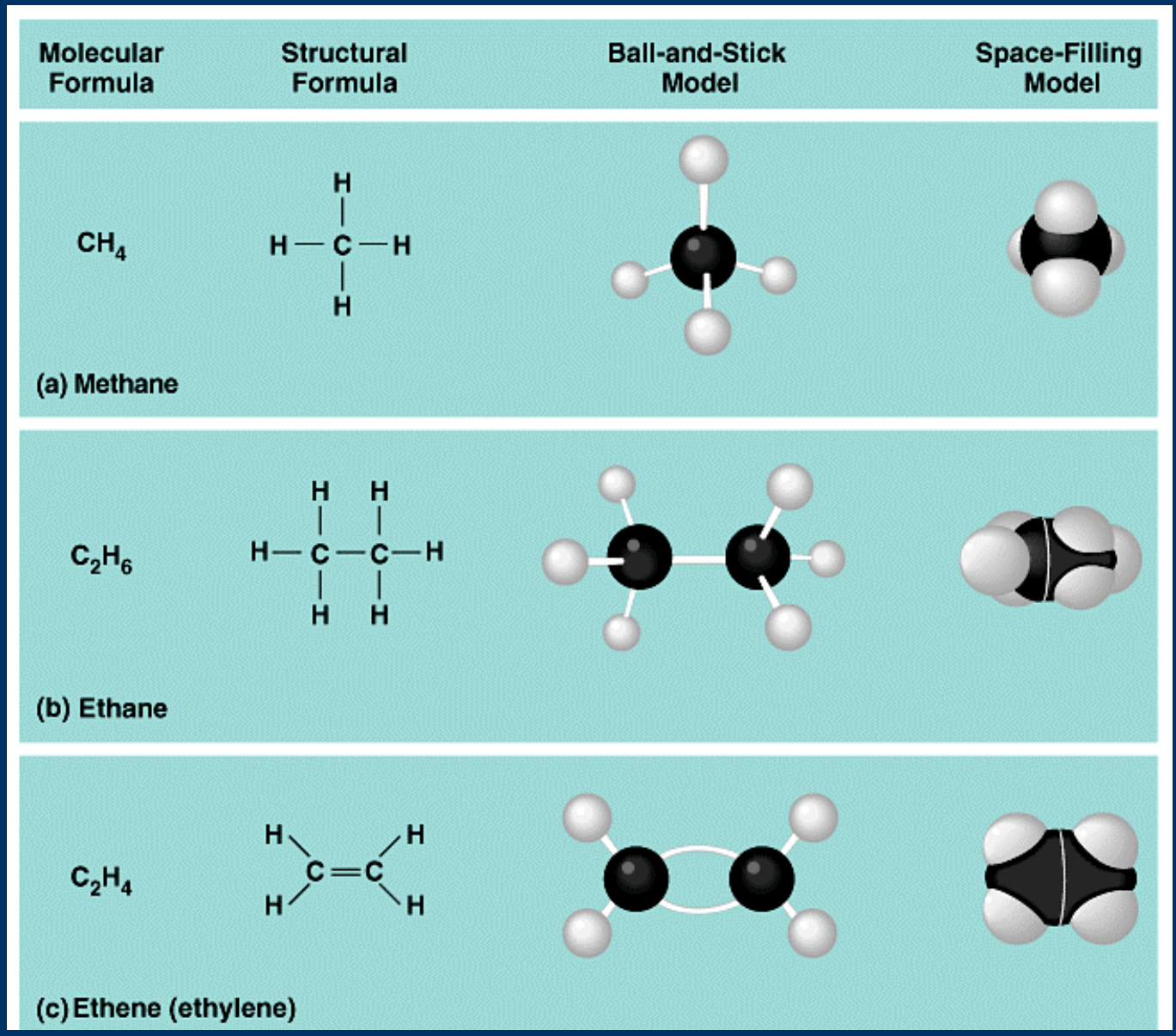
-valence electron of carbon atom = 4

-can be bonded to different atom

-can be single, double or triple bonded

