

Chapter 4

Carbon and the Molecular Diversity of Life

PowerPoint® Lecture Presentations for

Biology

Eighth Edition

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Lectures by Chris Romero, updated by Erin Barley with contributions from Joan Sharp

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Overview: Carbon: The Backbone of Life

- Why dedicate a whole chapter to Carbon?
- Importance of Carbon:

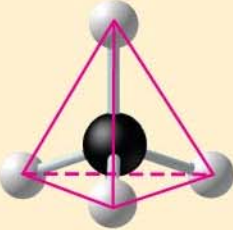

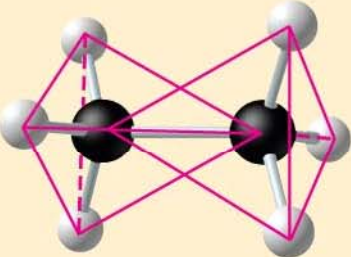

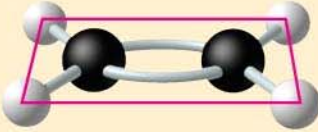

Periodic Table

Periodic Table of the Elements

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	57 La	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	89 Ac	104 Unq	105 Unp	106 Unh	107 Uns	108 Uno	109 Une	110 Unn								

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

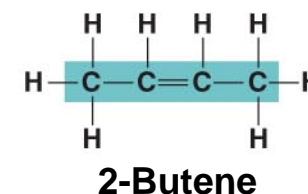
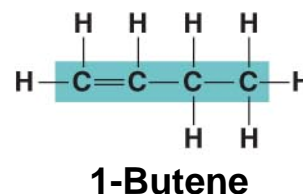
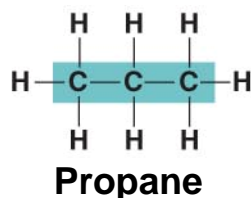
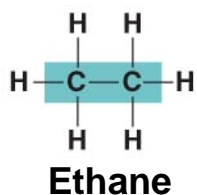
Fig 4-3

Name	Molecular Formula	Structural Formula	Ball-and-Stick Model	Space-Filling Model
(a) Methane	CH ₄	$ \begin{array}{c} \text{H} \\ \\ \text{H} - \text{C} - \text{H} \\ \\ \text{H} \end{array} $		
(b) Ethane	C ₂ H ₆	$ \begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H} - \text{C} - \text{C} - \text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array} $		
(c) Ethene (ethylene)	C ₂ H ₄	$ \begin{array}{c} \text{H} \quad \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C} = \text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \quad \text{H} \end{array} $		

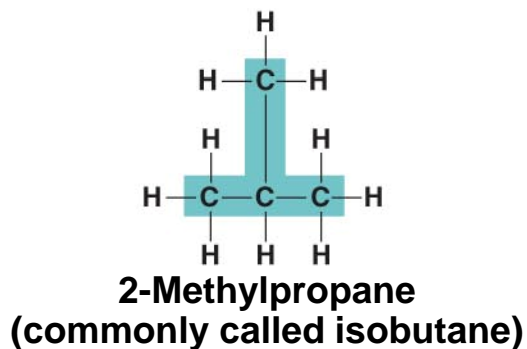
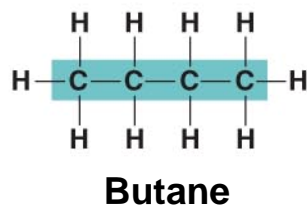
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- How many valence electrons does C have?
- How many covalent bonds can C form with other atoms?
- What atoms most frequently bond with C?

