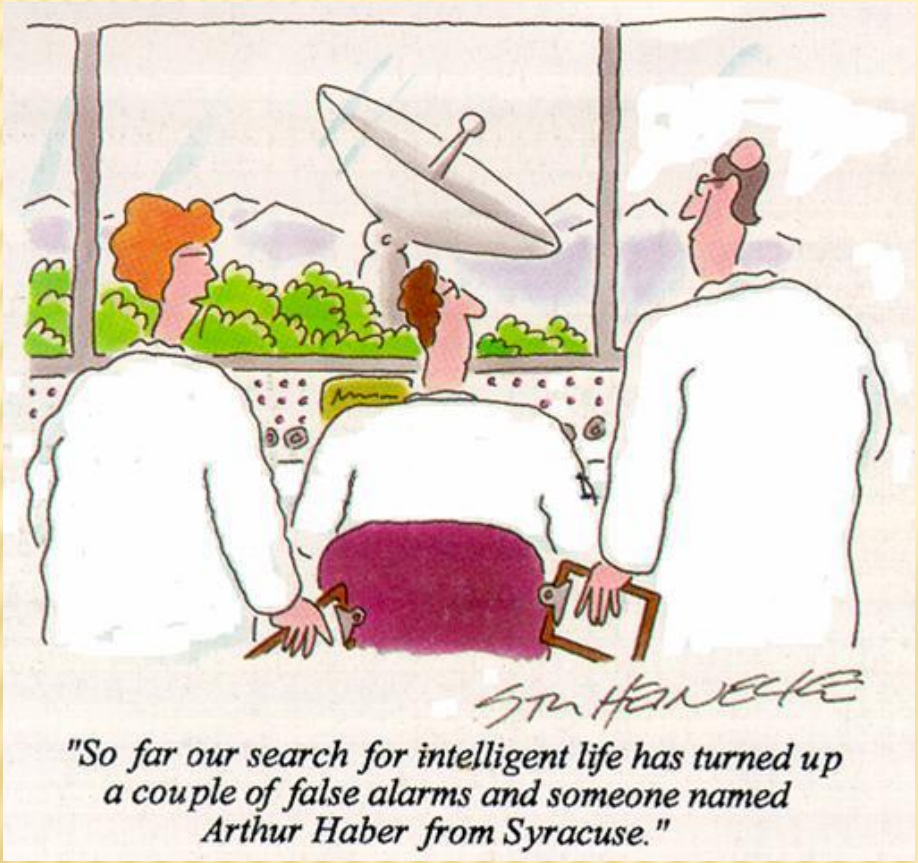
CHEM 241

Organic Chemistry I

11:00 – 11:50 am M W F

350 Crawford Hall

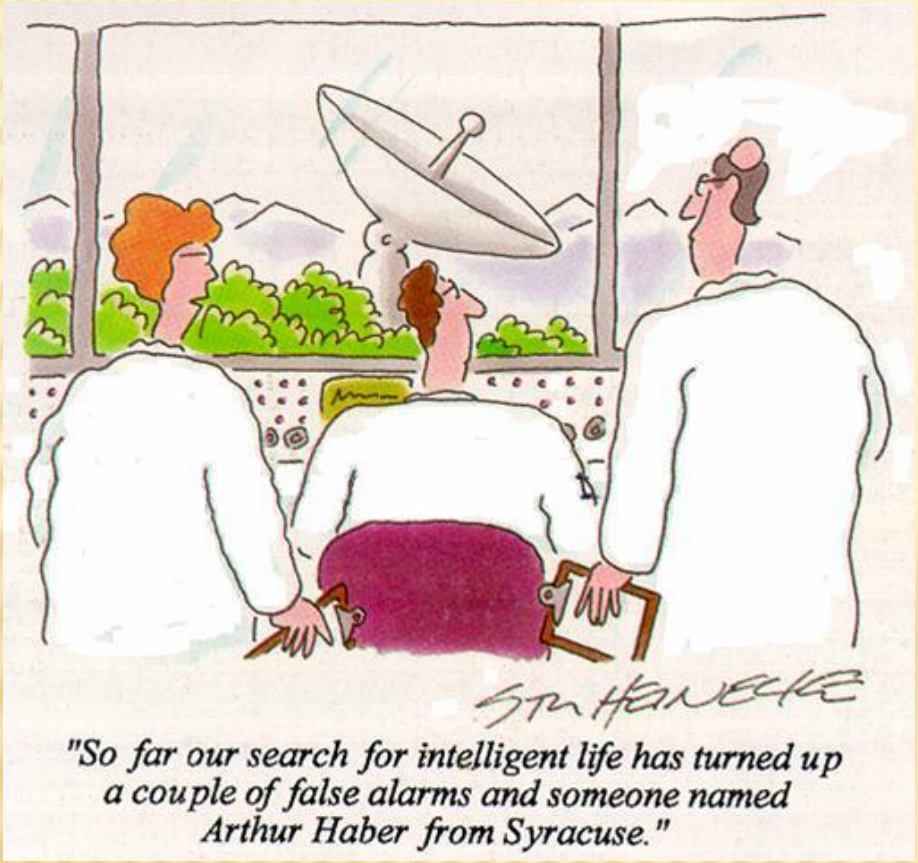
INSTRUCTOR BIO



DR. ARTHUR HABER

- Bristol Myers
- Frederick Cancer Research Center
- University of Michigan at Ann-Arbor
- University of Illinois at Urbana-Champaign
- Polytechnic Institute of Brooklyn
- Brooklyn Technical High School
- Jr. High School 234
- P.S. 206
- Who's Who Among American Teachers
  2006, 2000, 1996

INSTRUCTOR BIO cont'd



DR. ARTHUR HABER

- Father of a SUNY undergrad
- Yankees fan
- Socially inept and judgmental, not a people person
- Wears the same three golf shirts in rotation all summer long
- Enjoys being called La Grande Fromage
- Thinks Glass Plus® is better than Windex®
- Would rather be in Florida
- Loves strong artificial fragrances
- Has a hording problem
- Pedagogically sarcastic and cynical

Handouts

- Tentative Outline And Calendar
- Useful Information
- A 60-Second Course in Organic Chemistry
- Common Functional Groups
- The Organic Metropolis
- Other Handouts Available at