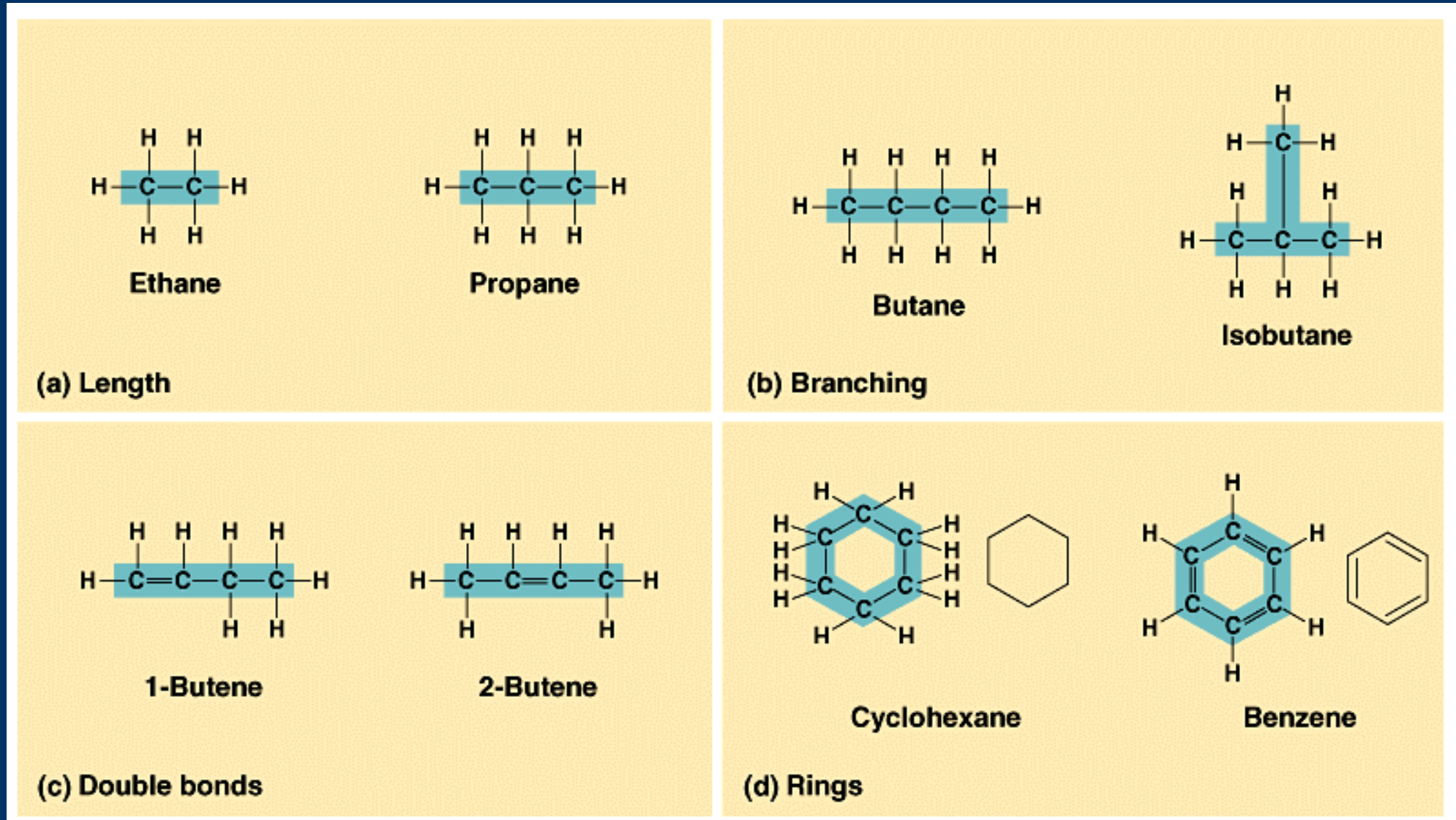


Shape of Simple Organic Molecules: the Hydrocarbons

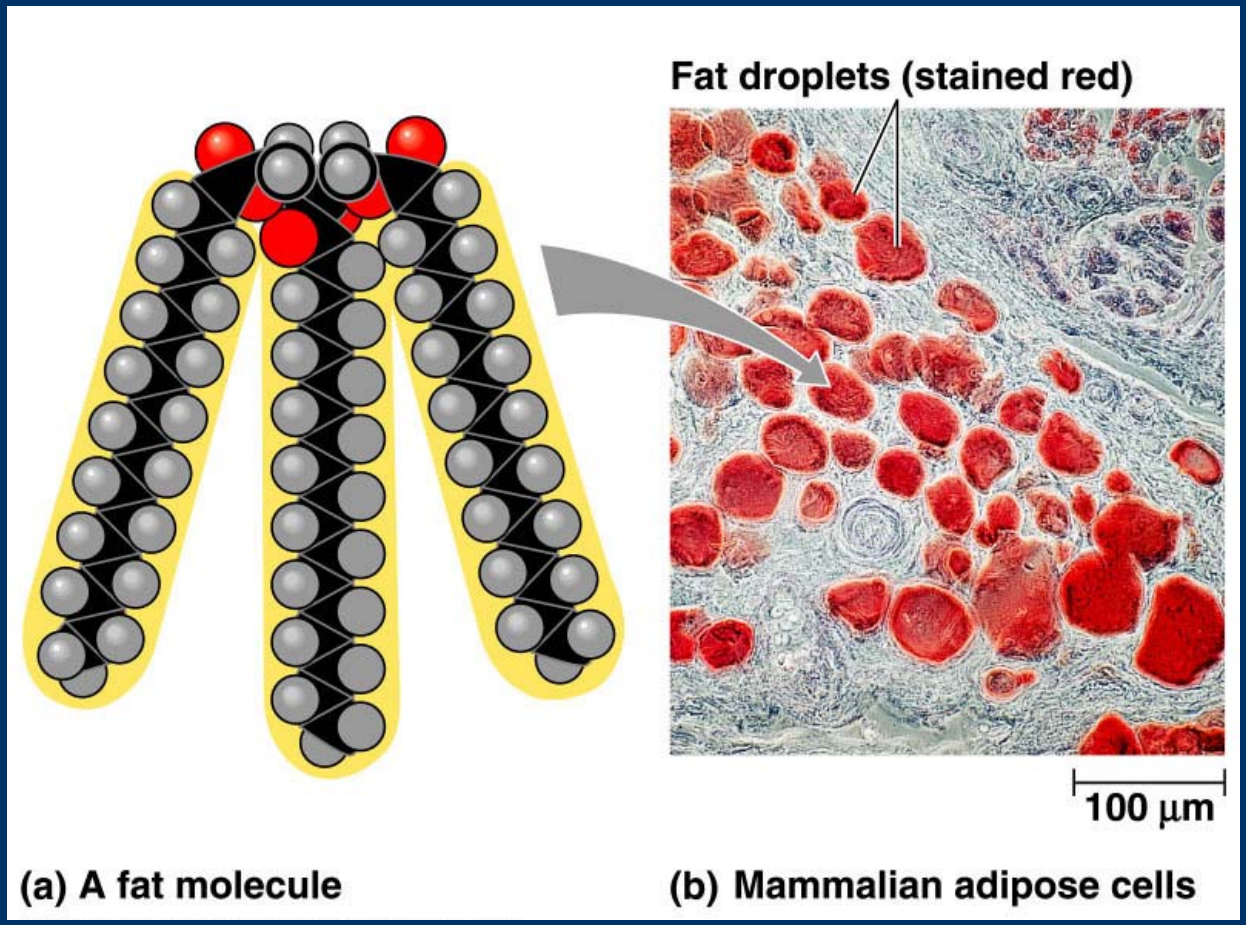


Variation of Carbon Skeleton:

length, branched, cyclic structure or double bonded



Fats: the long chain hydrocarbon compounds



Isomers

= variation in architecture of organic molecules

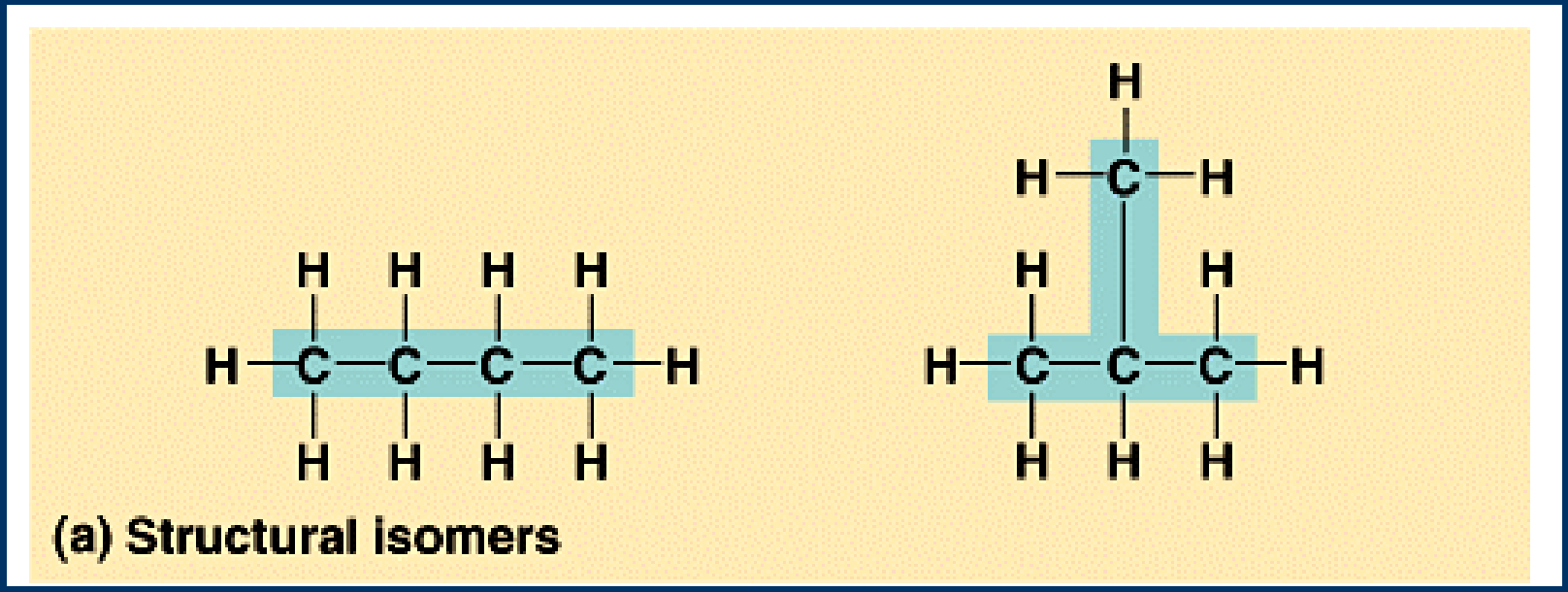
-the same molecular formula but different structures, thus different properties