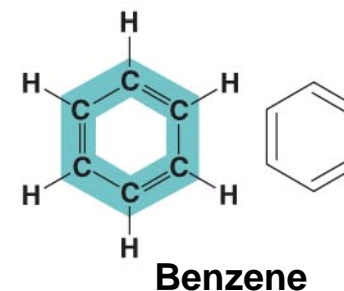
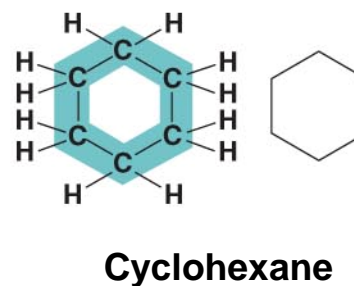
- Carbon chains form the skeletons of most organic molecules
- Carbon chains vary in length and shape



(a) Length



(c) Double bonds



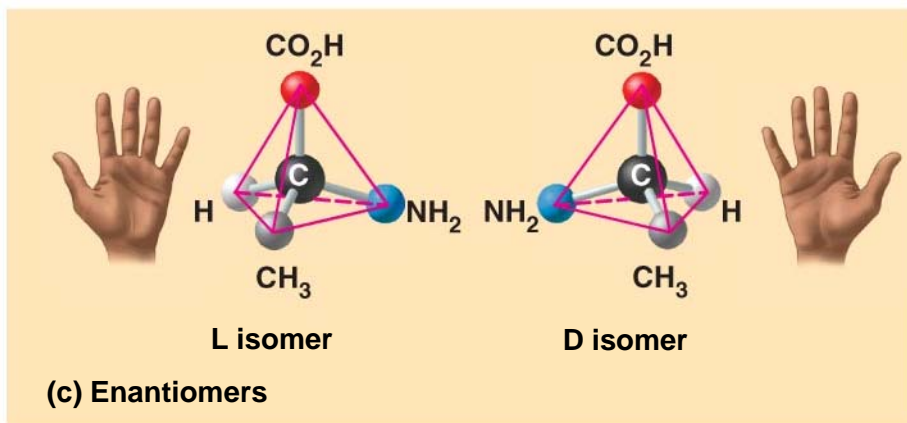
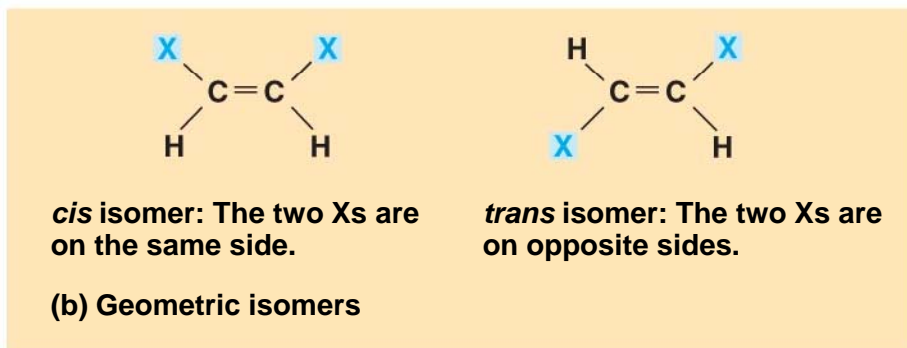
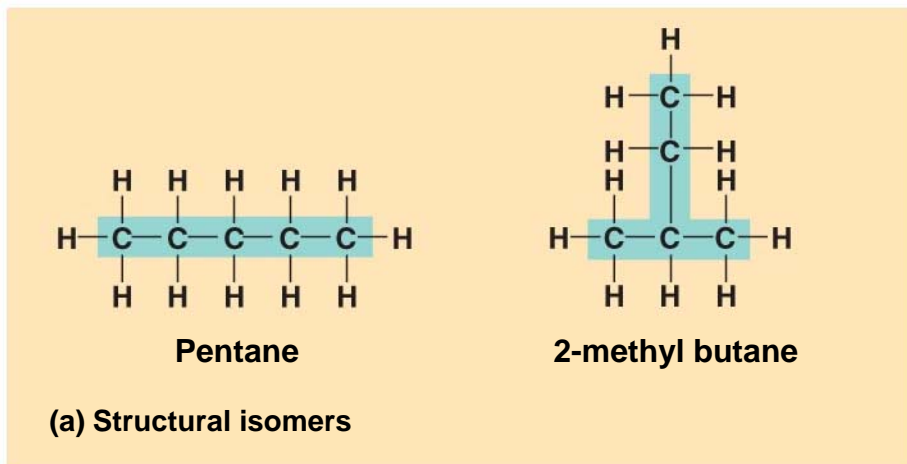
(b) Branching

(d) Rings

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Fig. 4-5

Fig. 4-7



What is an isomer?