  http://people.morrisville.edu/~habera/

TEXTBOOK

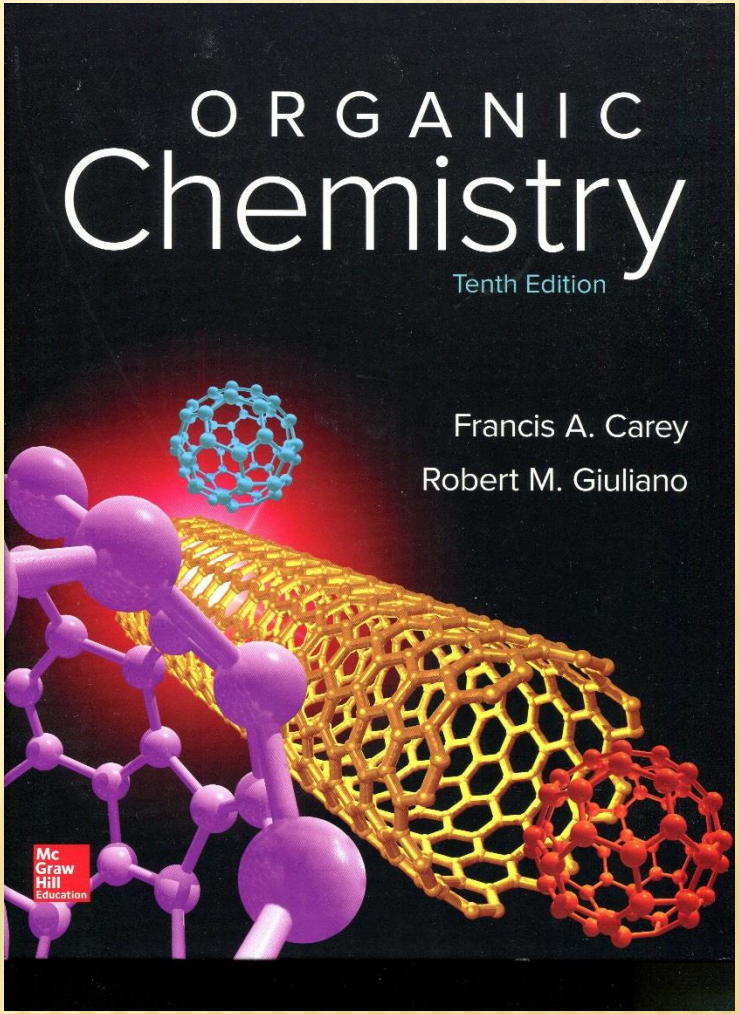
ORGANIC CHEMISTRY 10/e

Francis A. Carey

Robert M. Giuliano

McGraw Hill

2017



TEXTBOOK

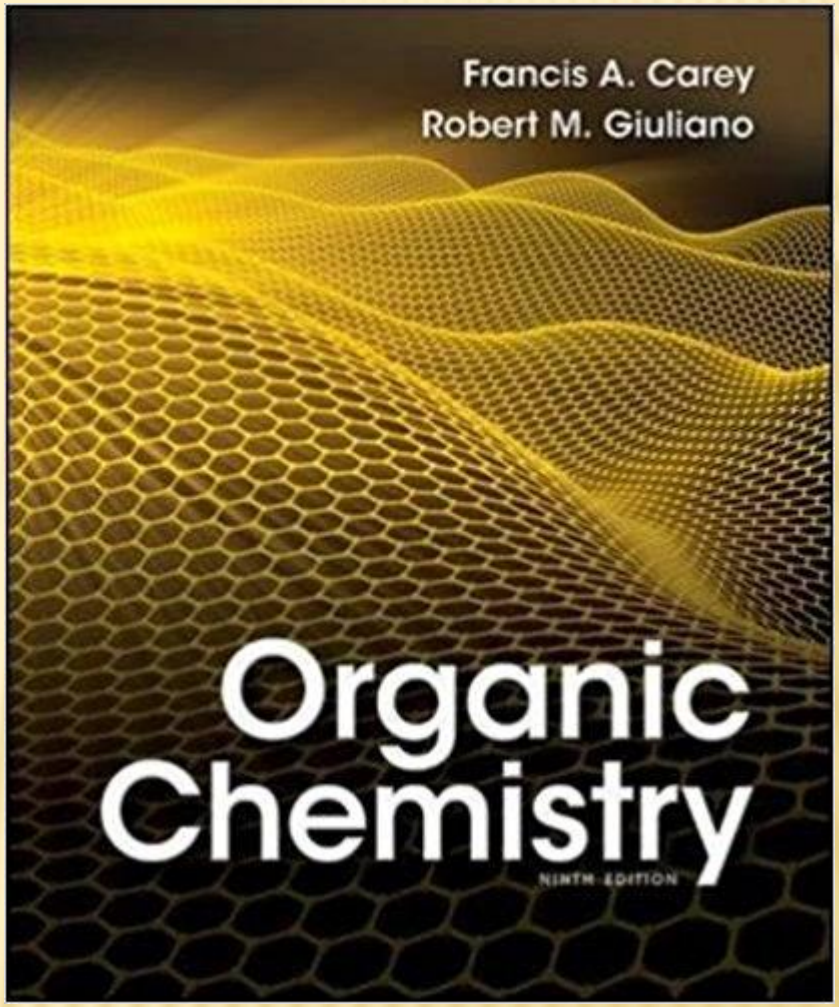
ORGANIC CHEMISTRY 9/e

Francis A. Carey

Robert M. Giuliano

McGraw Hill

2013



TEXTBOOK

ORGANIC CHEMISTRY

EIGHTH EDITION

F. A. Carey

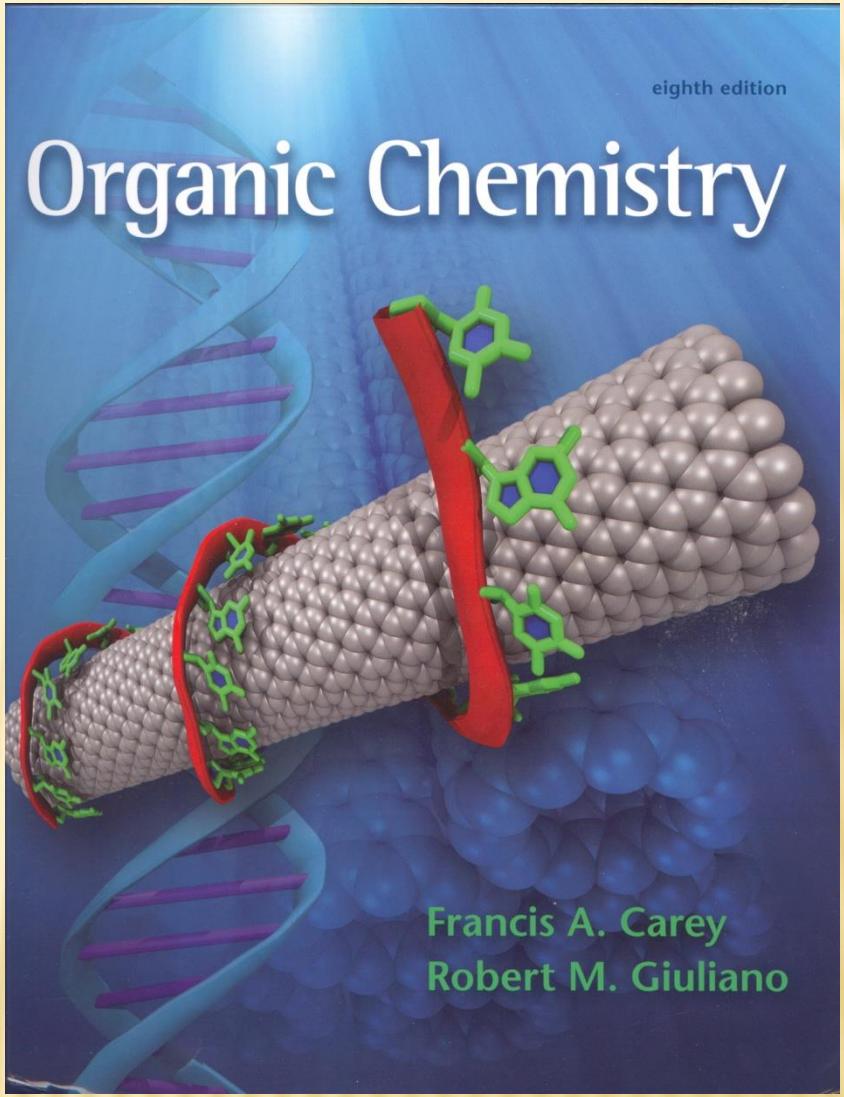
and

R. M. Giuliano

McGraw-Hill

New York

2011



ORGANIC CHEMISTRY

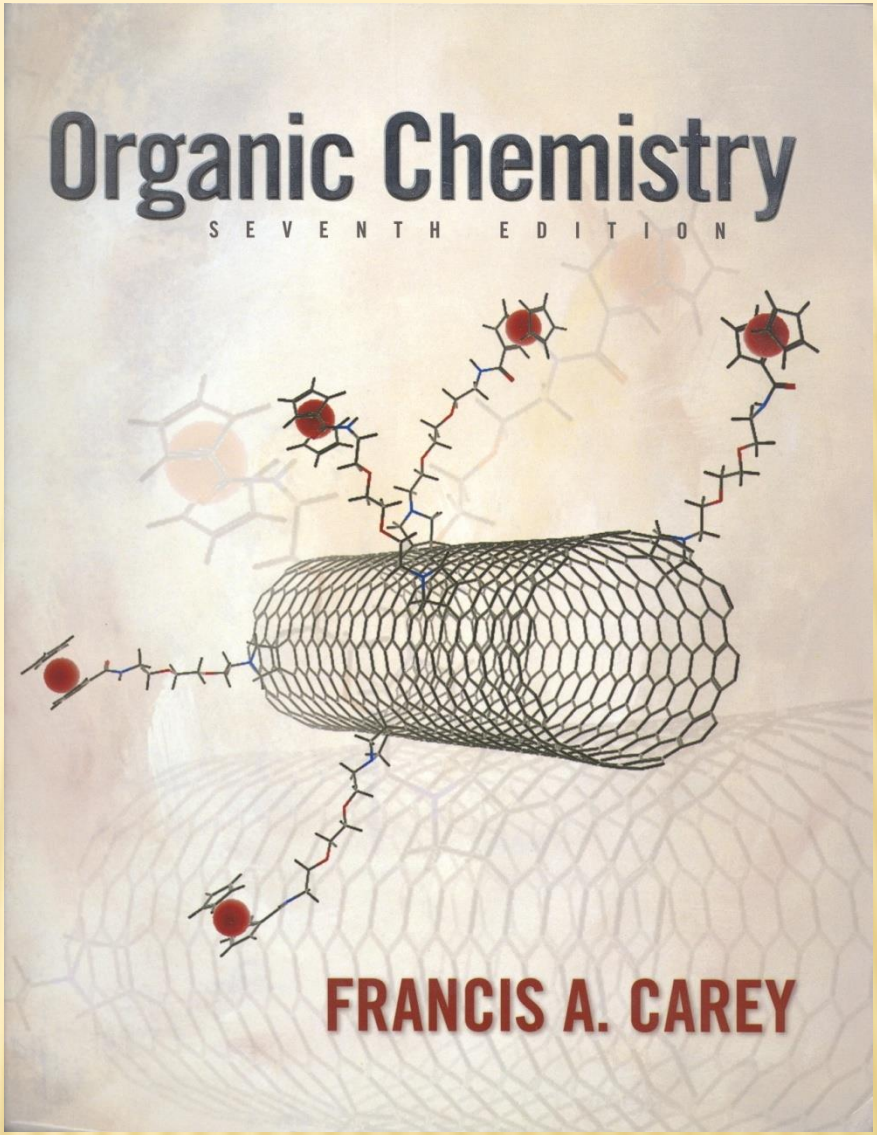
SEVENTH EDITION

F. A. Carey

McGraw-Hill

New York

2008



TEXTBOOK

HTTP://MOLECULARVISIONS.COM/

MOLECULAR MODELS

PHILOSOPHY

YOUR HIGH SCHOOL EDUCATION

May have been poor preparation for studying organic chemistry

While general chemistry is a survey of stoichiometry, physical chemistry, and some descriptive chemistry, each chapter can usually stand on its own and the order of presentation is almost irrelevant.

This is not so in organic chemistry.

Each chapter in an organic text builds upon what came before and the order of presentation is the main feature distinguishing one text from another.

ADVICE FROM YODA

- Do or do not, there is no try.

THE ORGANIC METROPOLIS

- Infrastructure
- Language
- General Personalities
- Specific Personalities

THE ORGANIC METROPOLIS

Infrastructure

- atomic structure
- periodic properties
- hybridized orbitals
- valence bond orbitals
- molecular orbitals
- bond energies (homolytic/heterolytic)
- thermodynamics
- kinetics
- Hammond-Leffler Principle
- flow of electrons (from electron rich sites to electron poor sites)
- Frontier Molecular Orbital theory
- stereochemistry

THE ORGANIC METROPOLIS

Language

- verbal
- graphic
- spectroscopic
- Lewis Structures

General Personalities

- oxidizing agent/reducing agent
- acid/base
- electrophile/nucleophile
- carbocation
- carbon radical
- carbanion
- carbene
- excited state carbon