- -structural isomers
- -geometric isomers
- -enanthiomers

Structural isomers

-differ in covalent arrangement of their atoms

-may also differ in the location of the double bonds



Geometric isomers

-the same covalent partnerships

-different in the spatial arrangement of double bond

-e.g. light-induced change of rhodopsin between 2 geometric isomers

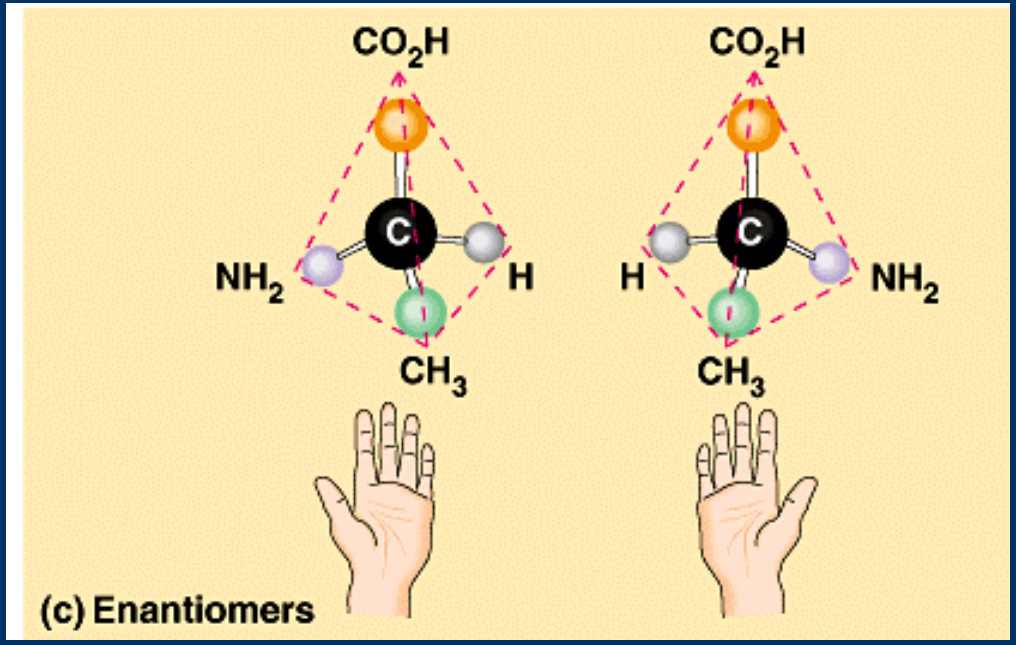
(b) Geometric isomers

Enanthiomers

-differ in spatial arrangement around an asymmetric carbon

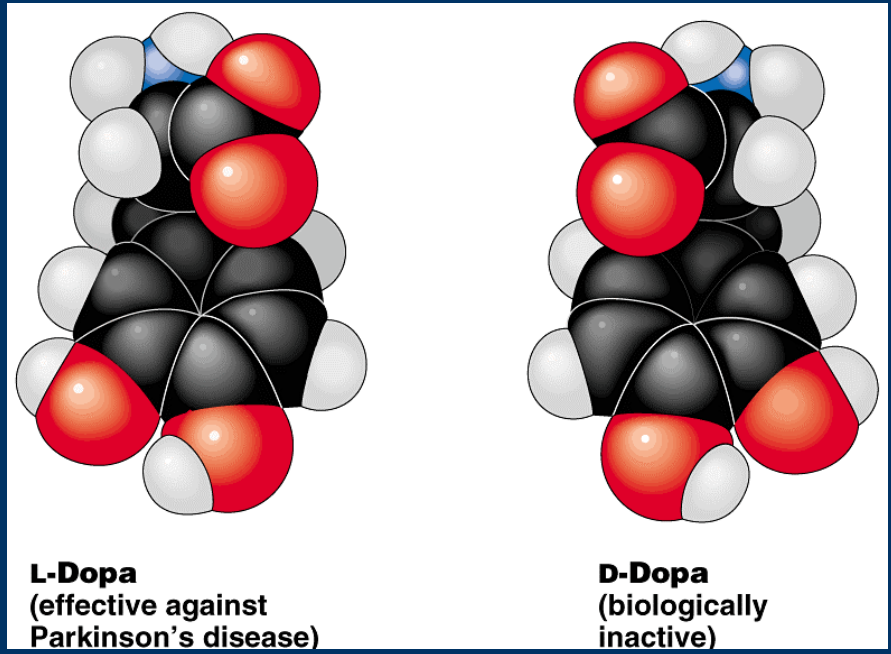
-asymmetric carbon = carbon which is attached to 4 different atoms or groups of atoms