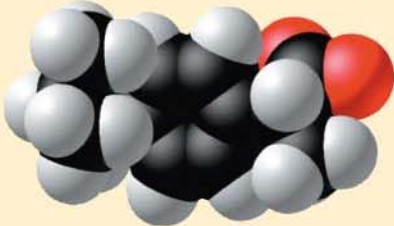

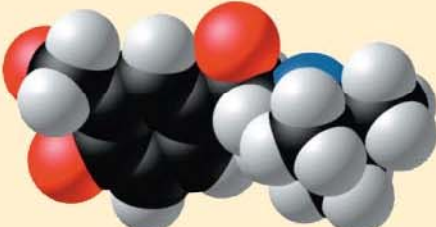

Do you have to have a double bond?

What is an asymmetric carbon?

Does it really matter?

Fig. 4-8

Two enantiomers of a drug may have different effects

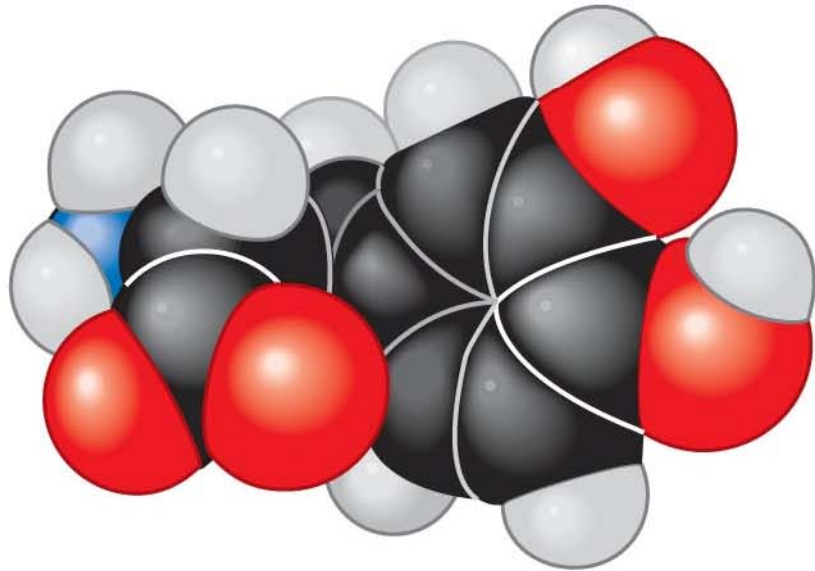
Drug	Condition	Effective Enantiomer	Ineffective Enantiomer
Ibuprofen	Pain; inflammation	 S-Ibuprofen	 R-Ibuprofen
Albuterol	Asthma	 R-Albuterol	 S-Albuterol