THE ORGANIC METROPOLIS

Specific Personalities

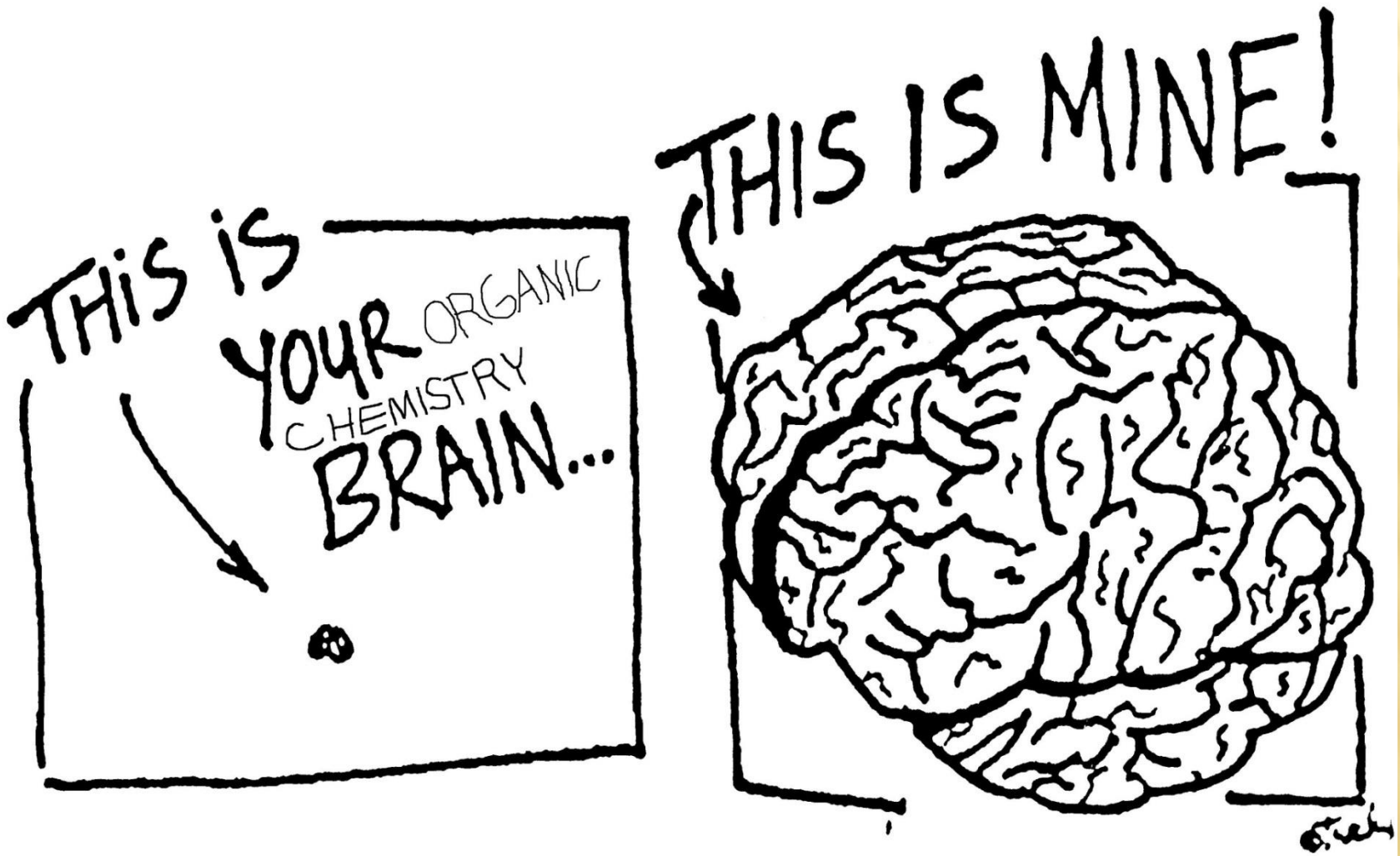
- functional group approach
  - nomenclature
  - structure
  - physical properties
  - synthesis
  - reactions
  - spectroscopic properties
  - simple chemical tests

ORGANIC CHEMISTRY: A NEW WAY OF THINKING

2, ___, ___, 8, ___, 12, ____, ___, ___, 20

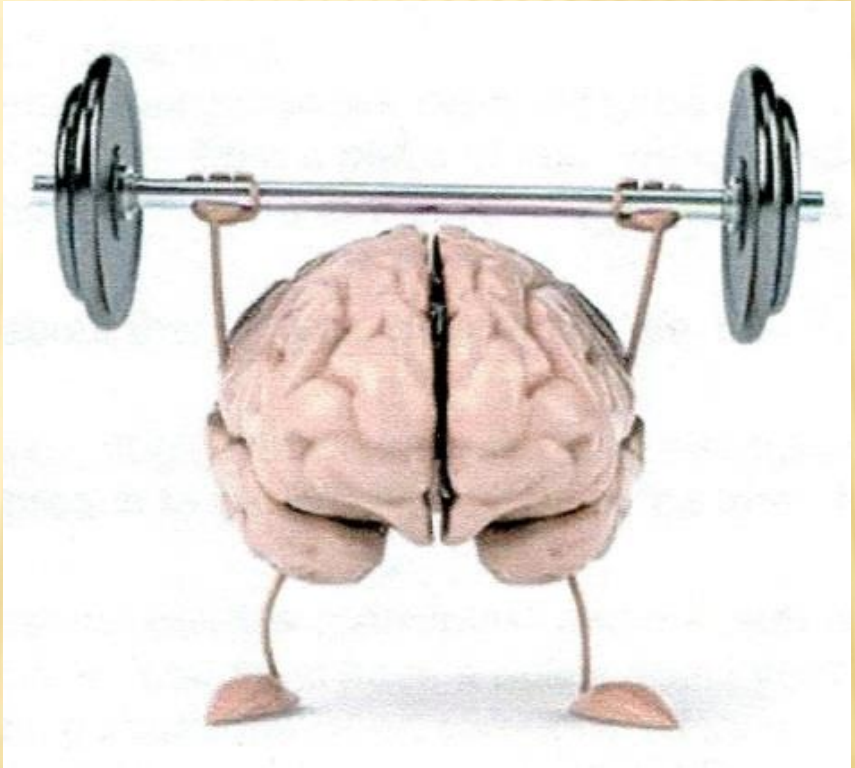
1, ___, 2, ___, ___, 8, ___, 21

4, ___, 23, 34, ___, ___, 50, ____, 72, 81, ___, ___, 103, ___, ___, 125, 135



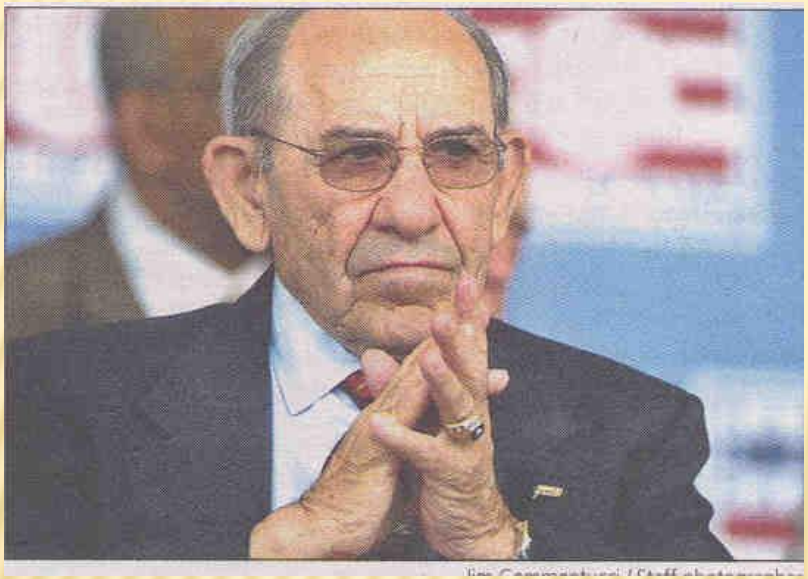
ANY QUESTIONS?

SUCCESS IN ORGO COMES FROM WORKING PROBLEMS



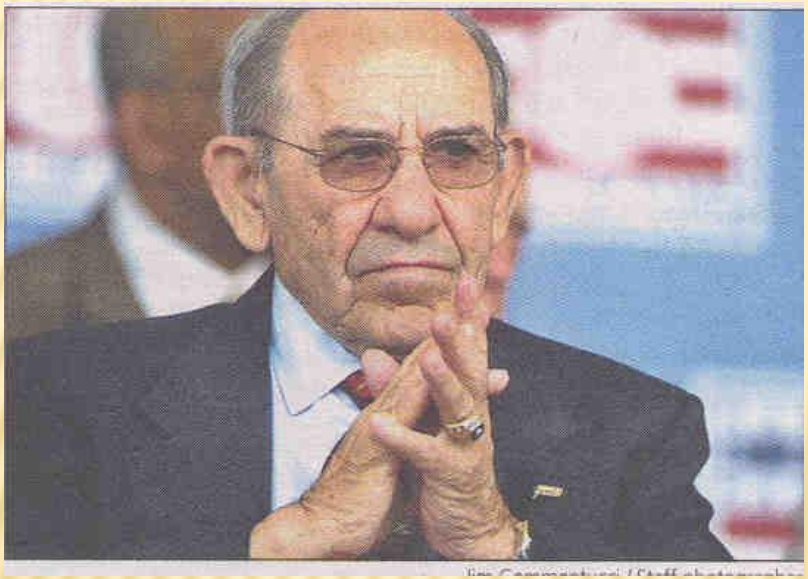
THE GREATEST AMERICAN PHILOSOPHER OF EDUCATION

YOGI BERRA



When you come to a fork in the road,

YOGI BERRA



When you come to a fork in the road,

take it.

NIKE

NIKE

Just do it!

THE EQUALIZER

Progress, not perfection.

Robert McCall

OTHER COMMENTS

- There will be no teaching to an exam
- Learning must be thematic
- Must read the textbook
- Solve problems (reading is just not enough)
- Work hard
- See Tentative Outline

GRADE CALCULATION

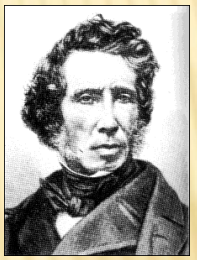
There will be an assignment for each chapter; an exam after three or four chapters.

Assign	Exam	Course Grade
50 65 73 68 256	80 $\%=\frac{256}{400}\times 10^2=64$	= (0.40)(64) + (0.60)(80) =73.6
50 65 73 68 80 92 65 77 85 75 70 88 888	80 90 75 245 $\%=\frac{245}{300}\times 10^2=82$ $\%=\frac{888}{1200}\times 10^2=74$	= (0.40)(74) + (0.60)(82) =78.8

GRADING SCHEME

A	100-92%
A-	91-88%
B+	87-85%
B	84-81%
B-	80-77%
C+	76-74%
C	73-70%
C-	69-66%
D+	65-63%
D	62-60%
F	<60%

History and Definition



- Compounds originating in living organisms
- Vital Force Doctrine (Vitalism)

- 1828 Friedrich Wöhler

$$NH_4OCN \longrightarrow H_2NC(=O)NH_2$$

ammonium cyanate
inorganic
"mineral world"

urea
organic
"living world"

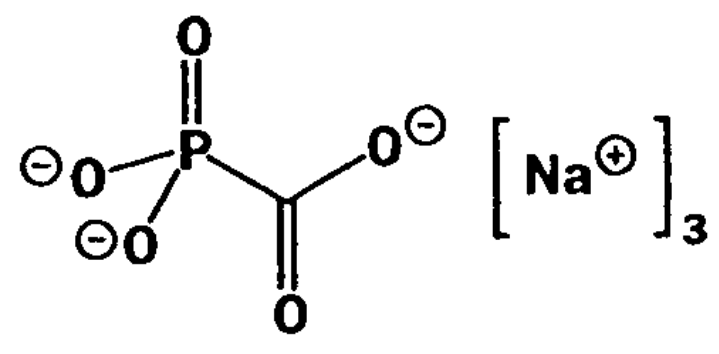
- ORGANIC CHEMISTRY

  The chemistry of carbon containing compounds (except those traditionally belonging to the mineral world – CO_3^{-2}, CN^{-1}, C_2^{-2}, OCN^{-1}, etc

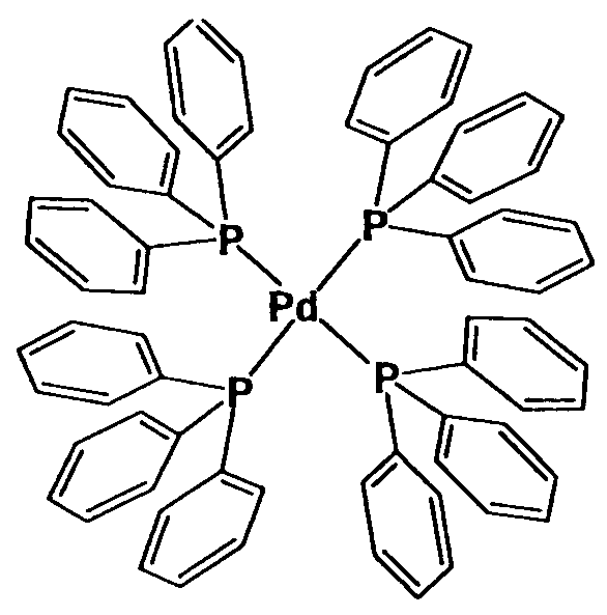
BUT

WHAT ABOUT THESE COMPOUNDS?