-enanthiomers are mirror image molecule



-enanthiomers have different chemical properties

-L-Dopa, is effective against Parkinson's disease.
D-Dopa is biologically inactive



-thalidomide was a mixture of 2 enanthiomers. One reduced morning sickness while the other caused severe birth defect

Functional Groups

= the component of organic molecules that are most commonly involved in chemical reactions.

-molecule with different functional groups have different properties e.g. sex hormone

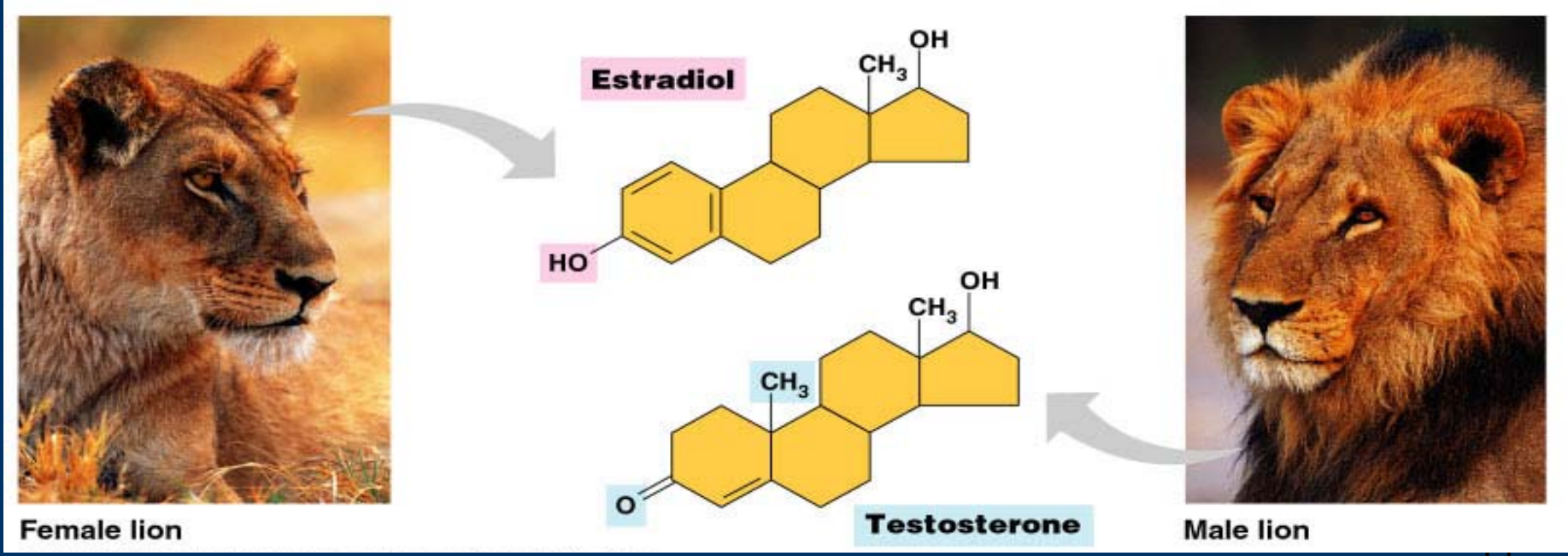
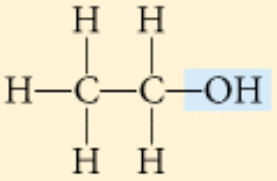


Table 4.1 Functional Groups of Organic Compounds

Functional Group	Formula	Name of Compounds	Example
Hydroxyl	—OH	Alcohols	 Ethanol (the drug of alcoholic beverages)

-the hydroxyl group is polar due to the high electronegativity of oxygen atom

-water solubility

-biomolecule containing hydroxyl group = sugar

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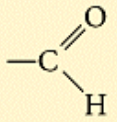
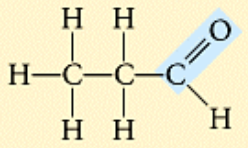
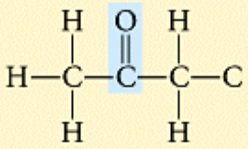
Carbonyl		Aldehydes	 Propanal
		Ketones	 Acetone

-Aldehyde = carbon compound with carbonyl group at the end of a carbon skeleton

-Ketone = carbon compound with carbonyl group at any position (except at the end) of a carbon skeleton

-isomers with aldehyde or ketone have different properties

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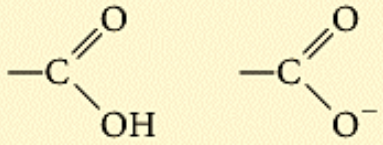
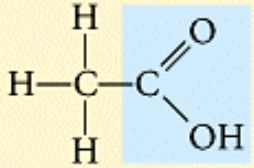
Carboxyl	 (non-ionized) (ionized)	Carboxylic acids	 Acetic acid* (the acid of vinegar)

*The ionized forms of the carboxyl and amino groups prevail in cells. However, acetic acid and glycine are represented here in their non-ionized forms.

-Carboxyl group is a source of hydrogen ions = acid

-dissociation of COOOH to $COOO^-$

-e.g. formic acid, acetic acid

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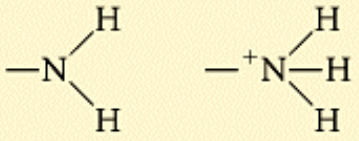
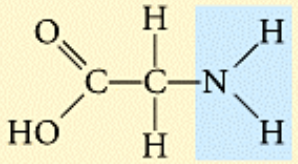
Amino	 (non-ionized) (ionized)	Amines	 Glycine* (an amino acid)

*The ionized forms of the carboxyl and amino groups prevail in cells. However, acetic acid and glycine are represented here in their non-ionized forms.

-the amino group acts as base

-can pick up proton to form NH_3^+

-amino acids, the building of protein, have carboxyl and amino groups

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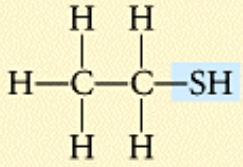
Functional Group	Formula	Name of Compounds	Example
Sulfhydryl	—SH	Thiols	 Ethanethiol

-sulfhydryl groups help stabilize the structure of proteins

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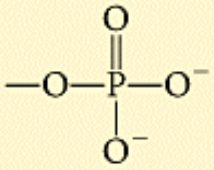
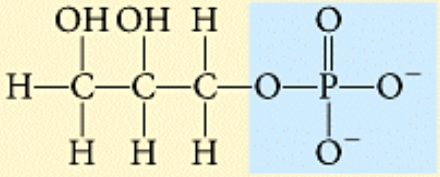
Functional Group	Formula	Name of Compounds	Example
Phosphate		Organic phosphates	 Glycerol phosphate

-phosphate is an anion formed by dissociation of phosphoric acid (H_3PO_4)

-one function of phosphate groups is the transfer of energy between organic molecules.