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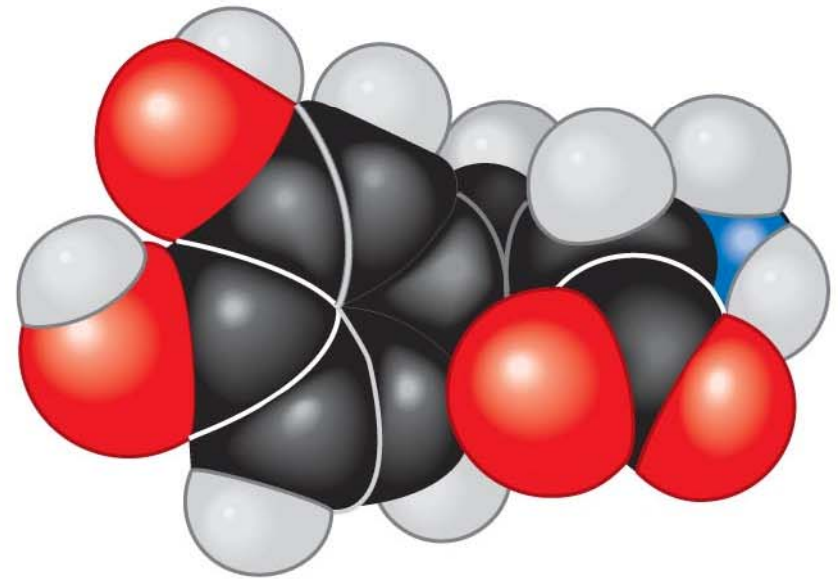
PLAY