- foscarnet, an antiviral agent



- *tetrakis* triphenylphosphine palladium, $[(C_6H_5)_3P]_4Pd$



The answer is that we don’t know and we don’t care. It is important these days to realize that strict boundaries between traditional disciplines are undesirable and meaningless.

Organic Chemistry
J. Clayden, N. Greeves, S. Warren, and P. Wothers
Oxford University Press, Inc.
2001

Uniqueness of Carbon and General Chemistry Prerequisites

INTRODUCTION

CARBON

There must be something unique about carbon for there to be a whole field dedicated to its chemistry.

Uniqueness of Carbon

- Forms strong, short covalent bonds with a wide variety of elements (metals and non-metals)

- Bonds to itself extensively in straight chains, branched chains, rings, and endless combinations

- Carbon readily changes hybridization: sp, sp^2, sp^3, even sp^3d in transition states

- Carbon makes use of a wide range of oxidation numbers:
  CH_4, -4 CO_2, +4 and all values between

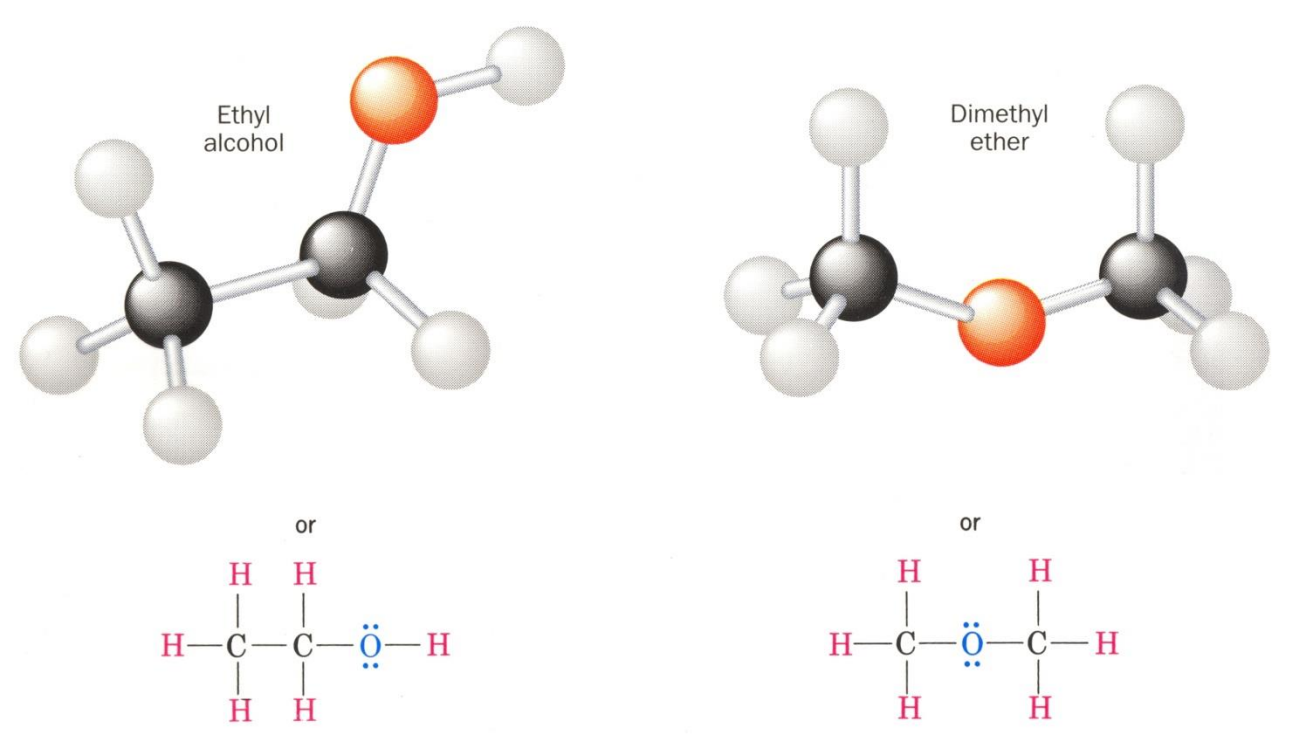
- Approximately 12 x 10^6 synthetic and naturally occurring organic compounds are documented; the number of such inorganic compounds is much less

- Extensive system of isomers – different compounds having the same molecular formula

- Functional Group Perspective – specific combinations of atoms reacting in a characteristic way, no matter what the molecular occurrence.

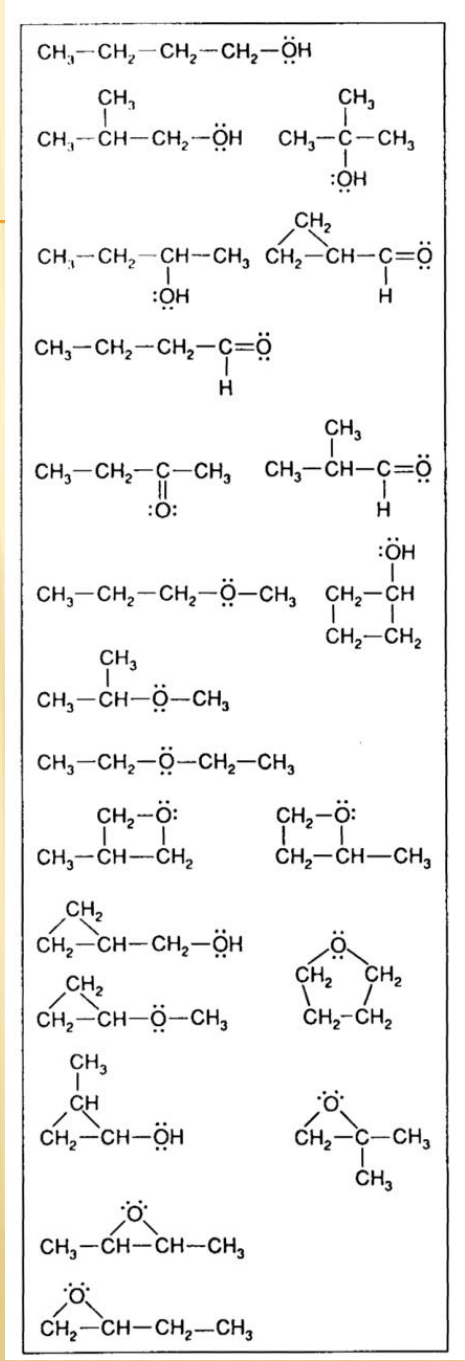
CONSTITUTIONAL ISOMERS

- C_2H_6O Ethanol versus Dimethyl Ether



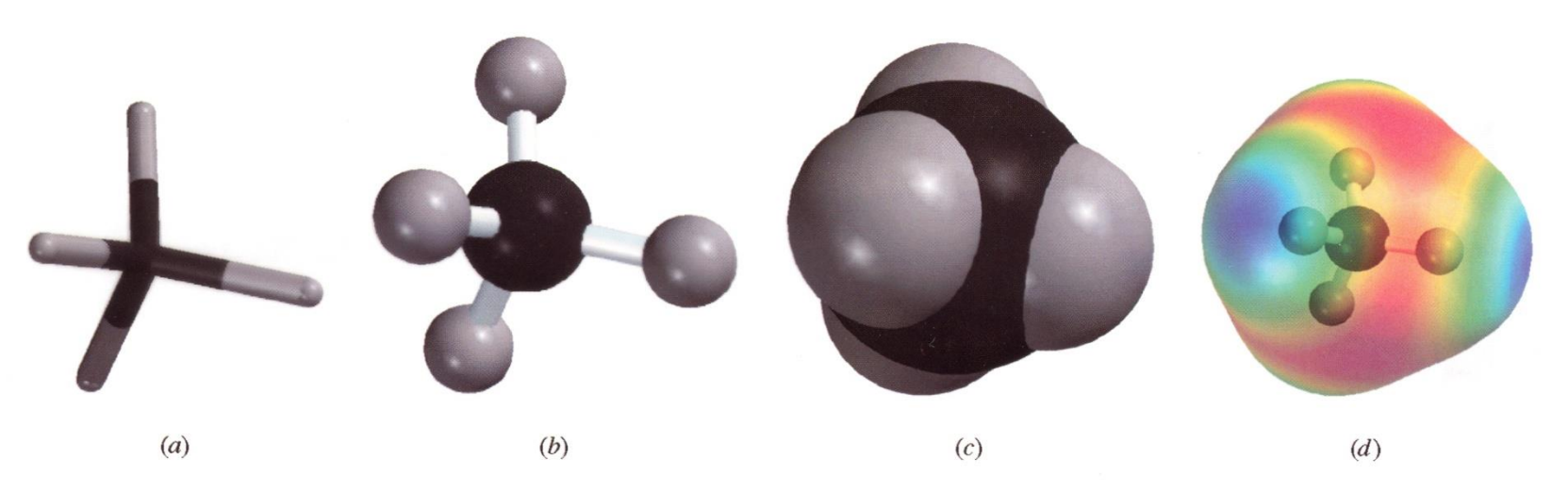
CONSTITUTIONAL ISOMERS

- 4 Carbons, 1 Oxygen,
  and the necessary H's



MOLECULAR MODELS

Wire Frame Ball and Stick Space Filling Electron Density



PRE-REQUISITES TO THE STUDY OF "ORGO"

- Quantum Mechanics
- Ionic Compounds/Ionic Bonds
- Molecular Compounds/Covalent Bonds
- Lewis Structures
- Valence Bond Theory
- Molecular Orbital Theory
- Isomers
- Representing Organic Molecules
- Non-Bonding Interactions/Intermolecular Forces
- Functional Groups

QUANTUM MECHANICS

- atomic orbitals
- electron configuration
- order of orbital filling and the periodic table
- quantum number, Pauli Principle, Hund's Rule
- periodic properties
  - atomic size
  - ionization energy
  - electron affinity
  - electronegativity
  - valence electrons

IONIC COMPOUNDS/IONIC BONDS

- metal – nonmetal
- metal – polyatomic ion
- aqueous solutions conduct electricity
- conduct electricity as liquids

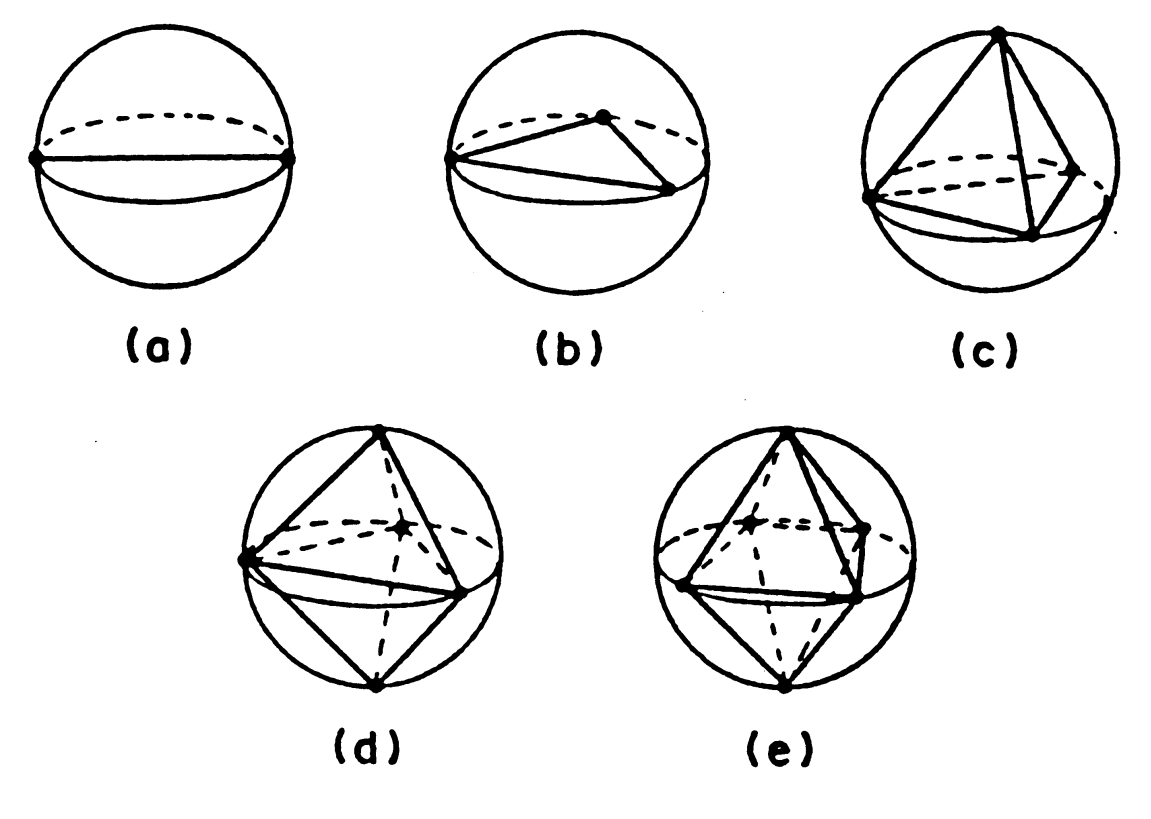
MOLECULAR COMPOUNDS/COVALENT BONDS

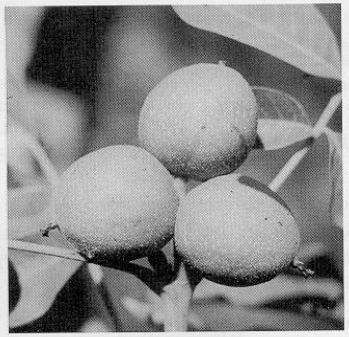
- nonmetal – nonmetal
- non-polar bonds
- polar bonds
- electronegativity difference
- aqueous solutions of polar molecular compounds may conduct electricity

LEWIS STRUCTURES

- octet rule and exceptions
- multiple bonds
- formal charge
- resonance
- VSEPR Theory – shapes of molecules
- molecular dipole moments – polar and non-polar molecules

VSEPR THEORY



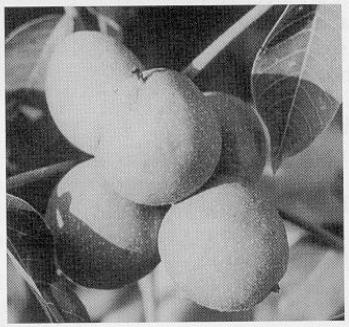


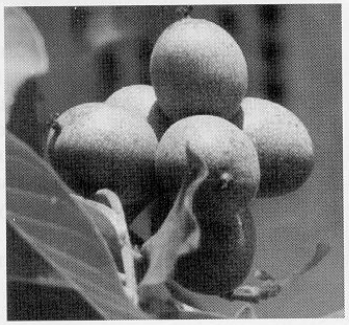
Walnuts

Sometimes walnuts grow together in small clusters on trees. Most of them grow singly or in twos, but threes and even fours are not uncommon. A cluster of five is unusual, and six is truly rare. Groups of chestnuts exhibit similar patterns, but we have yet to see larger clusters.

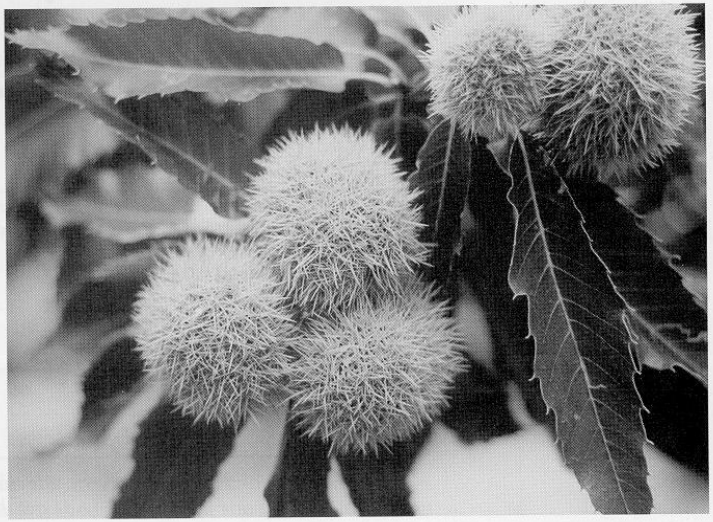
It is not surprising that the walnut clusters have the same shapes as the balloon groups. Just as the balloons group themselves (due to their elasticity), so do the walnuts (as they slowly grow), elbowing each other for space to find the most advantageous arrangements. These arrangements are the ones where they best utilize the available space, as the points-on-the-sphere model has shown on the previous page.

This is but one example showing that the forms and shapes in nature develop according to some underlying principles, among which the *need for space* is of primary importance.