Animation: L-Dopa

Fig. 4-UN9



L-dopa

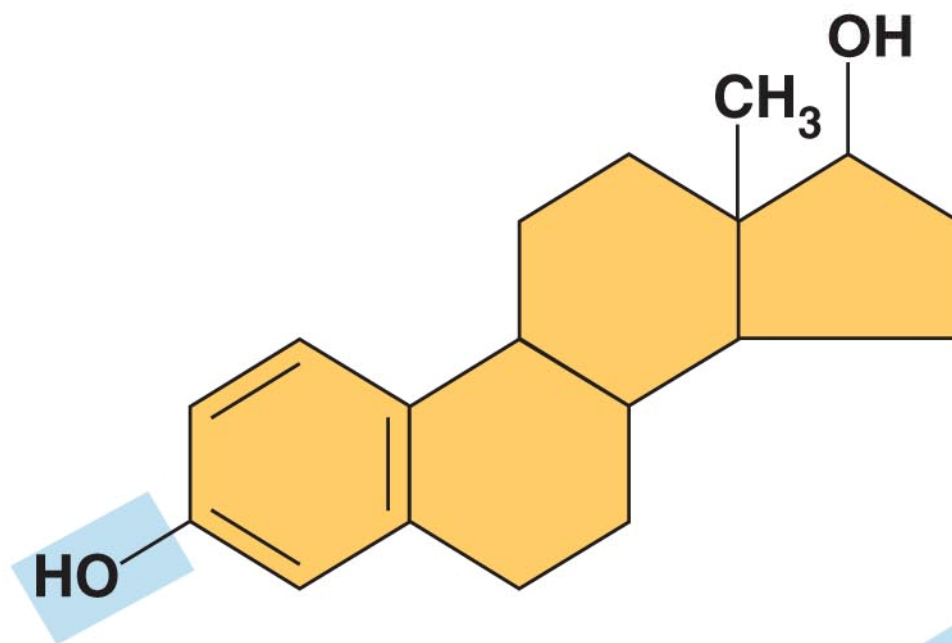


D-dopa

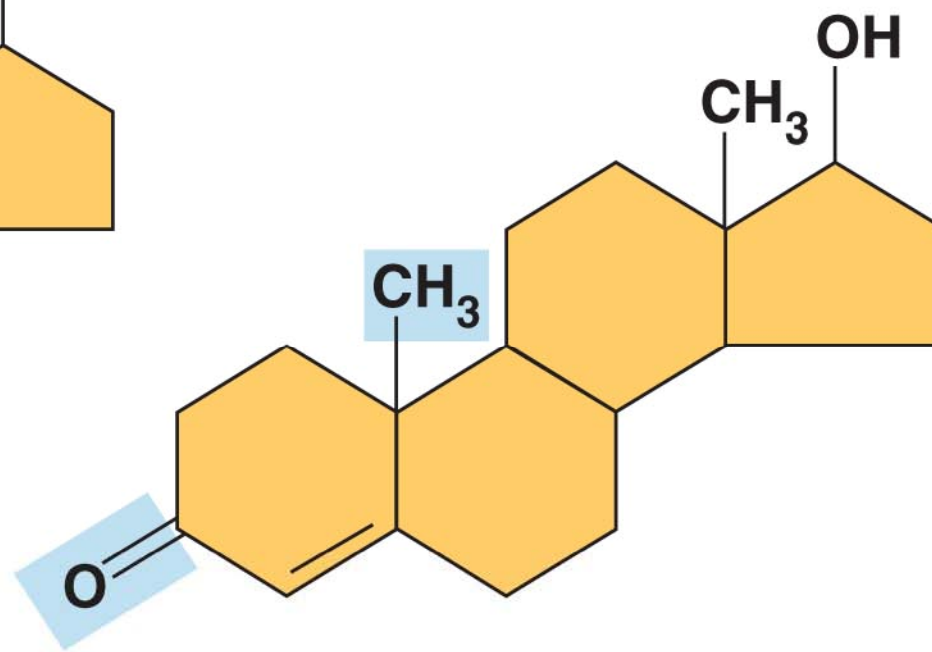
Fig. 4-9

Distinctive properties of organic molecules depend not only on the carbon skeleton but also on molecular components attached to it