Walnuts

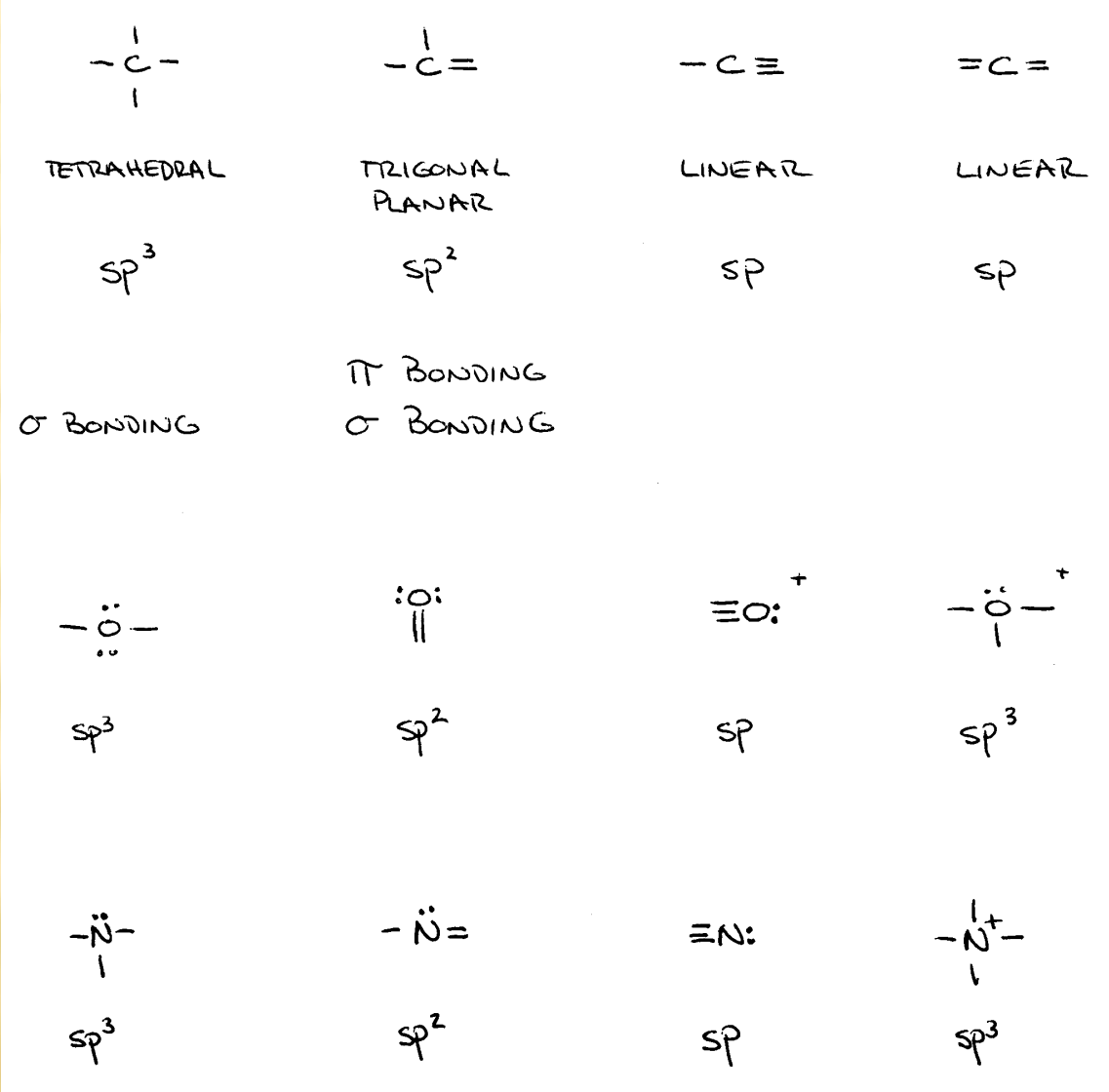


Chestnuts

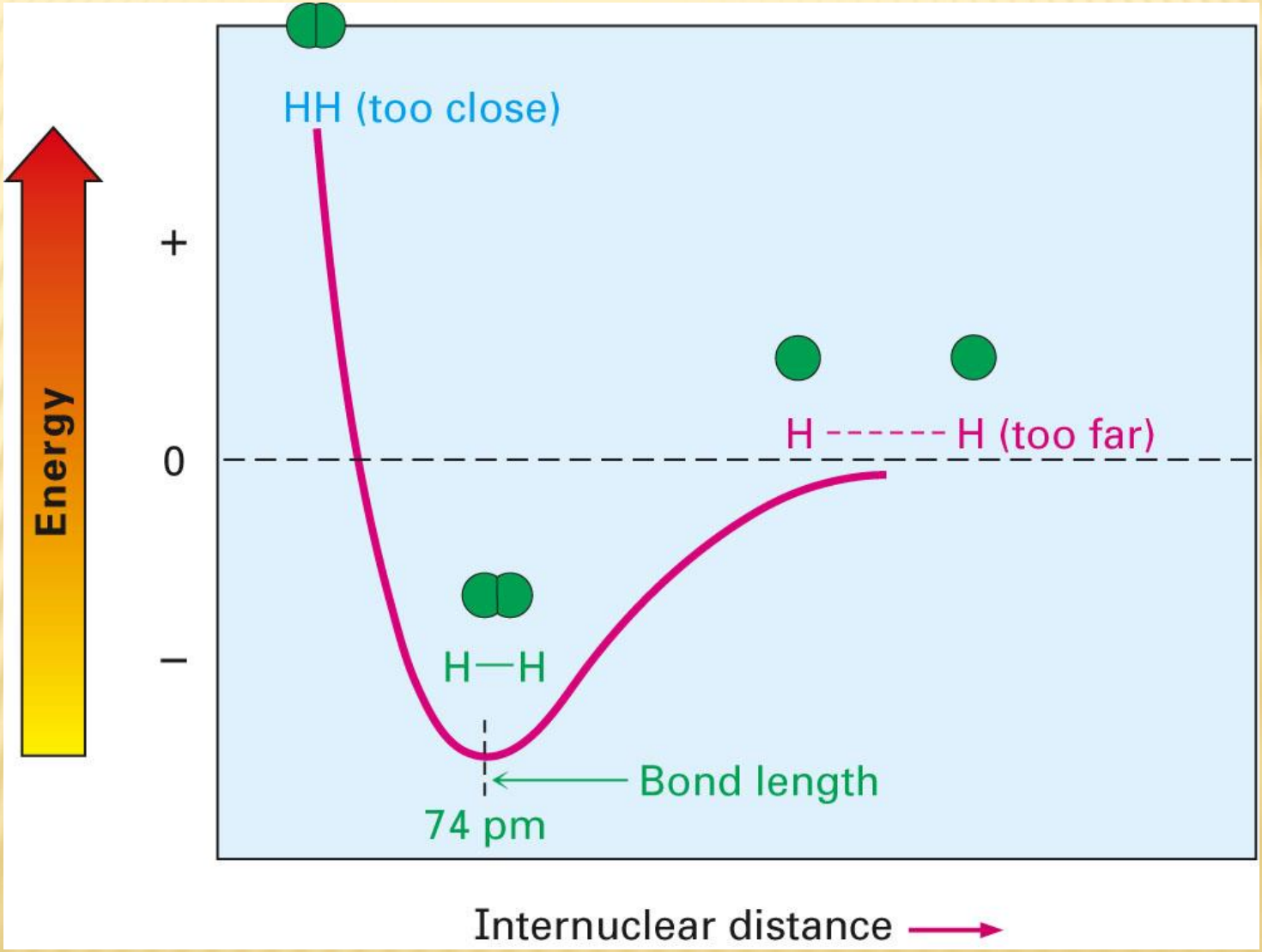
Symmetry: A Unifying Concept

I. Hargittai and M. Hargittai
Shelter Publications, Inc.
1994

VALENCE BOND THEORY



BOND FORMATION



MOLECULAR ORBITAL THEORY

- bonding orbitals
- non-bonding orbitals
- anti-bonding orbitals
- bond order
- delocalization/resonance
- σ/π orbitals
- Frontier Molecular Orbitals (FMO)

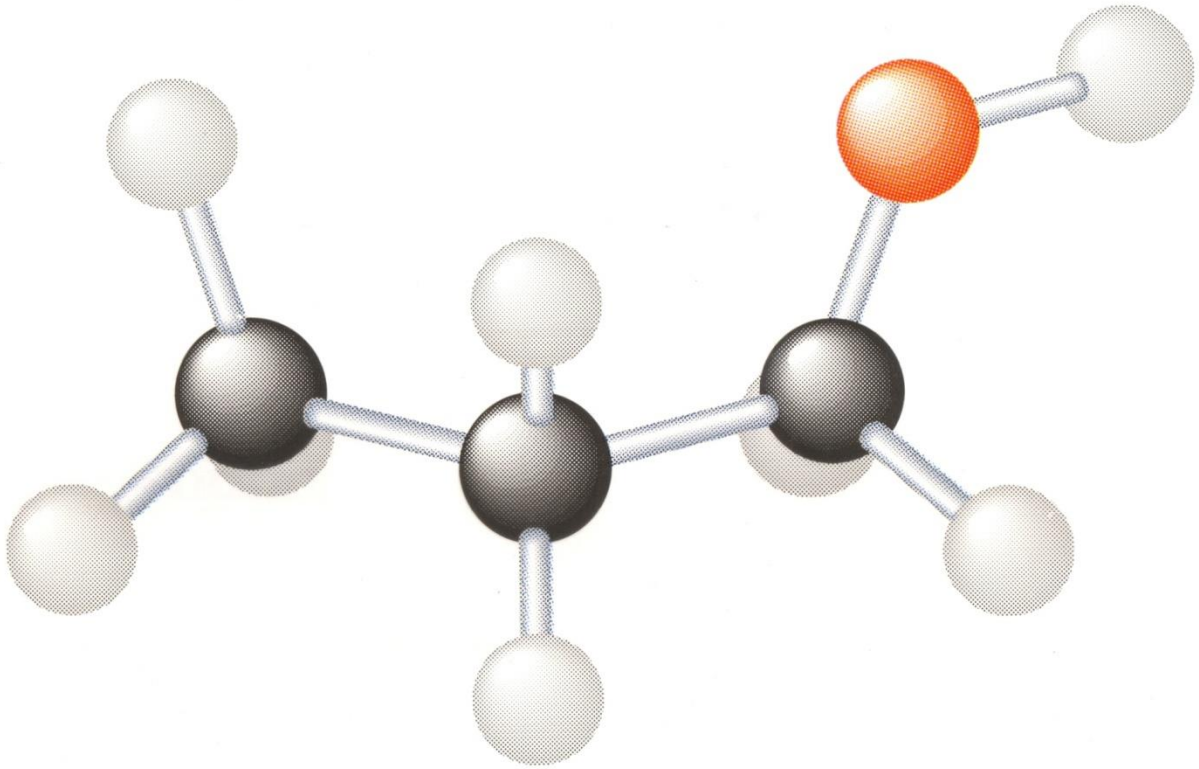
ISOMERS

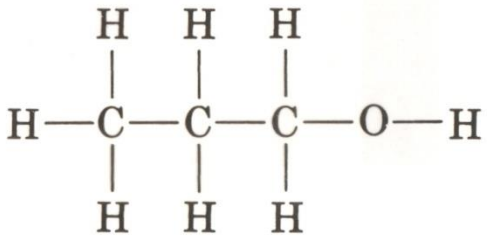
- Constitutional Isomers, e.g., C_2H_6O
- Stereoisomers

REPRESENTING ORGANIC MOLECULES

- models (wire frame, ball and stick, space filling, electron density)
- formula
- full Lewis structure
- condensed Lewis structure
- bond-line formula

C_3H_8O or C_3H_7OH





Dash formula

$CH_3CH_2CH_2OH$

Condensed formula

NON-BONDING INTERACTIONS/INTERMOLECULAR FORCES

•Ion-dipole	40 – 600 kJ/mol
•dipole-dipole*	5 - 25
•H-Bond*	10 - 40
•ion-induced dipole	3 - 15
•dipole-induced dipole*	2 - 10
•dispersion (London)*	0.05 - 40

*collectively known as van der Waals forces

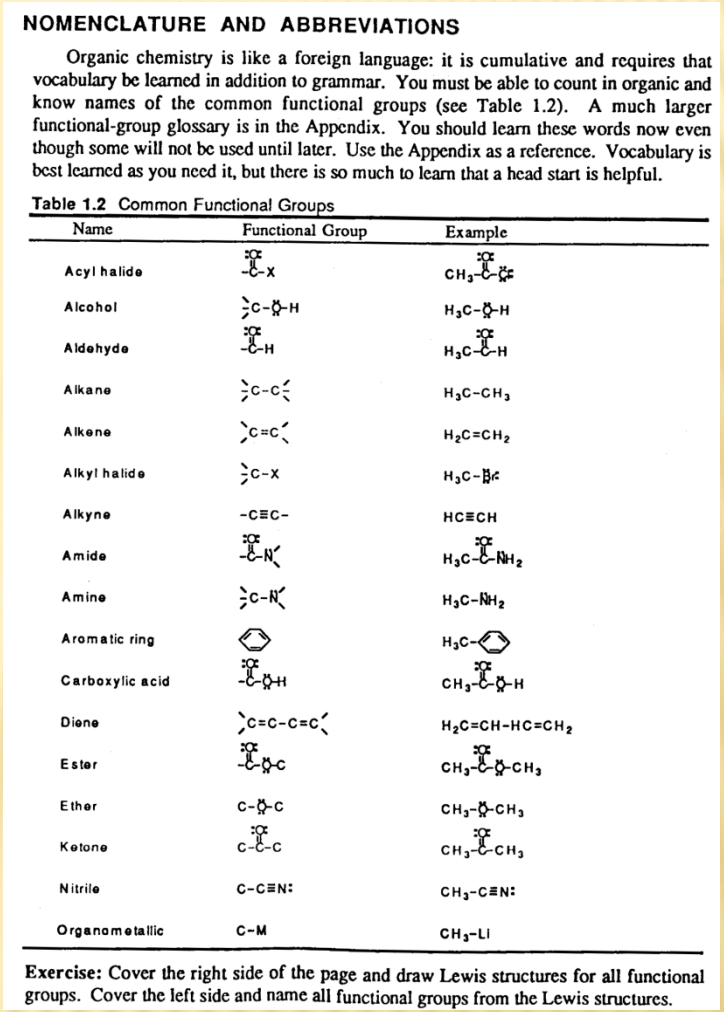
Electron Flow in Organic Chemistry

P. H. Scudder

John Wiley & Sons

1992

FUNCTIONAL GROUPS



NOMENCLATURE AND ABBREVIATIONS

Organic chemistry is like a foreign language: it is cumulative and requires that vocabulary be learned in addition to grammar. You must be able to count in organic and know names of the common functional groups (see Table 1.2). A much larger functional-group glossary is in the Appendix. You should learn these words now even though some will not be used until later. Use the Appendix as a reference. Vocabulary is best learned as you need it, but there is so much to learn that a head start is helpful.

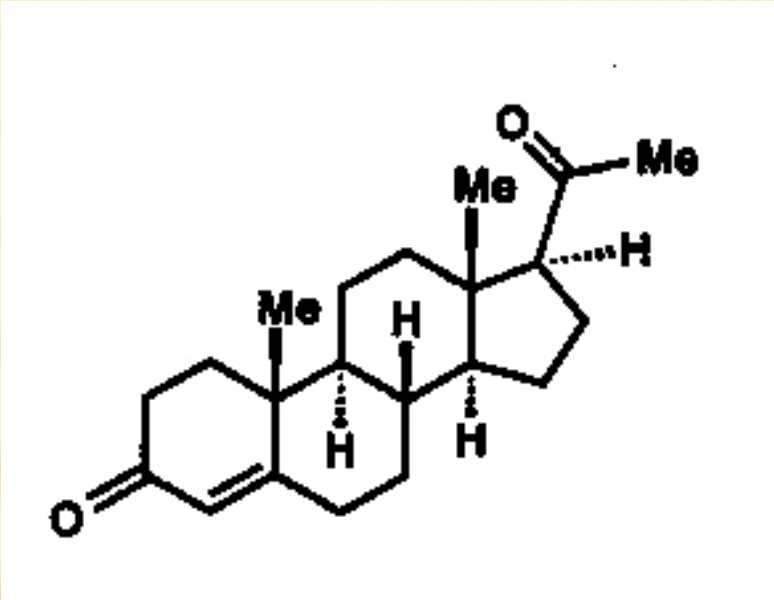
Table 1.2 Common Functional Groups

Name	Functional Group	Example
Acyl halide	–C(=O)–X	CH_3–C(=O)–Cl
Alcohol	>C–O–H	H_3C–O–H
Aldehyde	–C(=O)–H	H_3C–C(=O)–H
Alkane	>C–C<	H_3C–CH_3
Alkene	>C=C<	H_2C=CH_2
Alkyl halide	>C–X	H_3C–Br
Alkyne	–C≡C–	HC≡CH
Amide	–C(=O)–N<	H_3C–C(=O)–NH_2
Amine	>C–N<	H_3C–NH_2
Aromatic ring		H_3C–
Carboxylic acid	–C(=O)–O–H	CH_3–C(=O)–O–H
Diene	>C=C–C=C<	H_2C=CH–HC=CH_2
Ester	–C(=O)–O–C	CH_3–C(=O)–O–CH_3
Ether	C–O–C	CH_3–O–CH_3
Ketone	C–C(=O)–C	CH_3–C(=O)–CH_3
Nitrile	C–C≡N:	CH_3–C≡N:
Organometallic	C–M	CH_3–Li

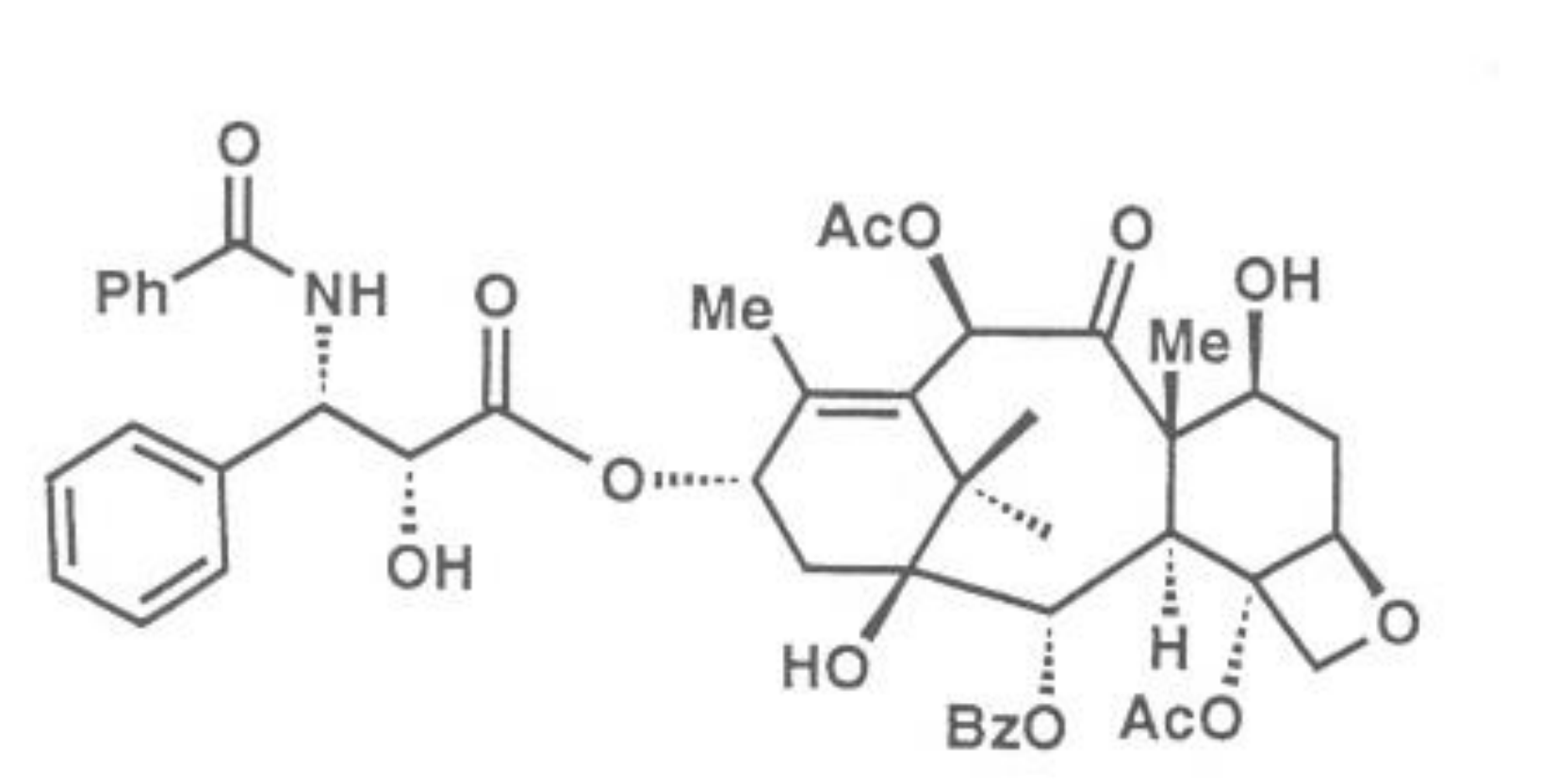
Exercise: Cover the right side of the page and draw Lewis structures for all functional groups. Cover the left side and name all functional groups from the Lewis structures.

CHALLENGES

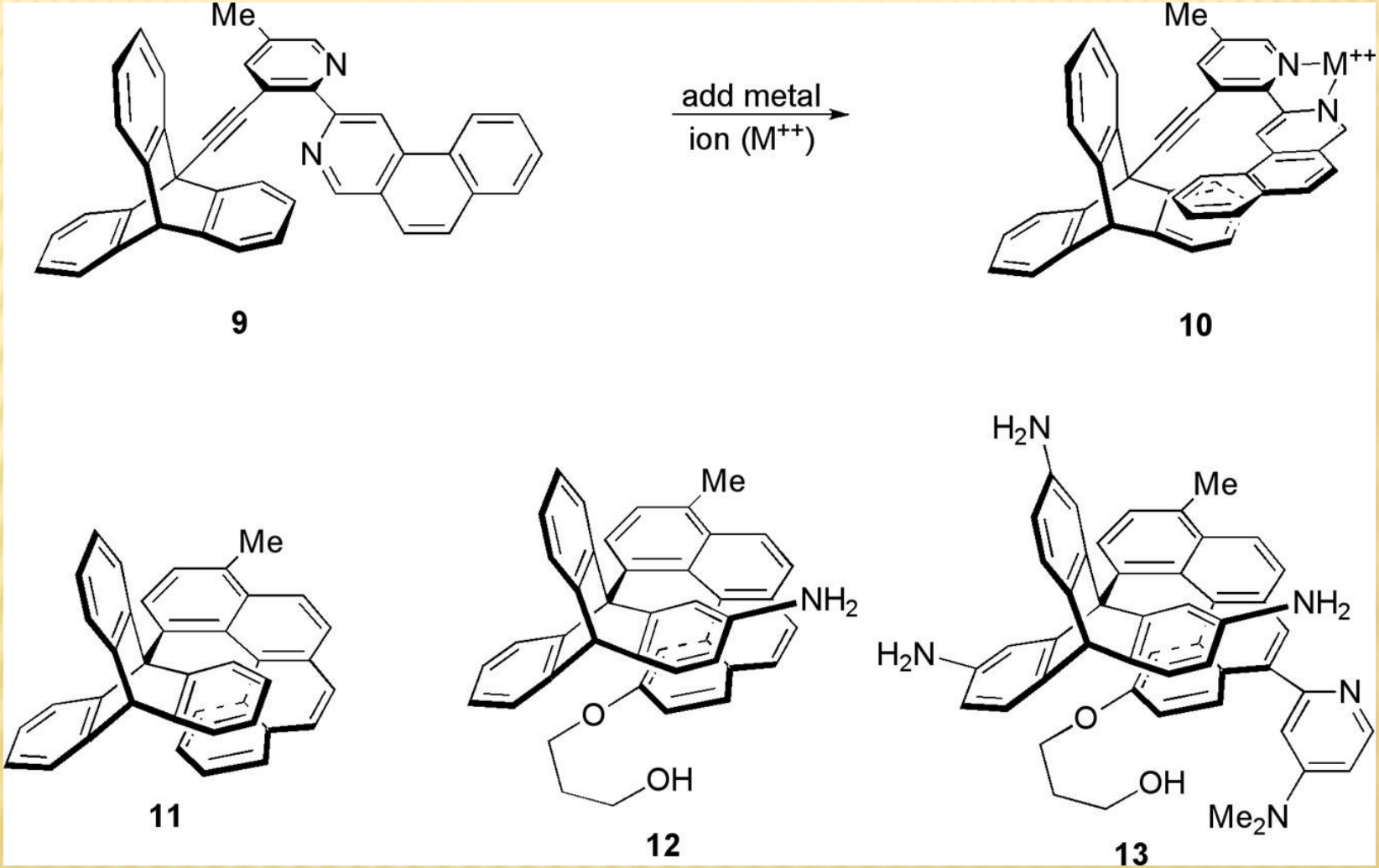
(±)-PROGESTERONE

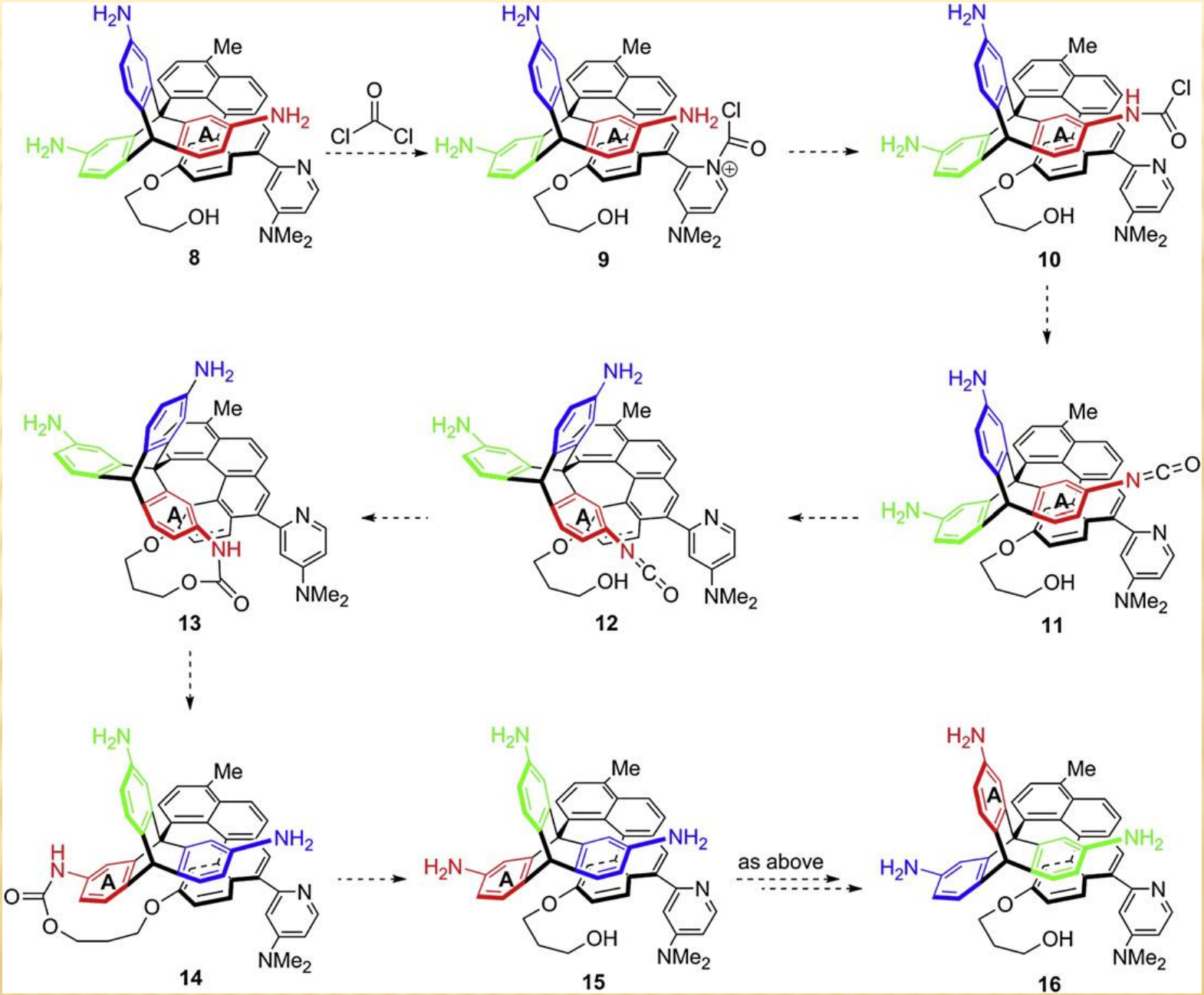


(-)-TAXOL



MOLECULAR MOTORS




8
9
10
11
12
13
14
15
16
as above

THE 2016 NOBEL PRIZE IN CHEMISTRY

The Nobel Prize in Chemistry 2016 was awarded jointly to

Jean-Pierre Sauvage,

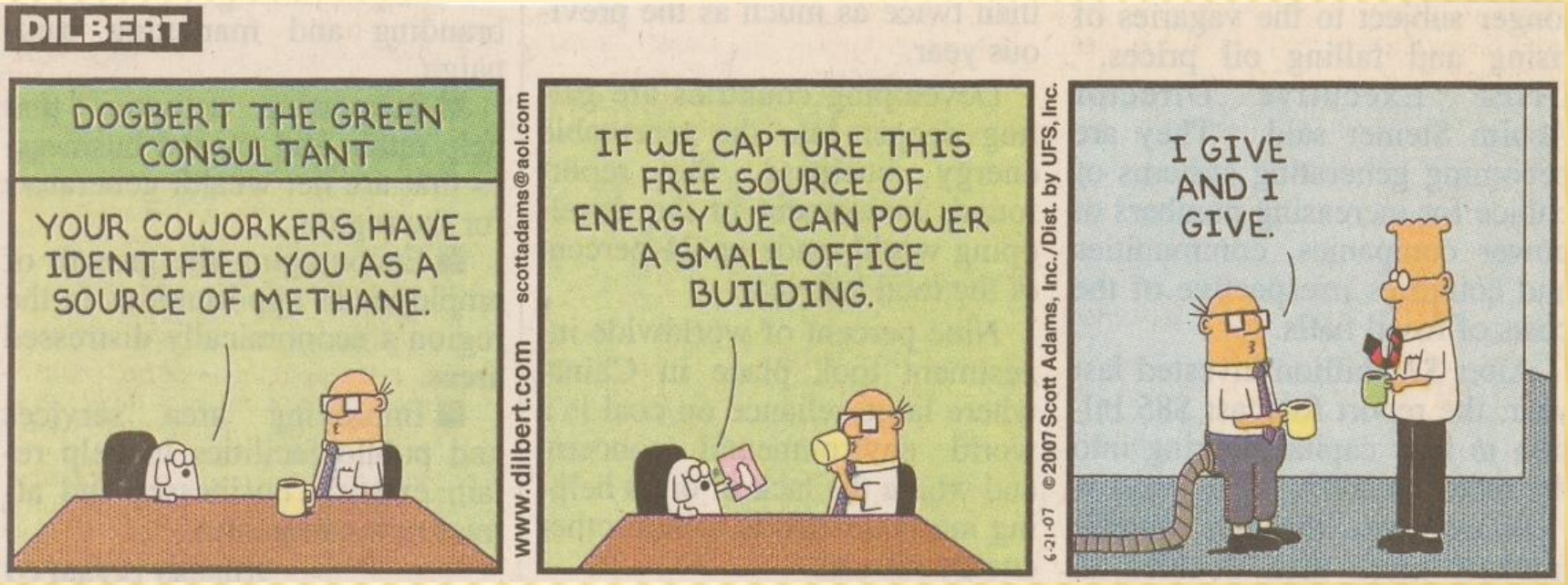
Sir J. Fraser Stoddart

Bernard L. Feringa

"for the design and synthesis of molecular machines".

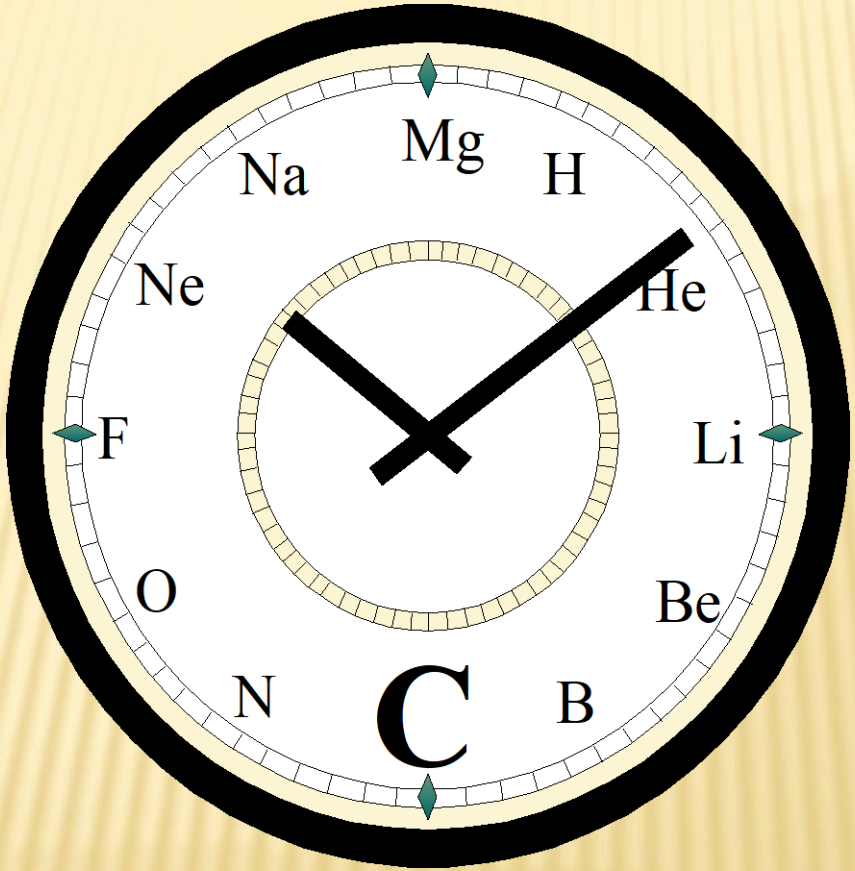
OTHER IMPORTANT APPLICATIONS OF ORGANIC CHEMISTRY

HYDROCARBONS



MAJOR COMPONENT OF THE TEXTILE INDUSTRY

(ORGANIC) CHEM TIME



THE END