Estradiol



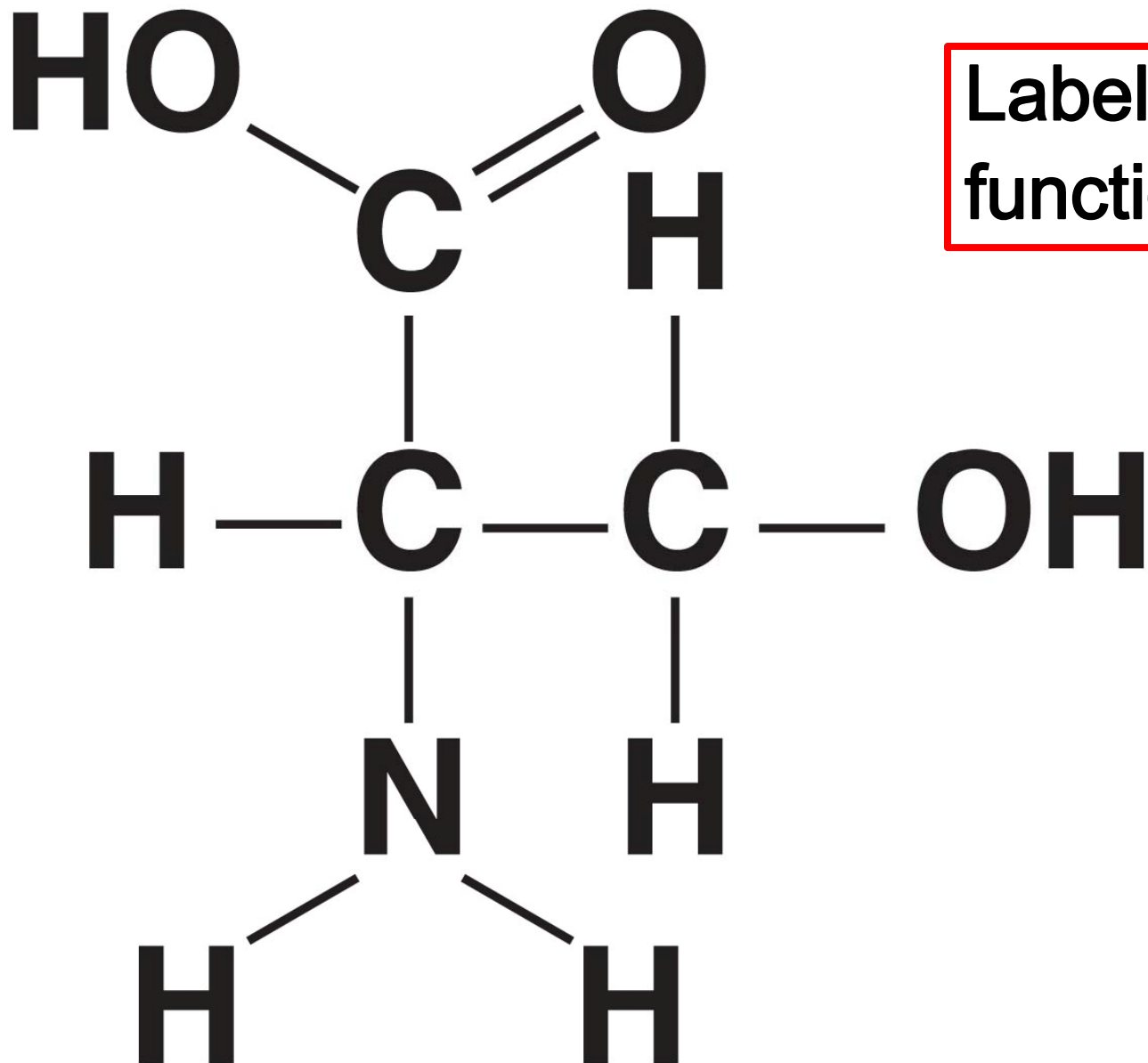
Testosterone



Functional groups are the components of organic molecules that are most commonly involved in chemical reactions

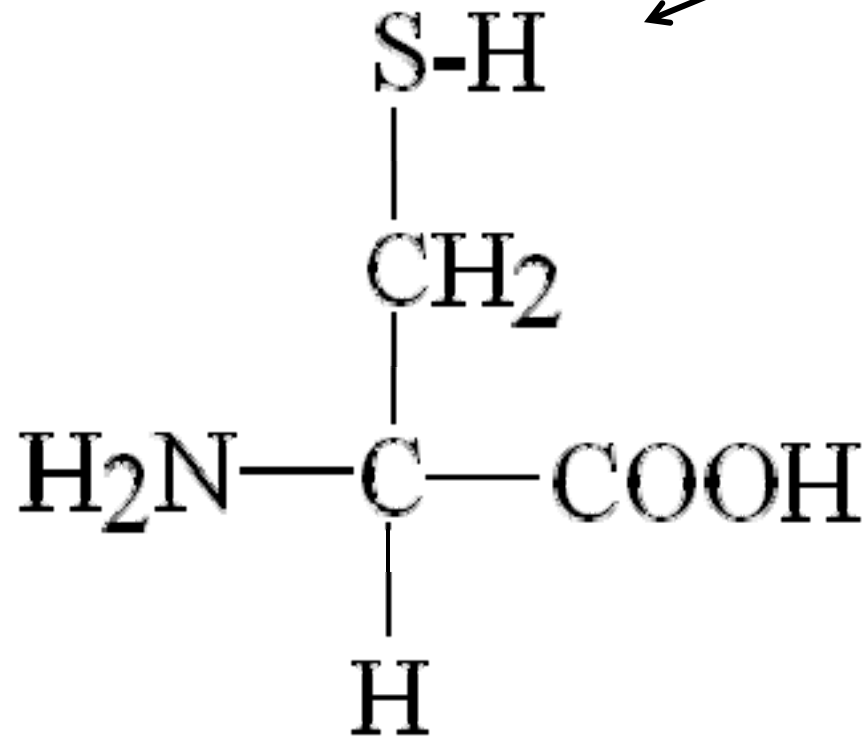
- Seven important functional groups – Draw them:
 - Hydroxyl group
 - Carbonyl group
 - Carboxyl group
 - Amino group
 - Sulfhydryl group
 - Phosphate group
 - Methyl group

Fig. 4-UN8



Label all of the functional groups

Name and describe the importance of this functional group?

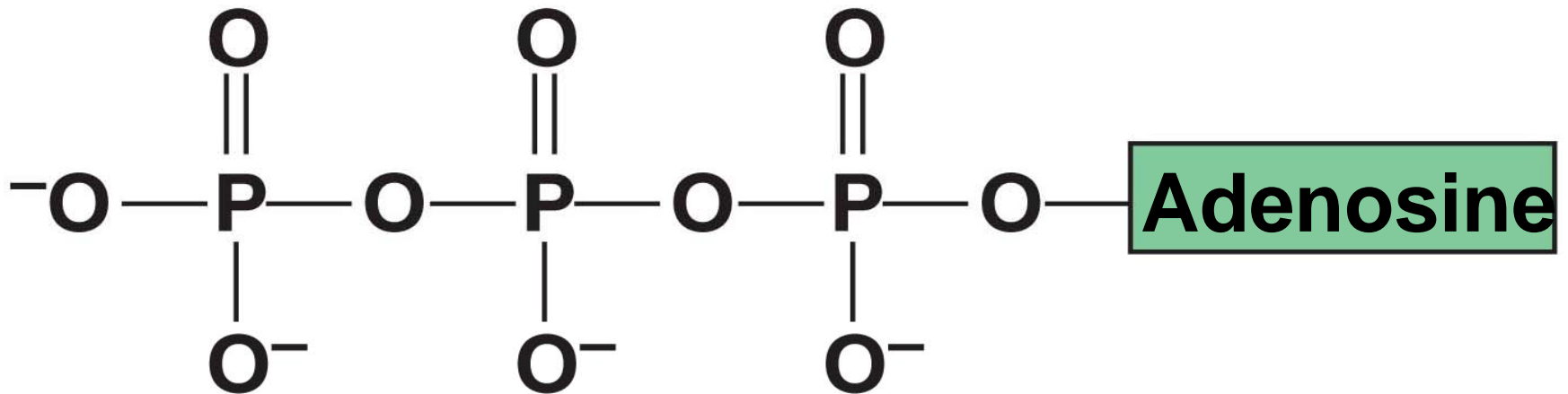


cysteine

Fig. 4-UN3

Name this molecule?

What is the importance of its functional groups?

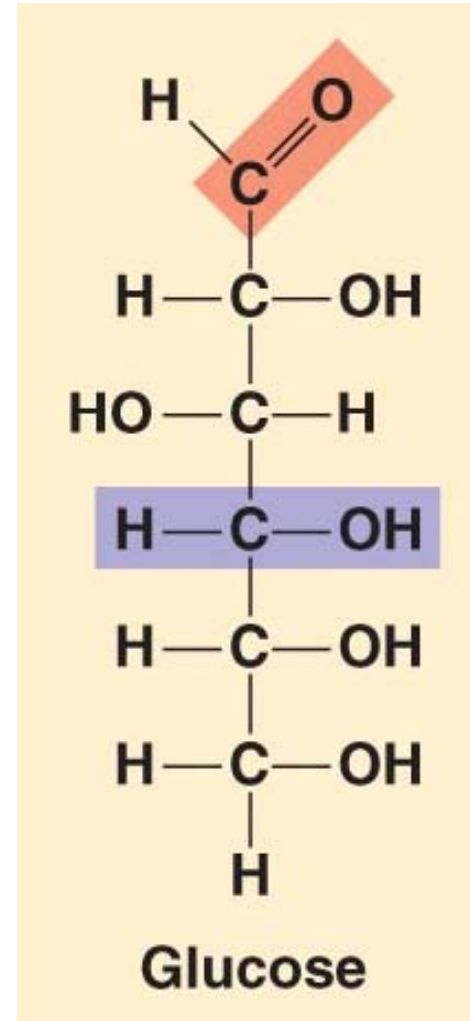


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Is this molecule soluble in water?



- yes
- no



The Chemical Elements of Life: *A Review*

BIG take-home messages are: