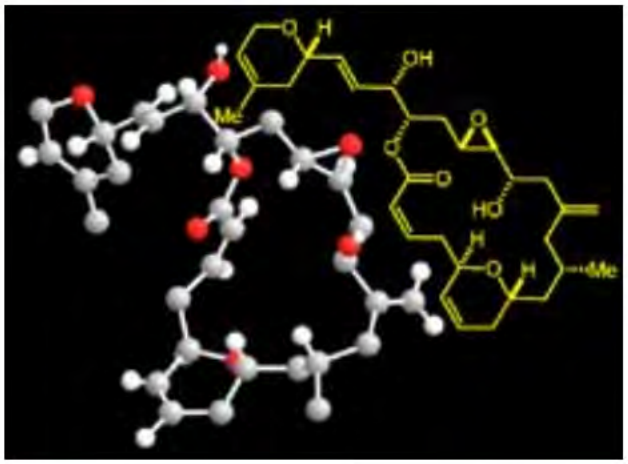
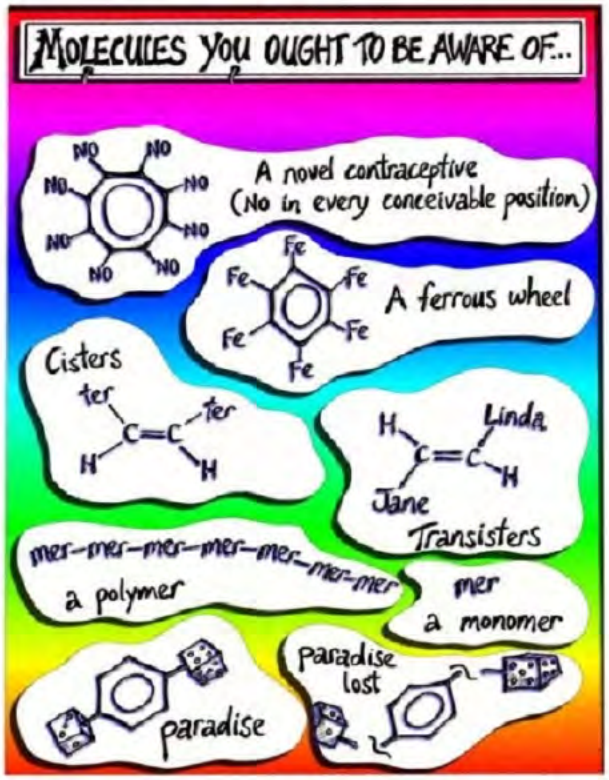
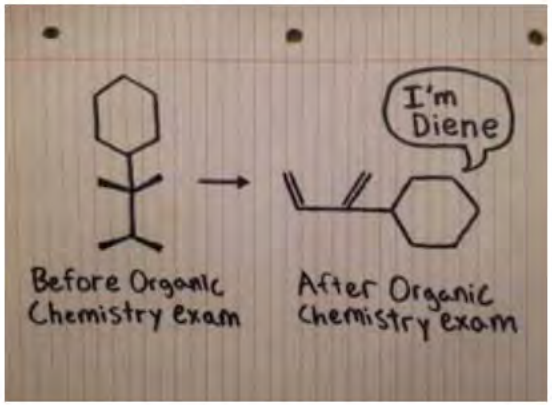
CH2310 - Organic Chemistry I







Extra Help

Alli Ross

MASH Sessions:	Mondays	4 PM	Academic Resources Center (ARC)
	Tuesdays	7 PM	Exam Proctoring Center (EPC)
	Wednesdays	7 PM	Exam Proctoring Center (EPC)
	Thursdays	4 PM	Academic Resources Center (ARC)

One-on-one Tutoring: By appointment at http://tutortrac.wpi.edu

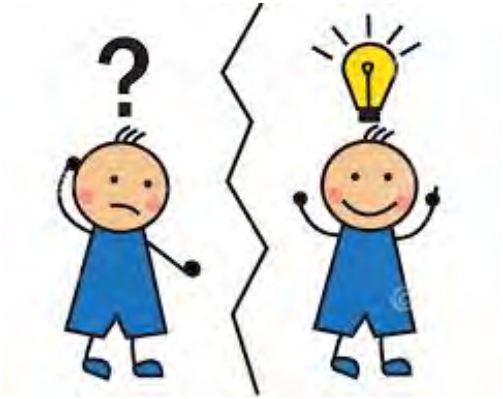
What is organic chemistry?

Why is it important?

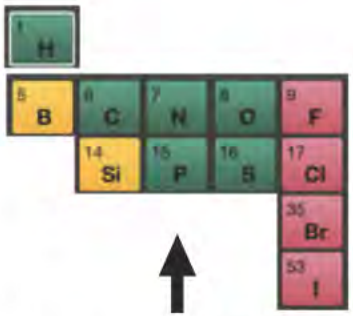
How is knowing it useful to me?

How is it being used today?

How can I use it moving forward?

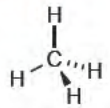


What Are Organic Compounds?

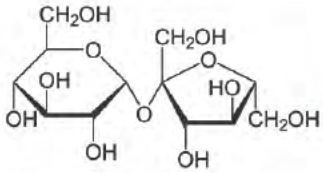


Organic chemist's periodic table

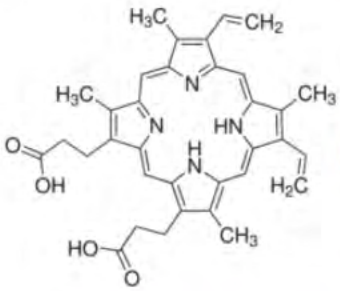
Small Organic Compounds (< 900 g/mol)



methane

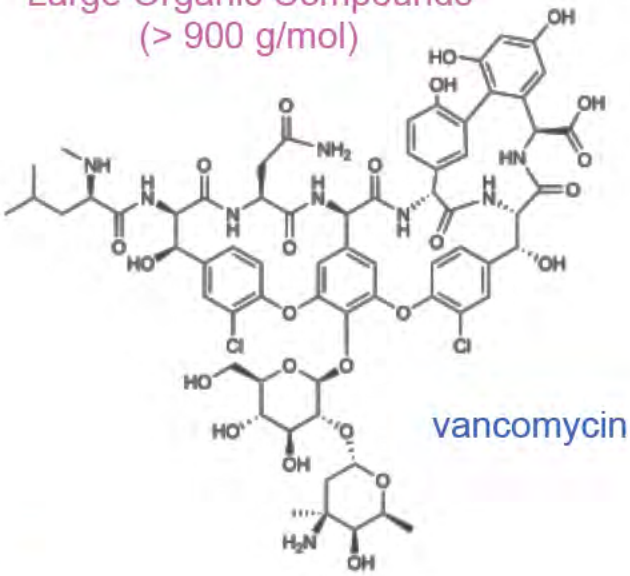


sucrose



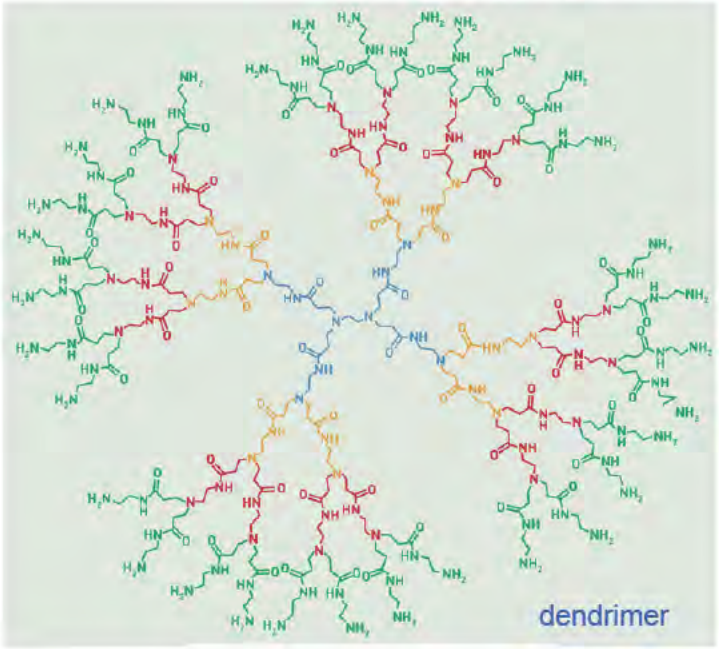
protoporphyrin

Large Organic Compounds (> 900 g/mol)

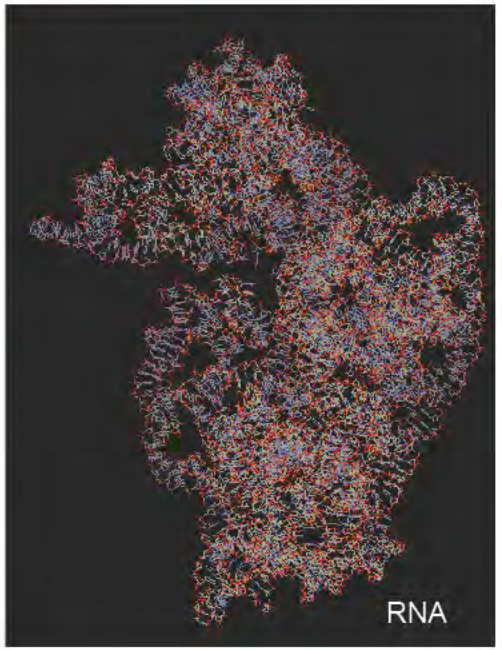


vancomycin

Massive Organic Compounds!



dendrimer

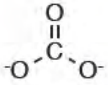


Inorganic Compounds/Ions

carbon monoxide

carbon dioxide

cyanide

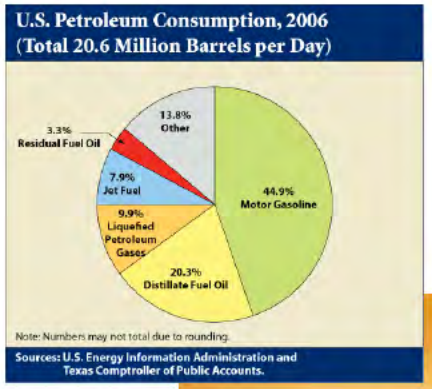


carbonate

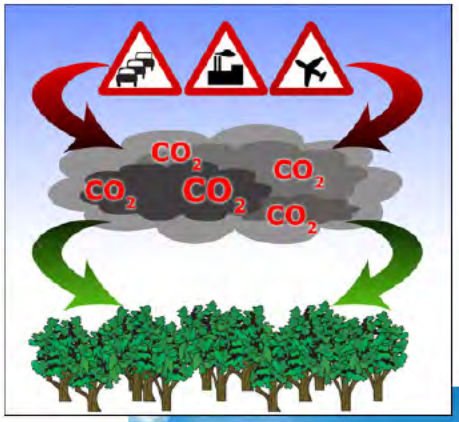
carbide

Sources of Organic Compounds?

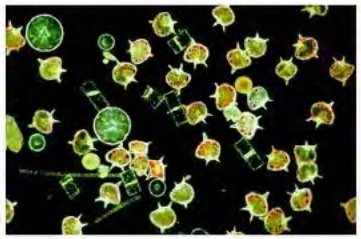
Plant Biomass



Petroleum



Carbon Dioxide



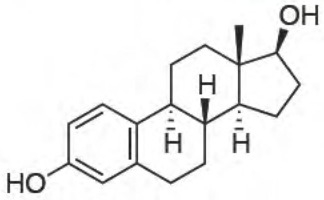
Organisms

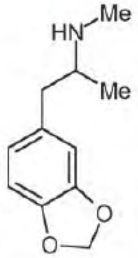
Coal

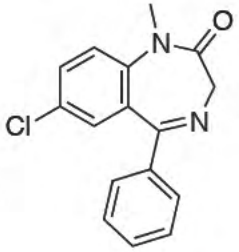
What are organic compounds used for?

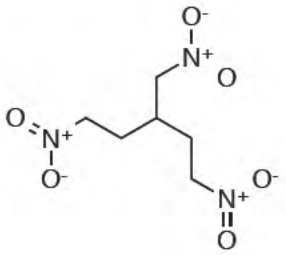
Pharmaceuticals

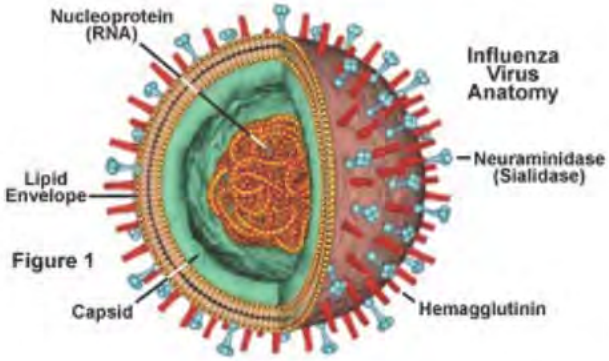
VALIUM®
(diazepam)

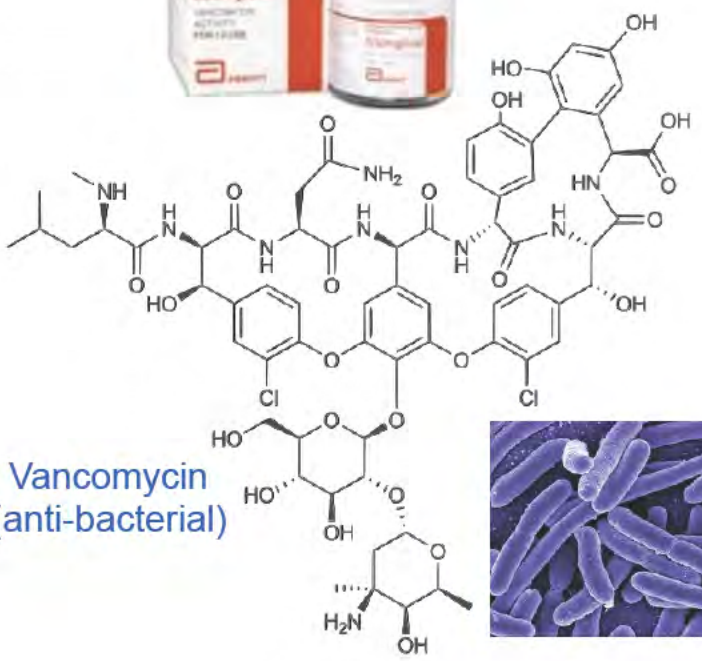


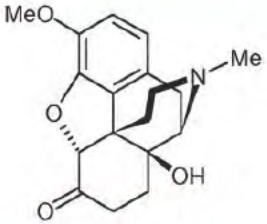




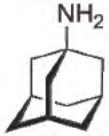








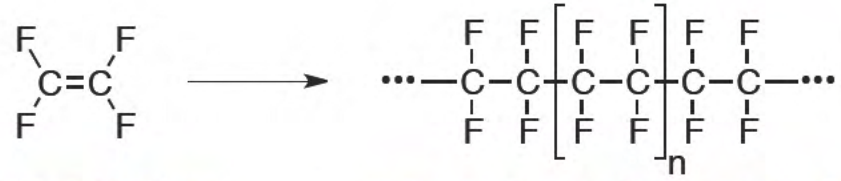
Oxycodone



Adamantadine
(anti-viral)

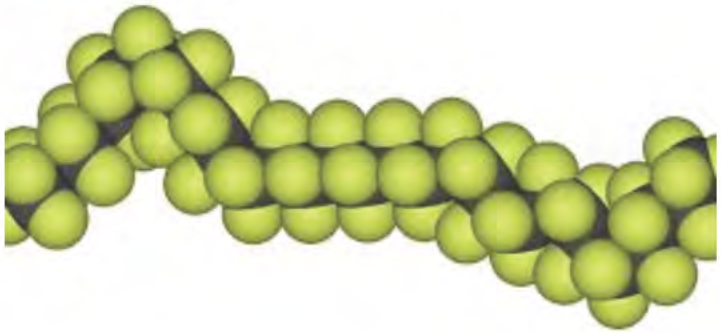
Vancomycin
(anti-bacterial)

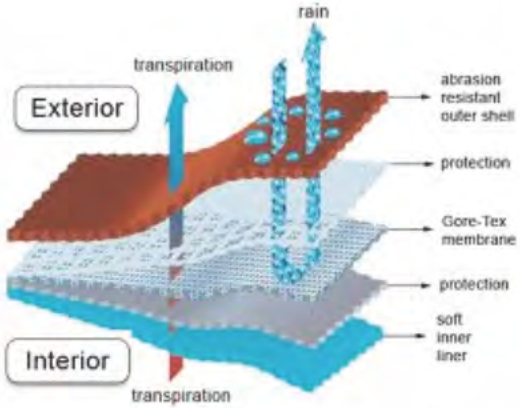
Polymers & Plastics



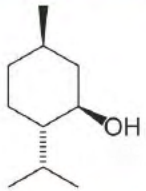
tetrafluoroethylene

polytetrafluoroethylene (PTFE)
Teflon

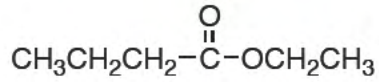




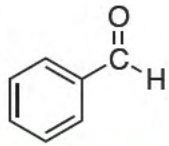
Food & Cosmetics



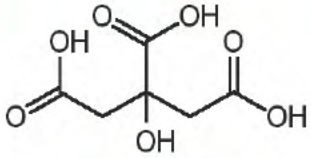
menthol



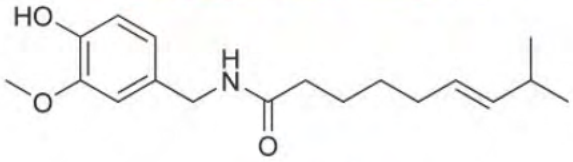
ethyl butyrate



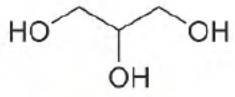
benzaldhyde



citric acid



capsacin

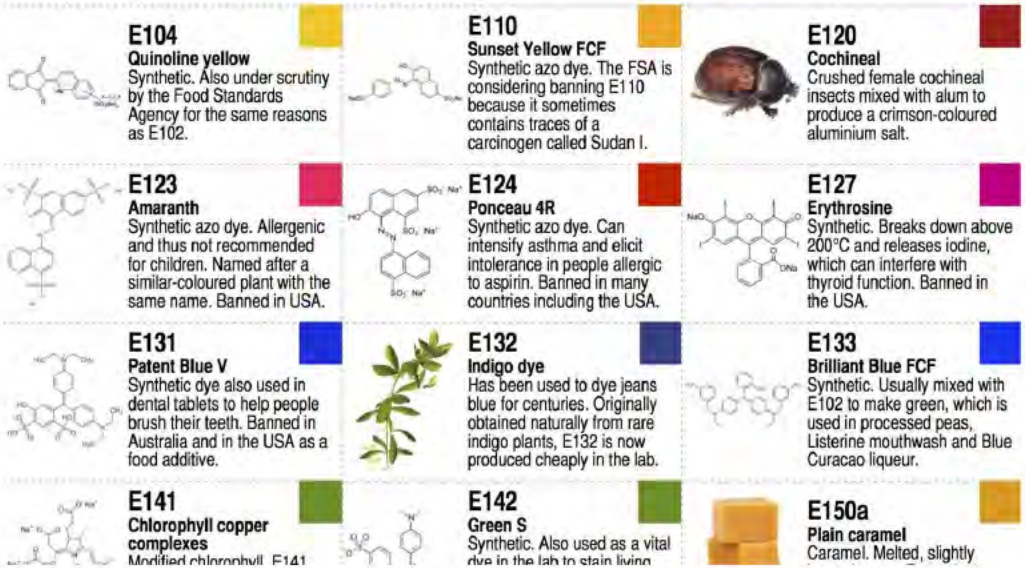


glycerol

General Mills Strawberry #3 Artificial Flavoring

Flavor Key	Mixture of Compounds	Composition
Sweetness Key	vanillin 0.5%; ethyl maltol 4.5%; furaneol 5%; ethanol 90%	42%
Jammy Key (Cheesy/Buttery)	butanoic acid 7.5%; diacetyl 2.5%; ethanol 90%	10%
Fruity Key	2-methylbutanoic acid 4%; 3-methyl-3-phenyloxiran-2-yl propionate 1.6%; ethyl 3-methylbutanoate 2%; ethyl butanoate 5%; butyl isovalerate 1.6%; methyl cinnamate 0.8%; isoamyl acetate 1%; gamma decalactone 2%; ethyl acetoacetate 10%; propylene glycol 72%	45%
Green Key	trans-hex-2-enal 1%; hex-1-en-3-ol 5%; hexanolic acid 1.5%; hexanal 5%; ethanol 92%	3%

Dyes & Pigments



E104
Quinoline yellow
Synthetic. Also under scrutiny by the Food Standards Agency for the same reasons as E102.

E110
Sunset Yellow FCF
Synthetic azo dye. The FSA is considering banning E110 because it sometimes contains traces of a carcinogen called Sudan I.

E120
Cochineal
Crushed female cochineal insects mixed with alum to produce a crimson-coloured aluminium salt.

E123
Amaranth
Synthetic azo dye. Allergenic and thus not recommended for children. Named after a similar-coloured plant with the same name. Banned in USA.

E124
Ponceau 4R
Synthetic azo dye. Can intensify asthma and elicit intolerance in people allergic to aspirin. Banned in many countries including the USA.

E127
Erythrosine
Synthetic. Breaks down above 200°C and releases iodine, which can interfere with thyroid function. Banned in the USA.

E131
Patent Blue V
Synthetic dye also used in dental tablets to help people brush their teeth. Banned in Australia and in the USA as a food additive.

E132
Indigo dye
Has been used to dye jeans blue for centuries. Originally obtained naturally from rare indigo plants, E132 is now produced cheaply in the lab.

E133
Brilliant Blue FCF
Synthetic. Usually mixed with E102 to make green, which is used in processed peas, Listerine mouthwash and Blue Curacao liqueur.

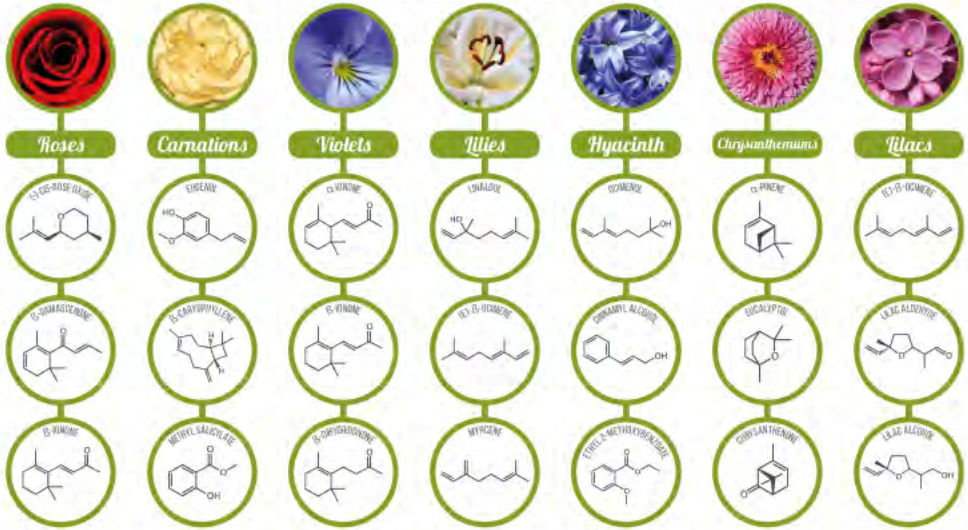
E141
Chlorophyll copper complexes
Modified chlorophyll. E141

E142
Green S
Synthetic. Also used as a vital dye in the lab to stain living

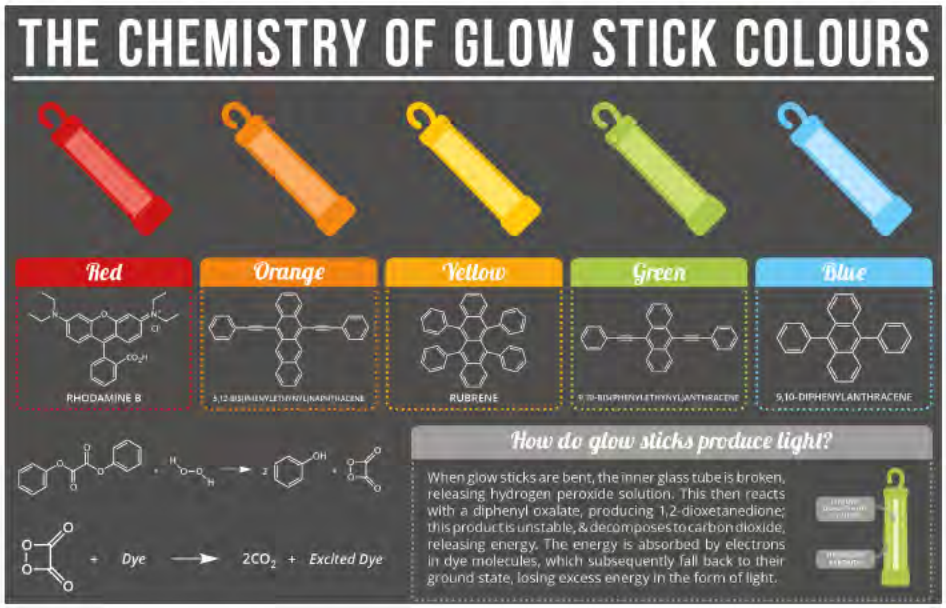
E150a
Plain caramel
Caramel. Melted, slightly

AROMA COMPOUNDS IN COMMON FLOWERS

A wide range of compounds contribute to the scents of flowers. This graphic looks at a selection of major contributors for a number of common flowers. Note that volatile aroma compounds can vary significantly between species; this graphic represents a broad overview of common components, and is by no means definitive!

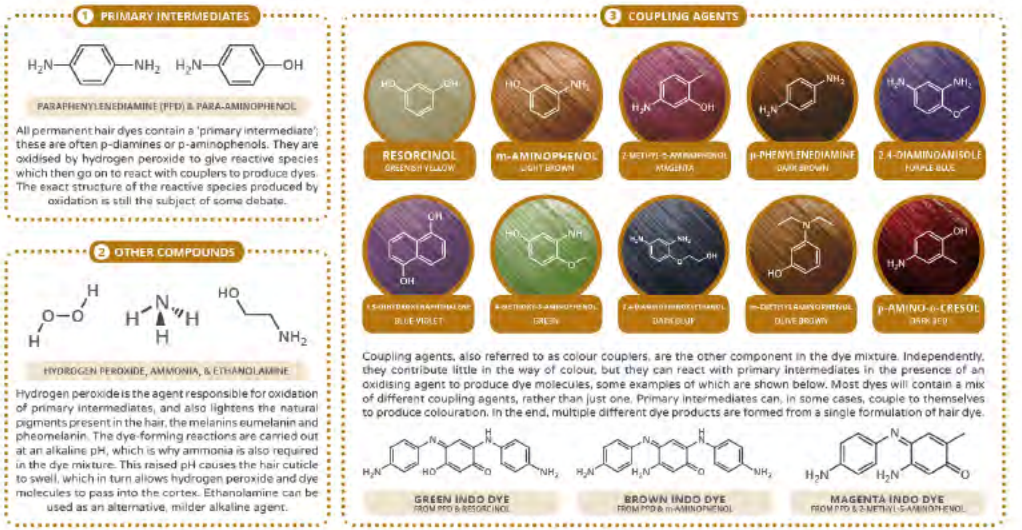


THE CHEMISTRY OF GLOW STICK COLOURS



THE CHEMISTRY OF PERMANENT HAIR DYES

There are a number of different types of hair dyes, but the most commonly used are permanent (oxidative) dyes. These dyes have a range of different components that react with each other to produce the desired end colour. In this graphic, we examine some of these chemicals, and how they form dyes.



Energy

natural gases

CH_4

CH_3CH_3

$CH_3CH_2CH_3$

$CH_3CH_2CH_2CH_3$

liquid fuel

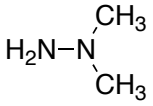
$CH_3CH_2CH_2CH_2CH_2CH_3$

$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$

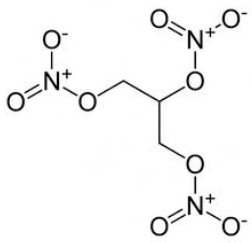
CH_3CH_2OH

$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$

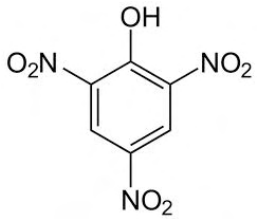
rocket fuel



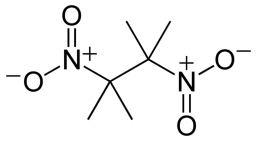
explosive compounds



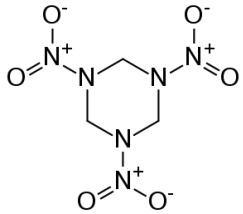
nitroglycerine



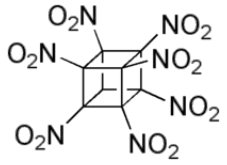
picric acid



C4

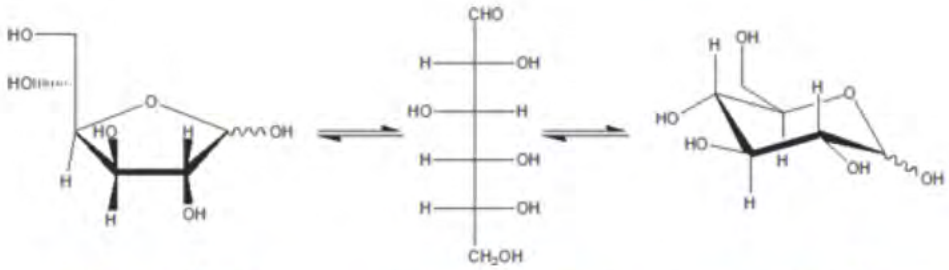


RDX

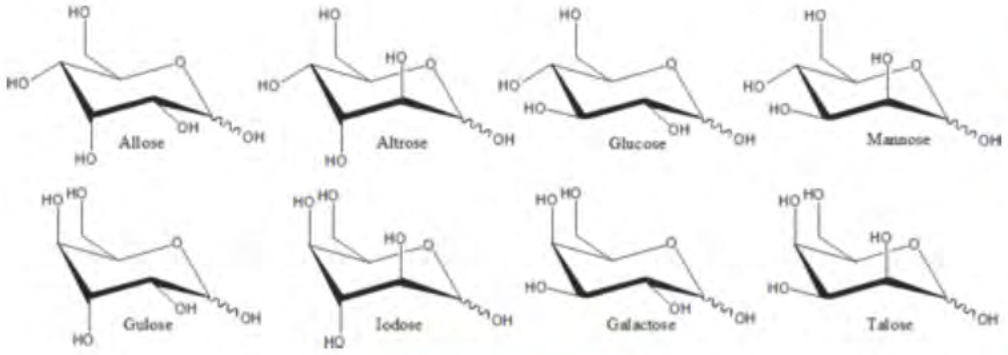


heptanitrocubane

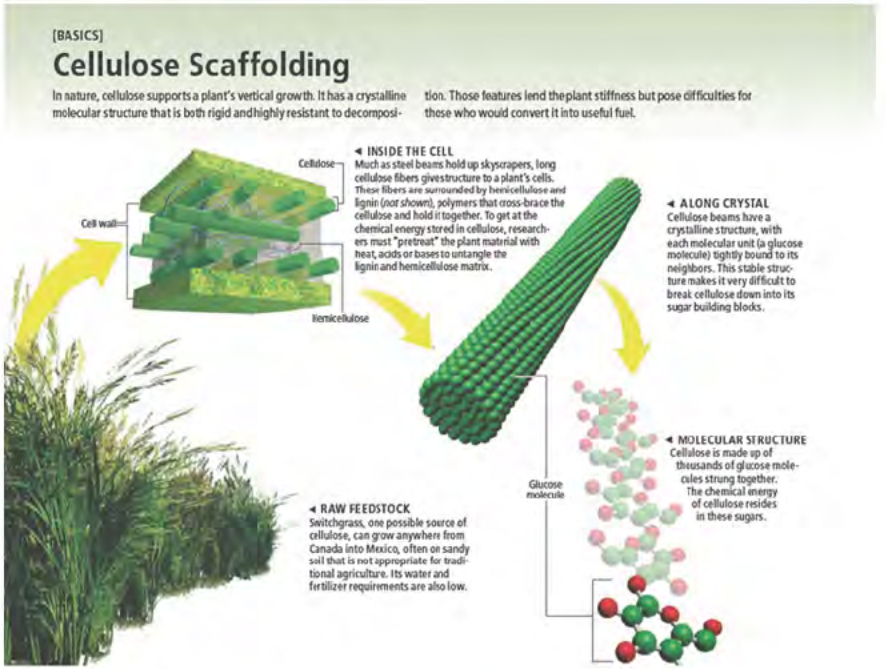
Sugars & Polysaccharides



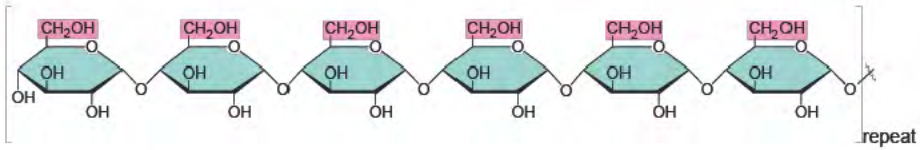
furanose form acyclic form pyranose form



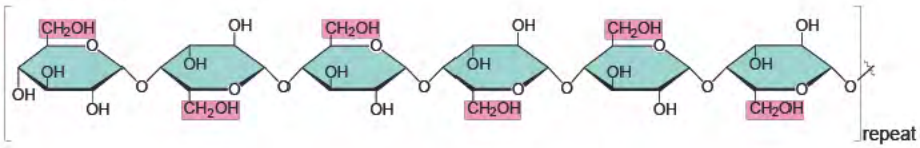
pyranose sugars



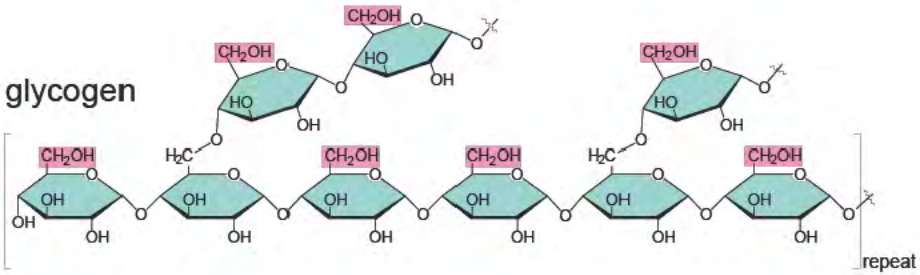
starch



cellulose

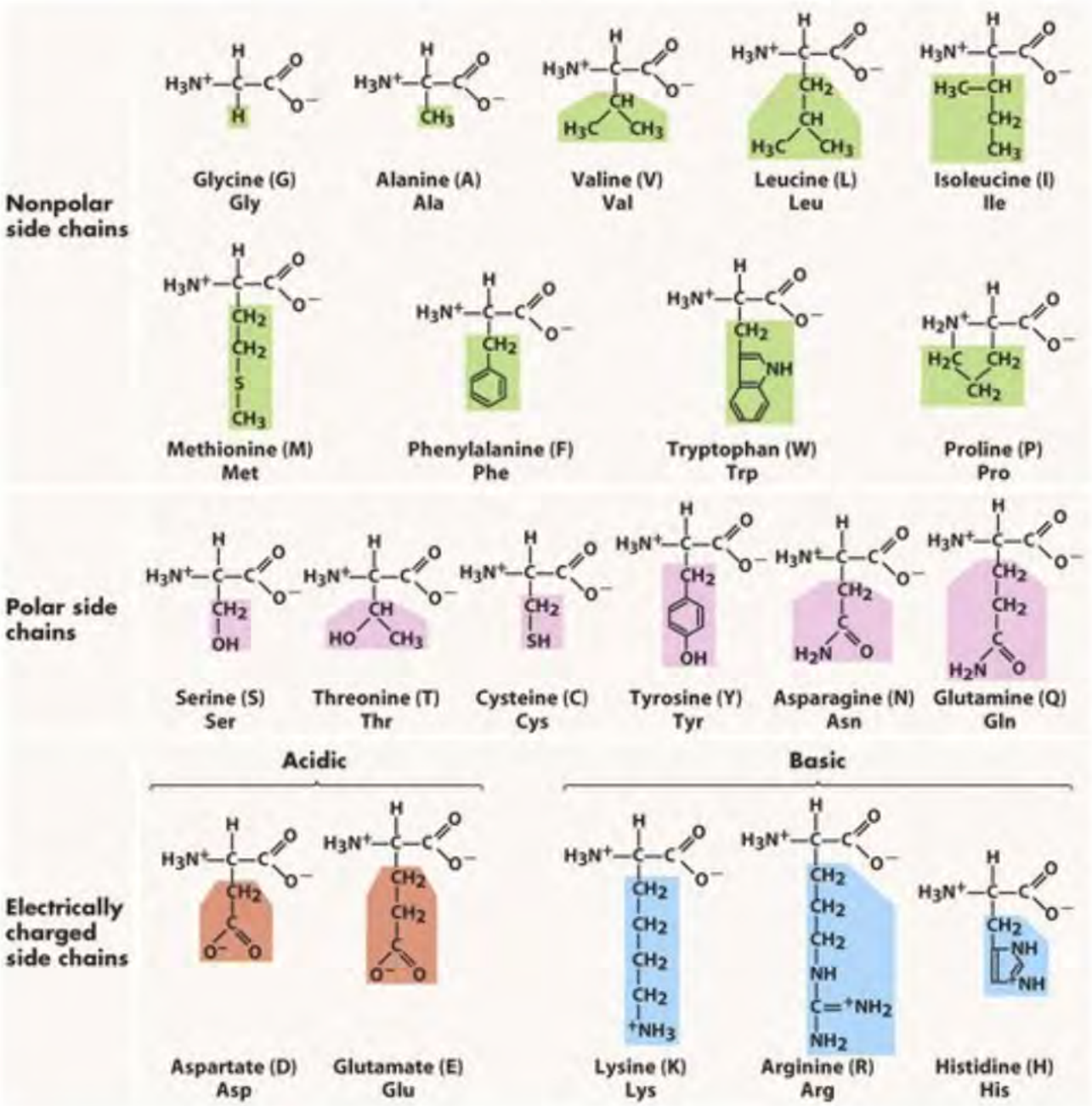


glycogen

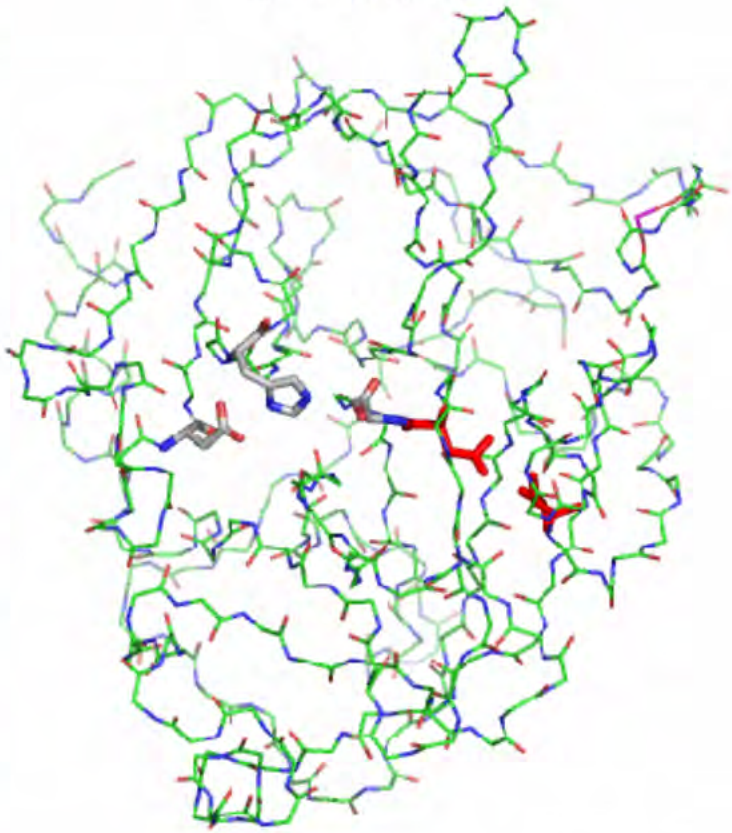


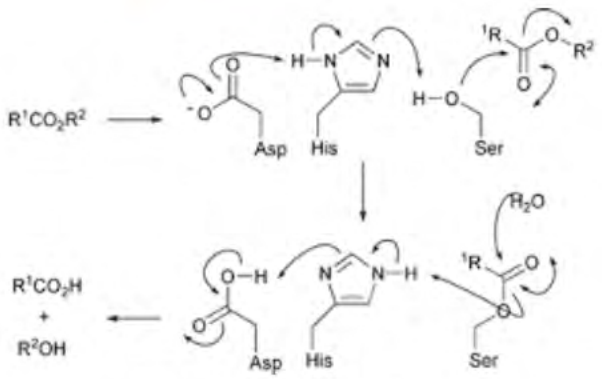
Need for new types of plastics that biograde

Amino Acids & Proteins/Enzymes

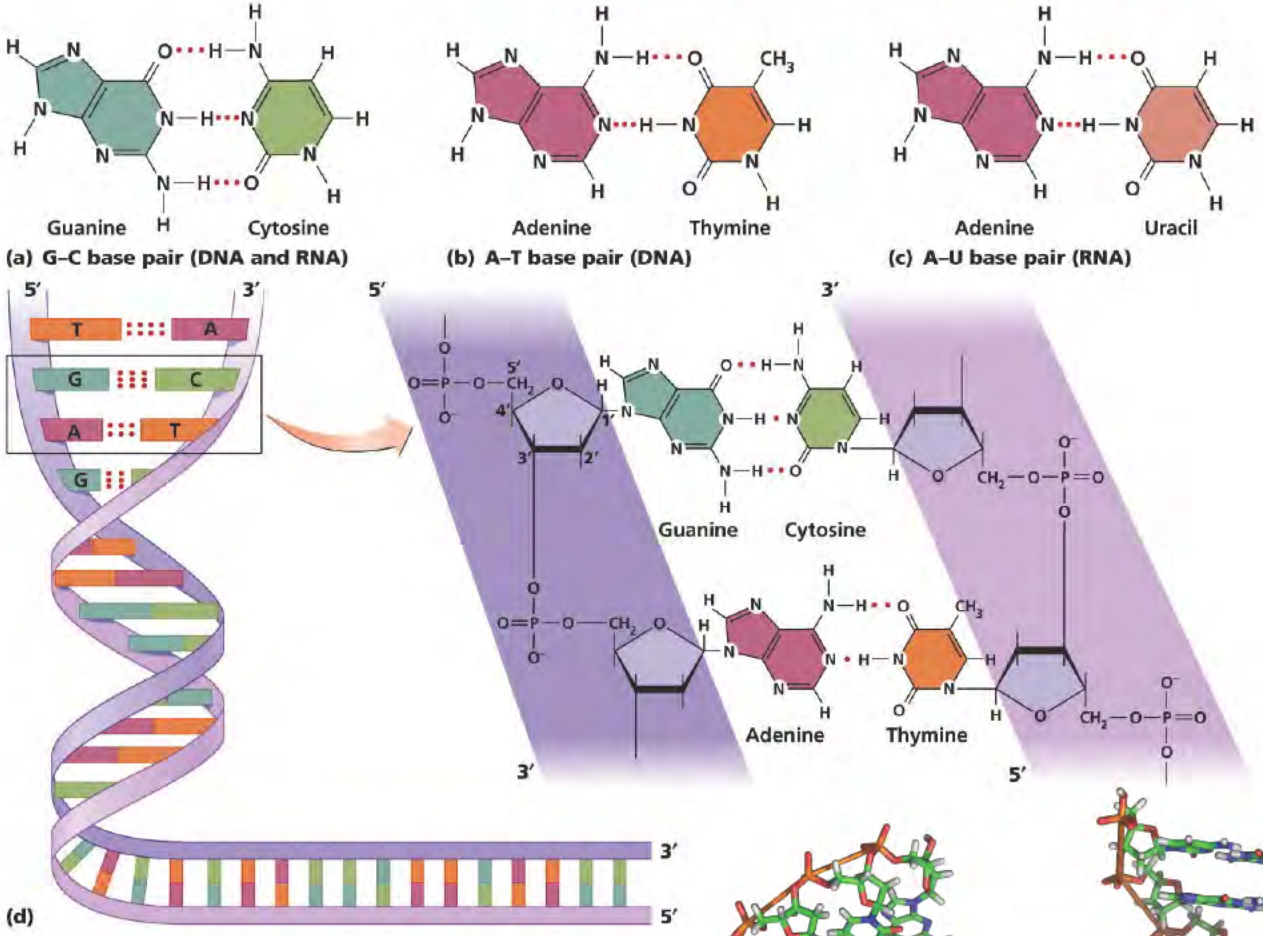


serine protease

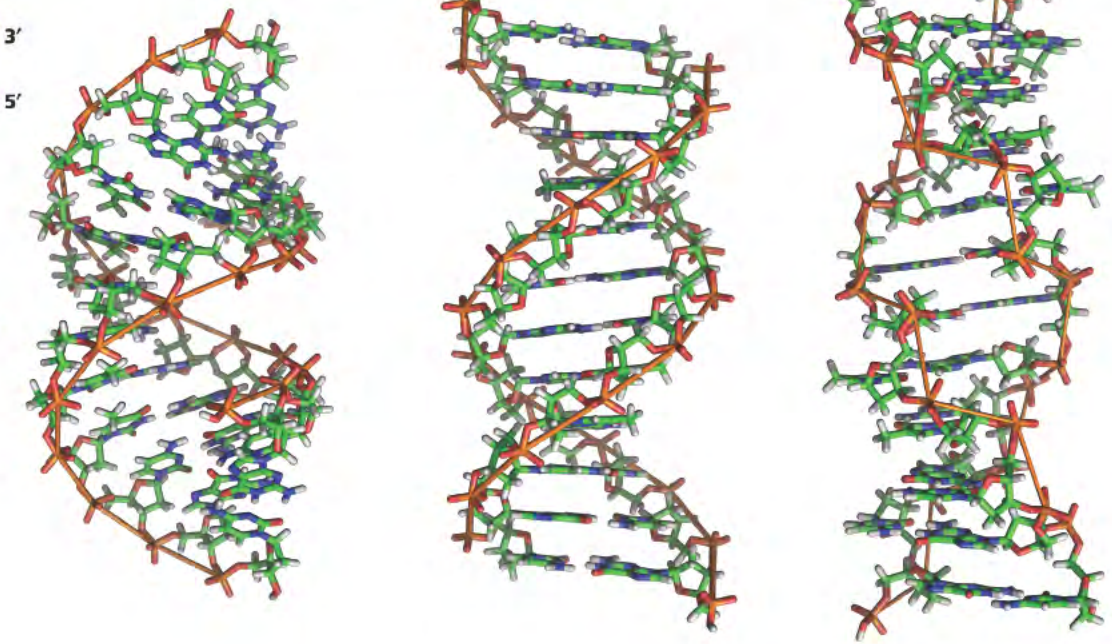




Nucleic Acids & DNA

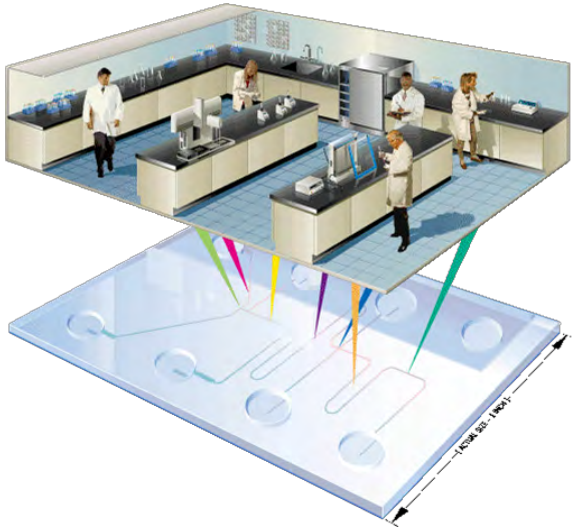


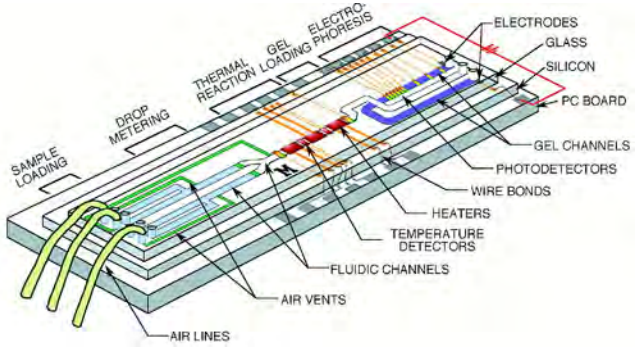
A, B, & Z forms of DNA

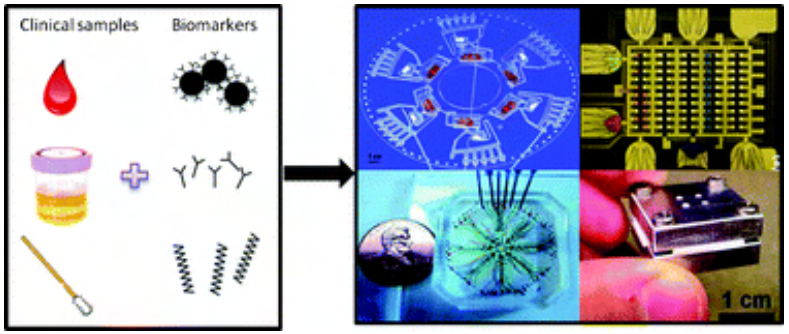


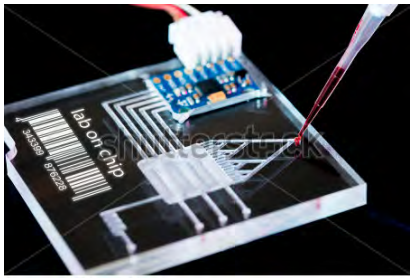
Lab on a chip

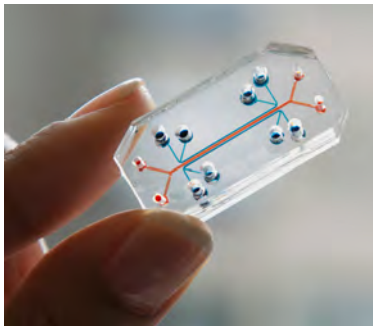

Lab on a Chip

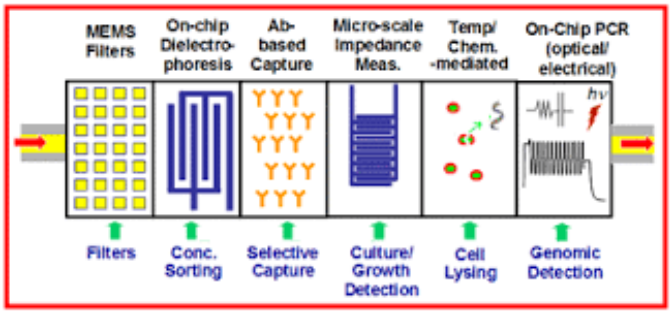


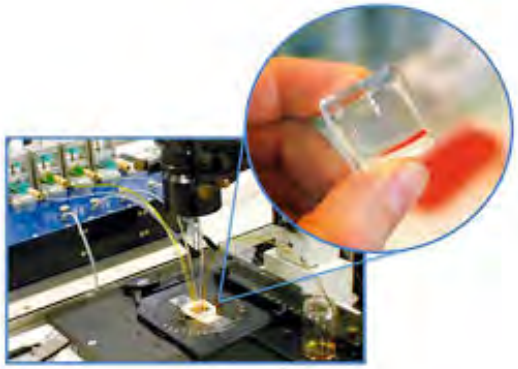

ELECTRODES
GLASS
SILICON
PC BOARD
GEL CHANNELS
PHOTODETECTORS
WIRE BONDS
HEATERS
TEMPERATURE DETECTORS
FLUIDIC CHANNELS
AIR VENTS
AIR LINES
SAMPLE LOADING
DROP METERING
THERMAL REACTION
GEL LOADING
ELECTRO-PHORESIS

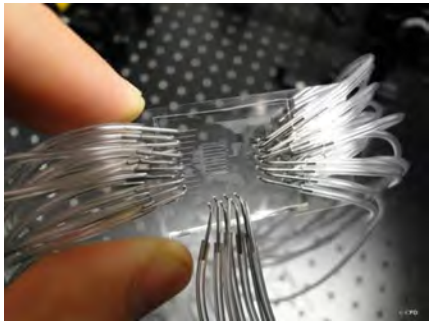

Clinical samples
Biomarkers
1 cm

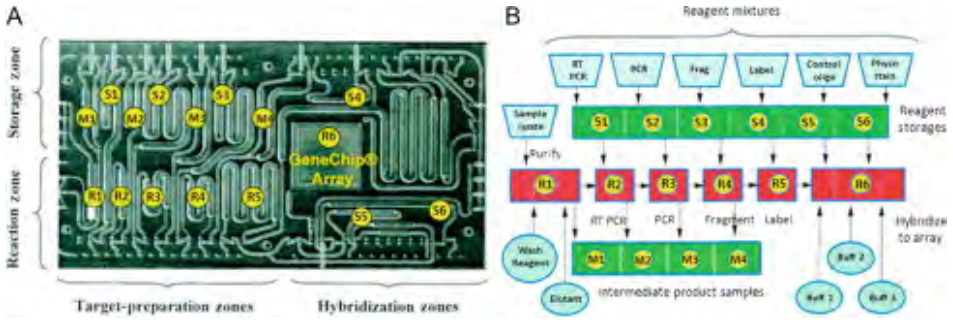

lab on chip



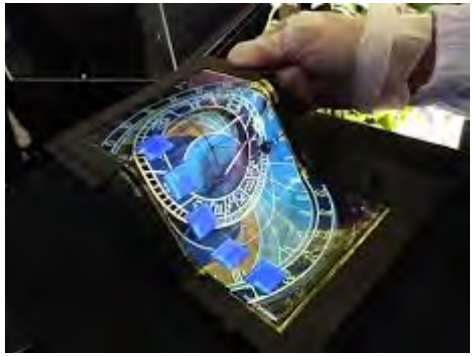

MEMS Filters
On-chip Dielectro-phoresis
Ab-based Capture
Micro-scale Impedance Meas.
Temp/ Chem. -mediated
On-Chip PCR (optical/ electrical)
Filters
Conc. Sorting
Selective Capture
Culture/ Growth Detection
Cell Lysing
Genomic Detection

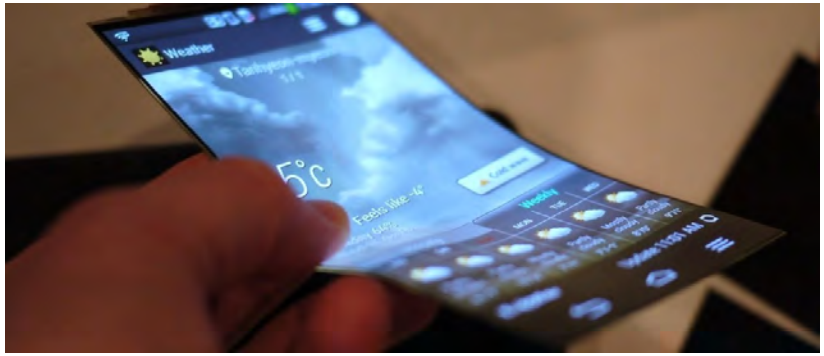




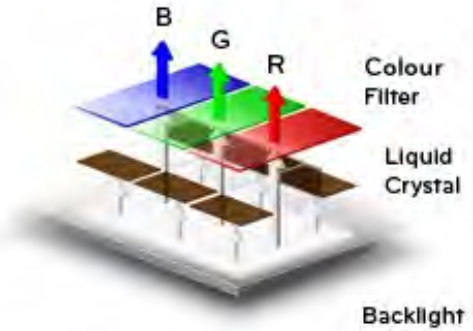

A
B
Storage zone
Reaction zone
GeneChip® Array
Target-preparation zones
Hybridization zones
Reagent mixtures
Reagent storages
Purify
RT PCR
PCR
Fragment
Label
Hybridize to array
Intermediate product samples

Technology



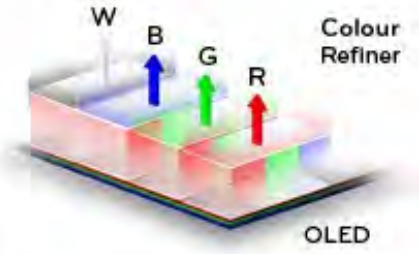


LED/LCD

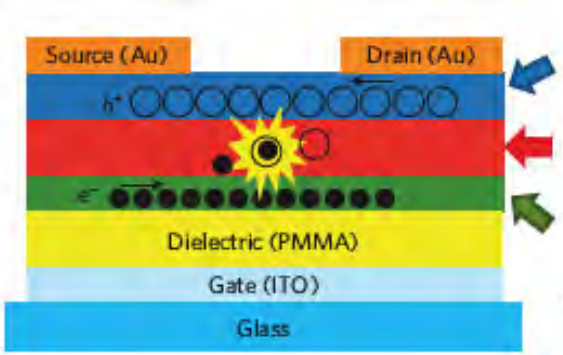


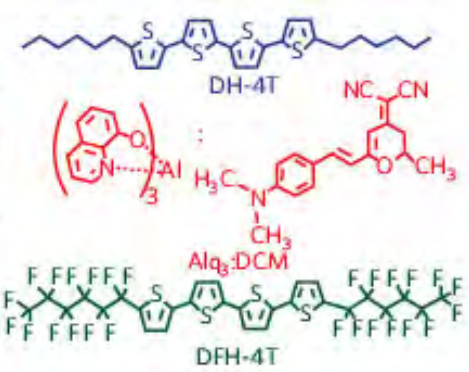
- Complex Structure
- BLU (Backlight Unit) CCFL, LED
- Lighting Unit = Pixel Unit

LG OLED



- Simple Structure
- Self-emissive
- Lighting Unit = Pixel Unit

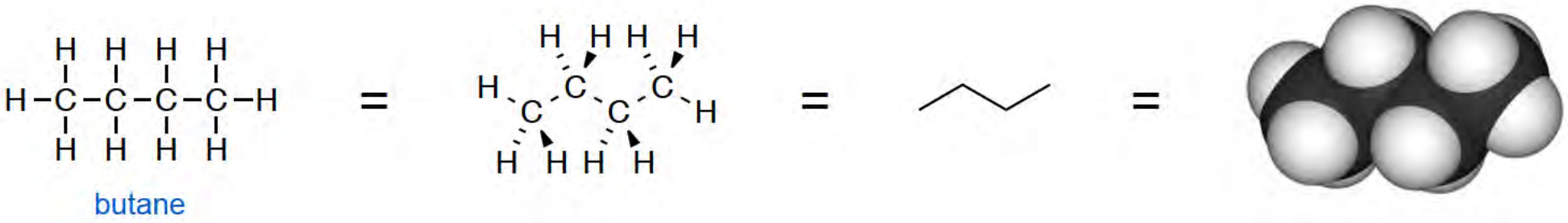




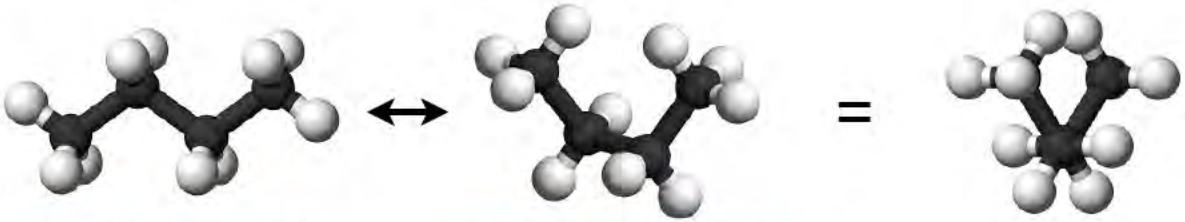
What will we cover in CH2310?

….and later in CH2320 and CH2330?

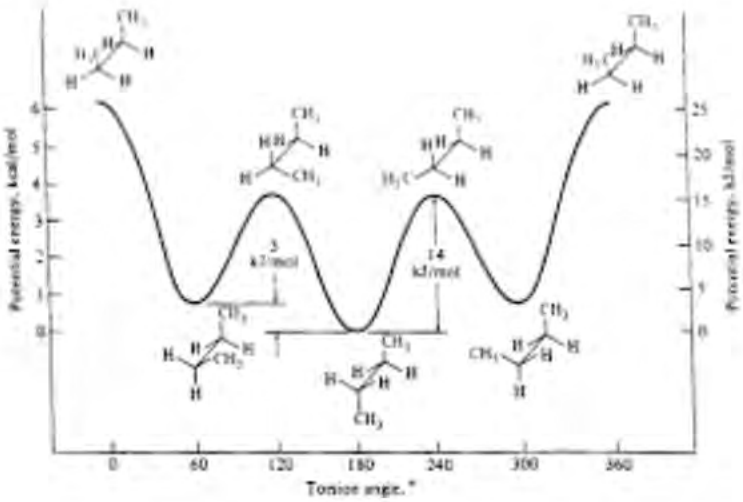
Structure, Conformation, Stereochemistry & Nomenclature

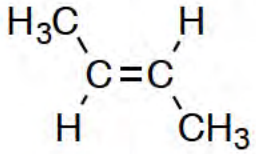


butane

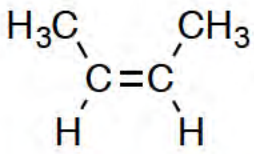


anti conformation gauche conformation





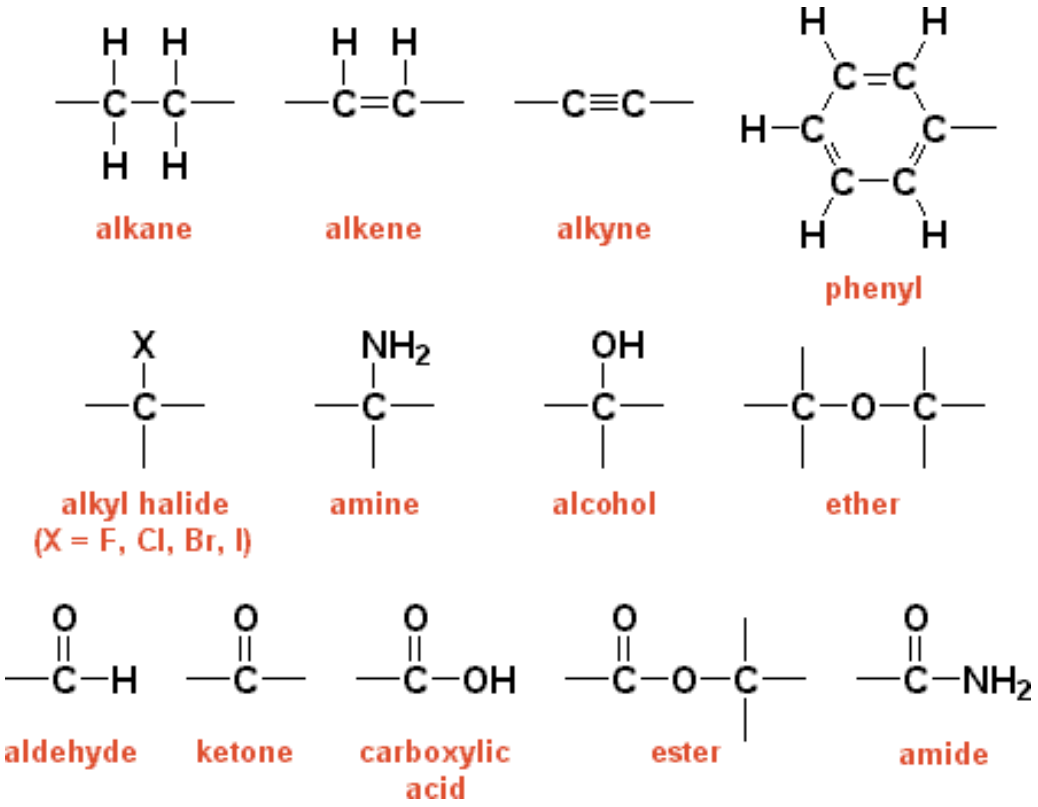
trans-but-2-ene
(*E*)-but-2-ene



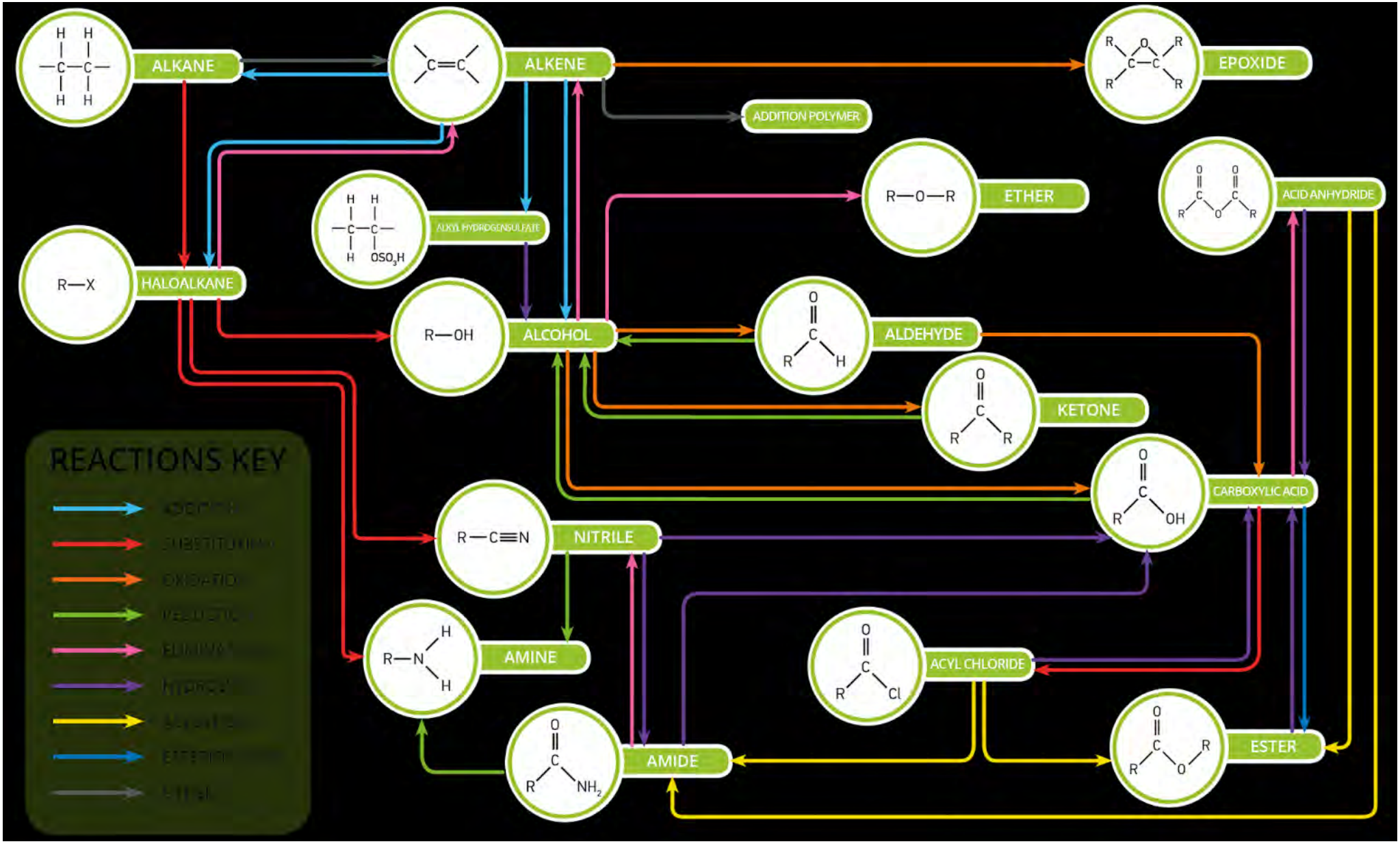
cis-but-2-ene
(*Z*)-but-2-ene

Functional Groups - What are they & what chemistry do they do?

Functional Groups - the main players

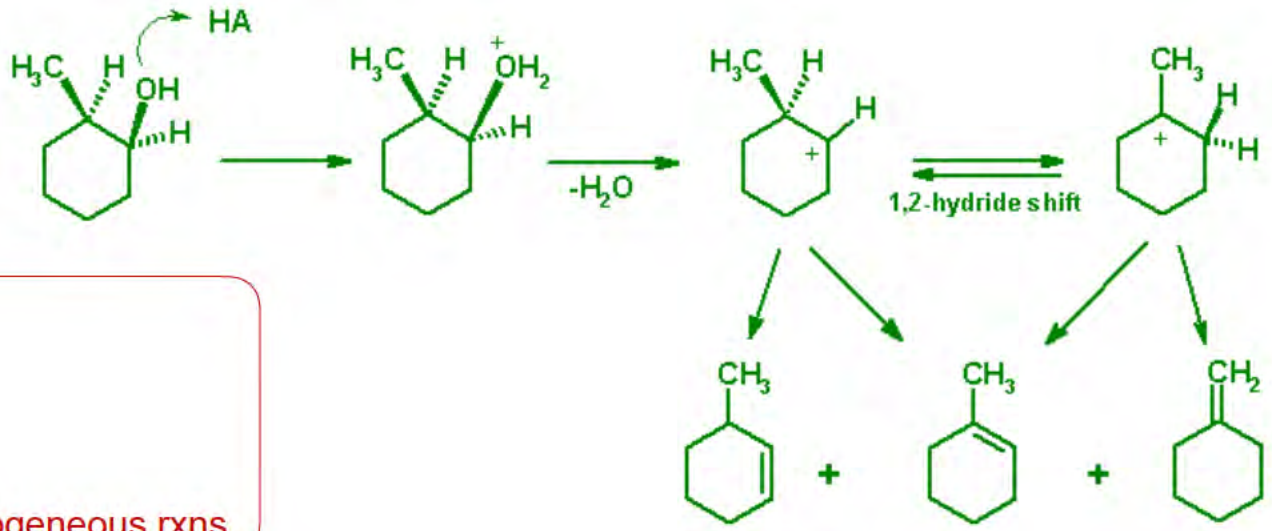


Transformations of Functional Groups



Mechanisms of Reactions — How Reactions Work

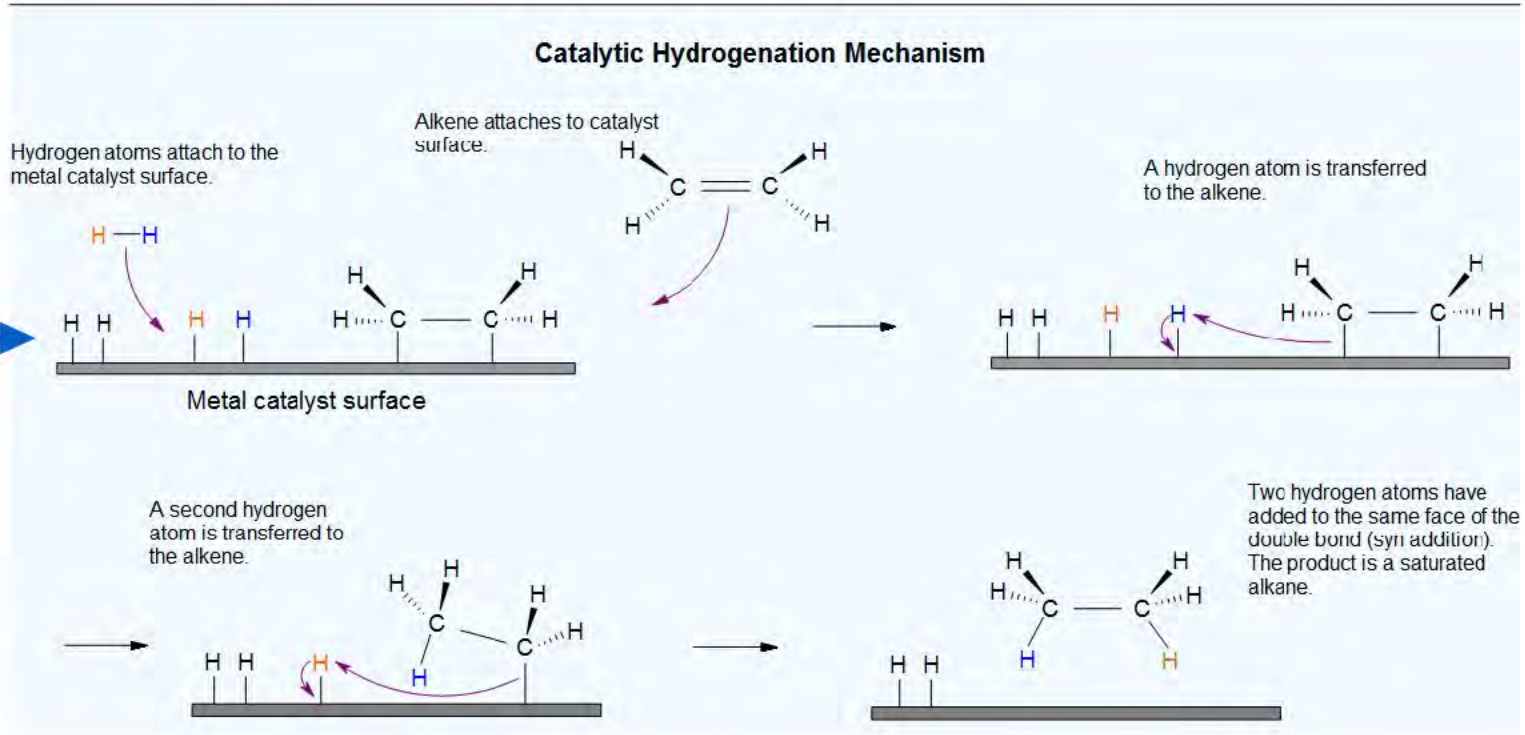
Dehydration of Alcohols



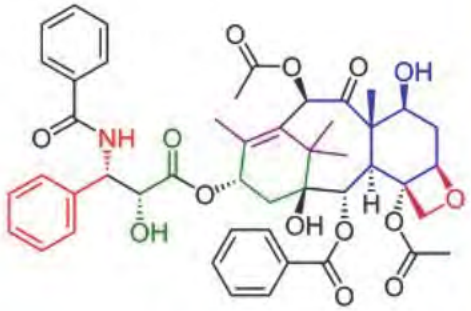
Types of organic reactions

- Addition rxns
- Elimination rxns
- Substitution rxns
- Acid-base rxns
- Homogeneous vs heterogeneous rxns

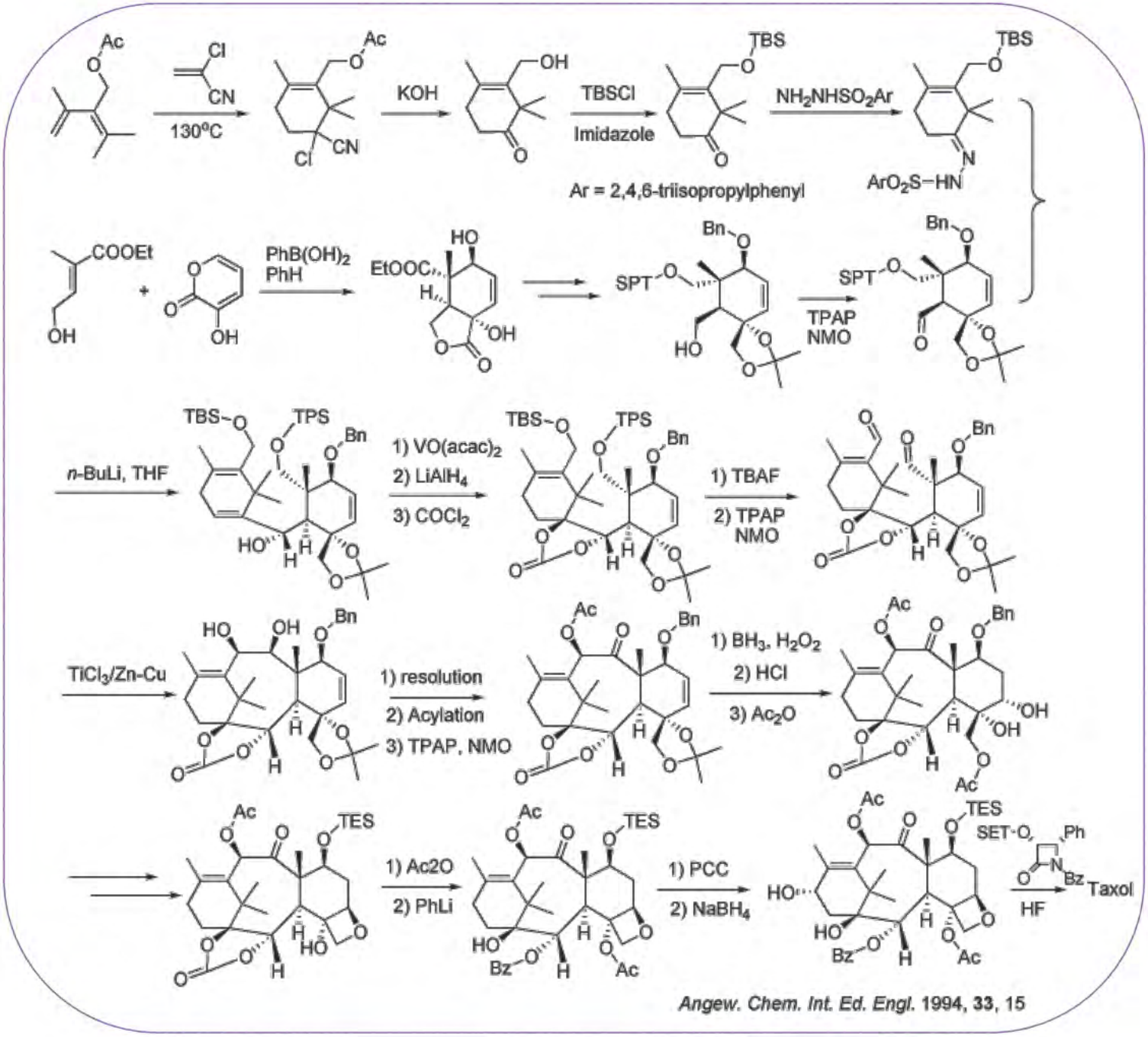
Catalytic Hydrogenation of Alkenes



Synthesis of Taxol — Synthesis in Multiple Steps

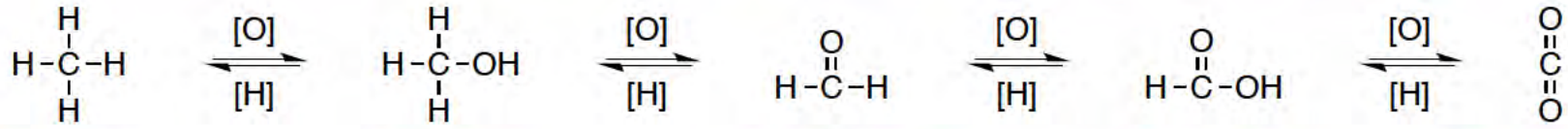


Taxol
potent anti-cancer drug

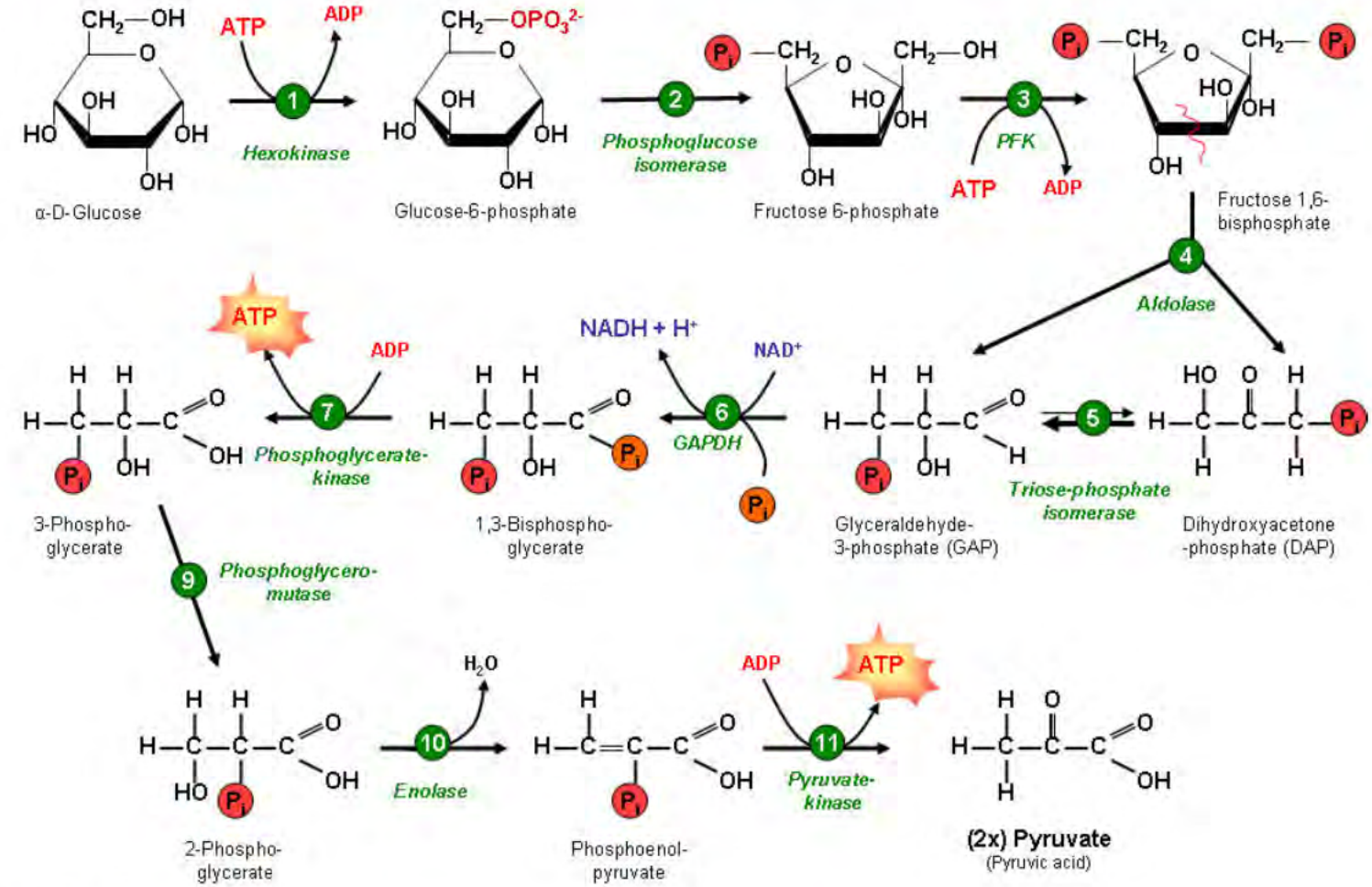


Oxidation & Reduction

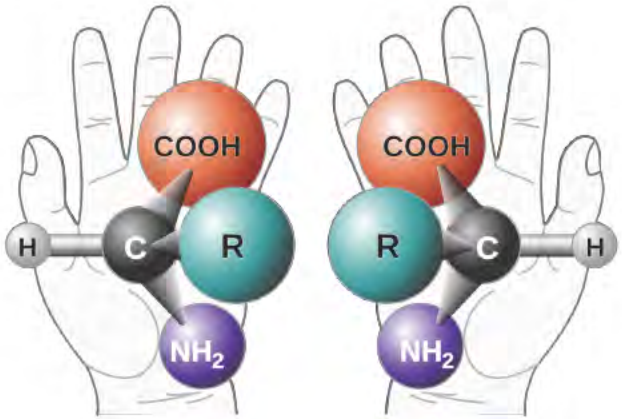
In the Lab

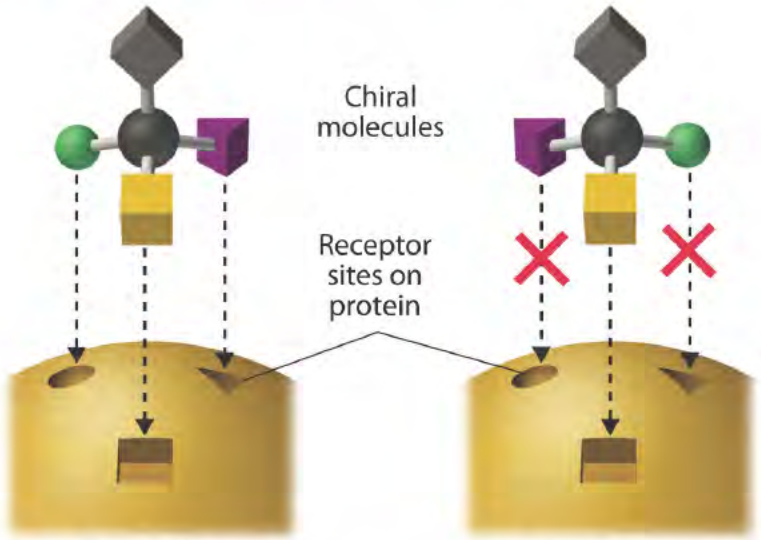


In Organisms



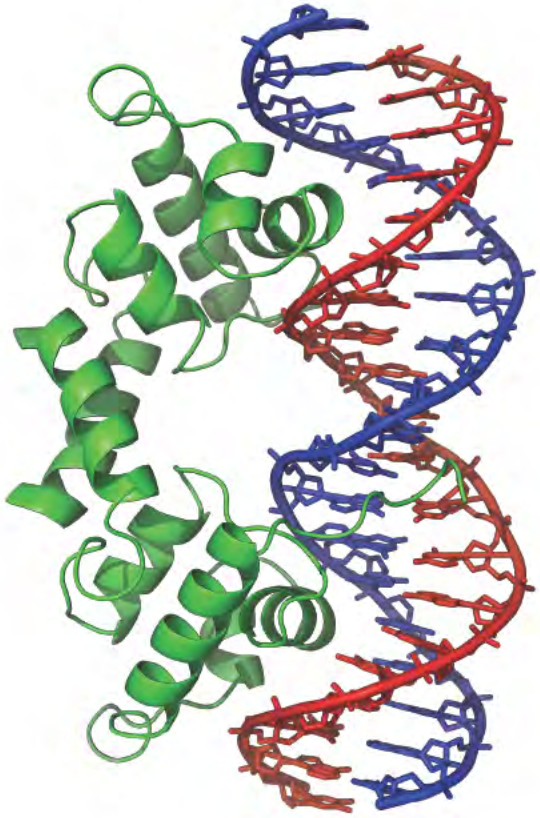
Chirality & Asymmetric Carbon





(a) Molecule fits receptor site, leading to a response

(b) Molecule does not fit receptor site; no response

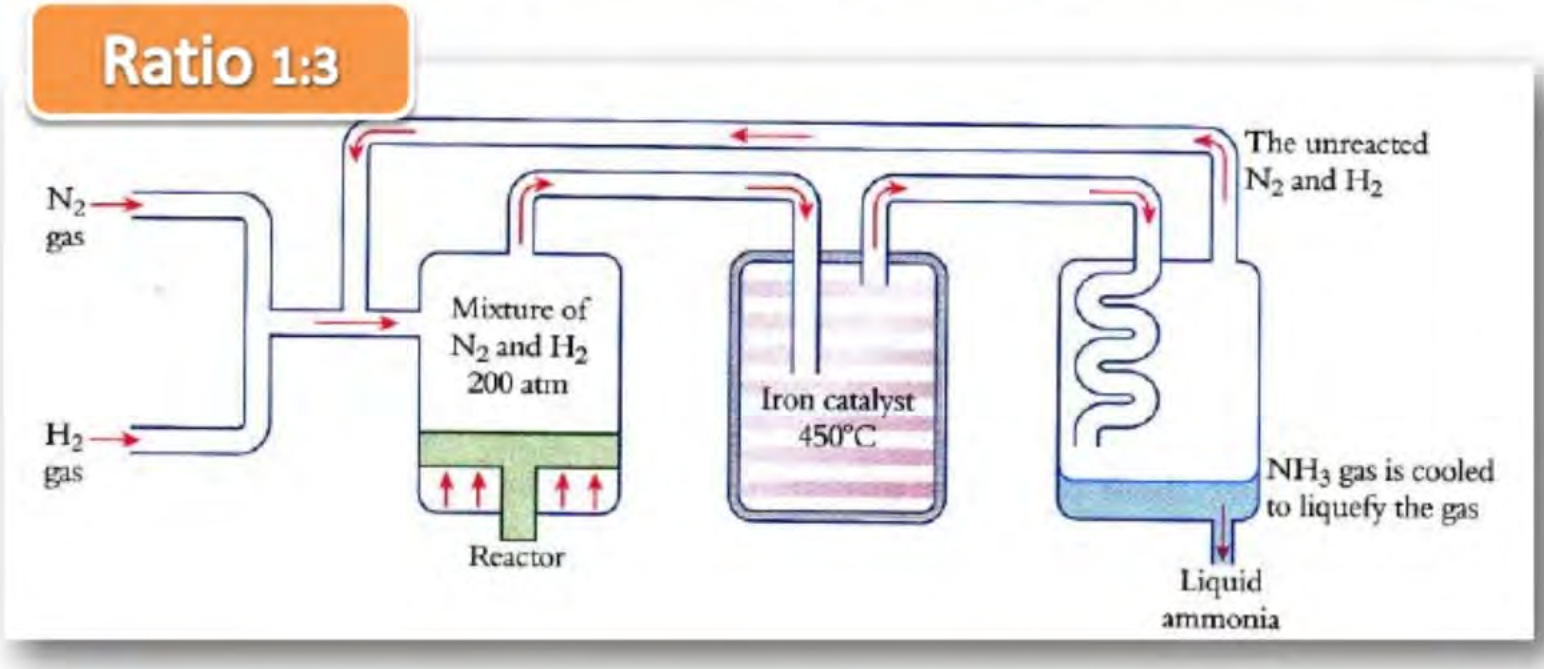


Why is knowing this stuff important?

How can I use organic chemistry moving forward?

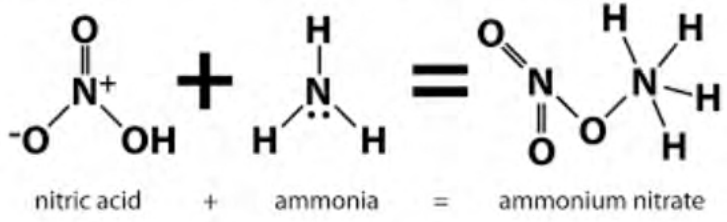
Most important chemical reaction discovered in the last 100 years

The Manufacture of Ammonia, NH_3 through the Haber Process



$$N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$$

Production of Ammonium Nitrate Fertilizer



nitric acid + ammonia = ammonium nitrate

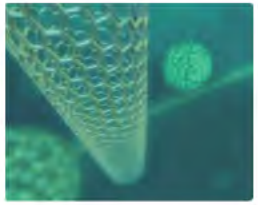
Where is chemical research headed today?
What important problems need to addressed?

energy

raw materials

global warming

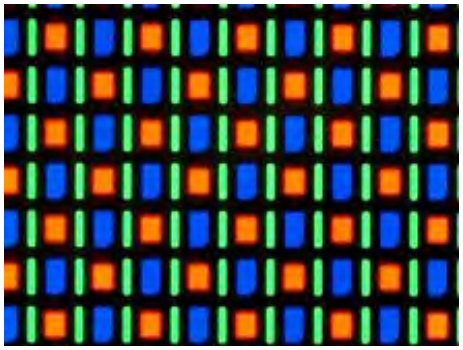
new materials & technology

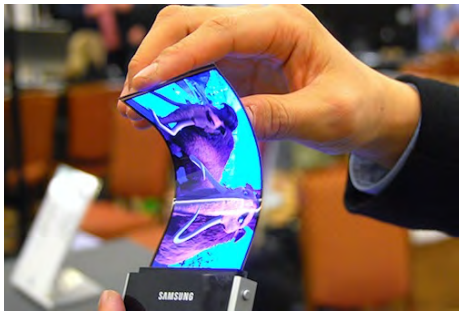


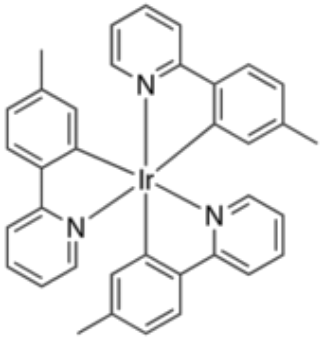
food

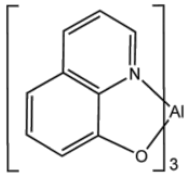
medicine

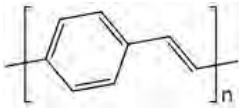
Display Technology - OLED Molecular Electronics

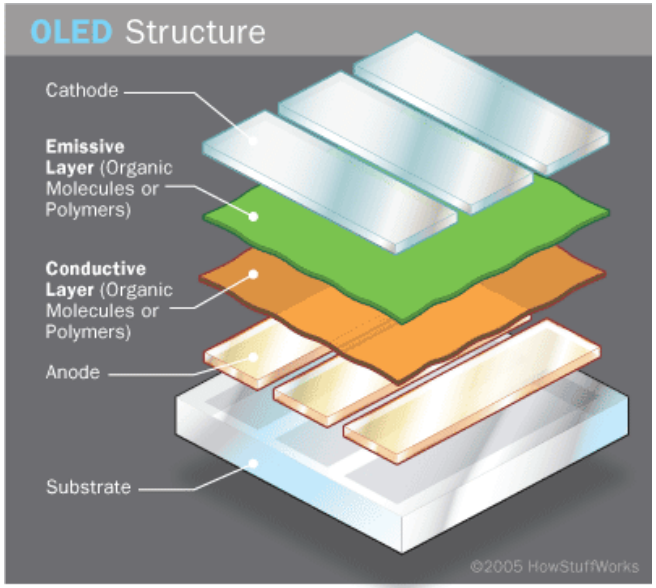


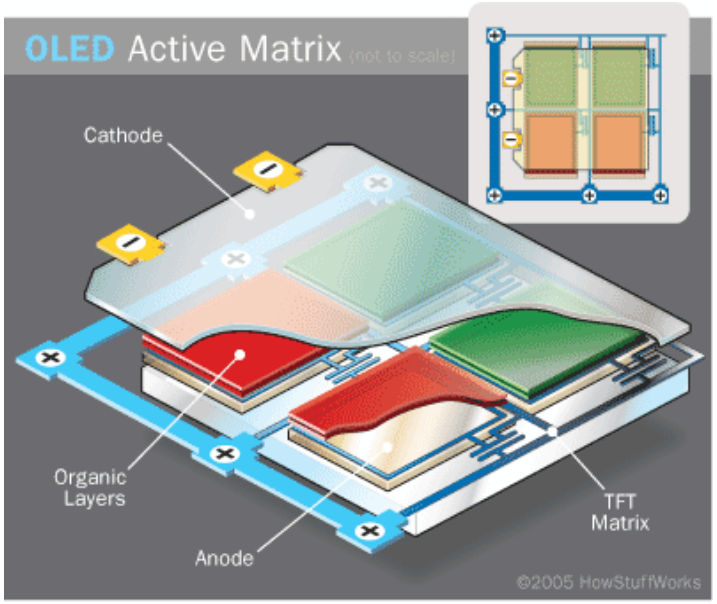




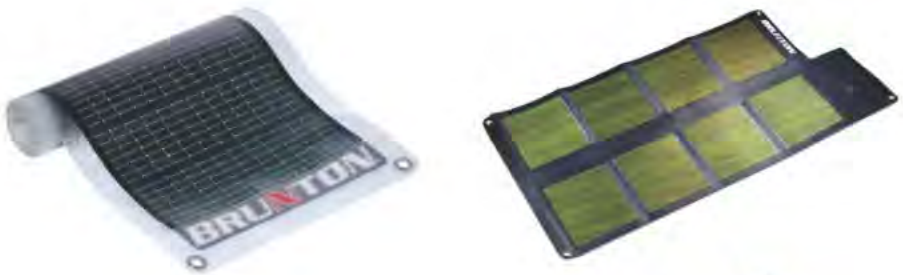


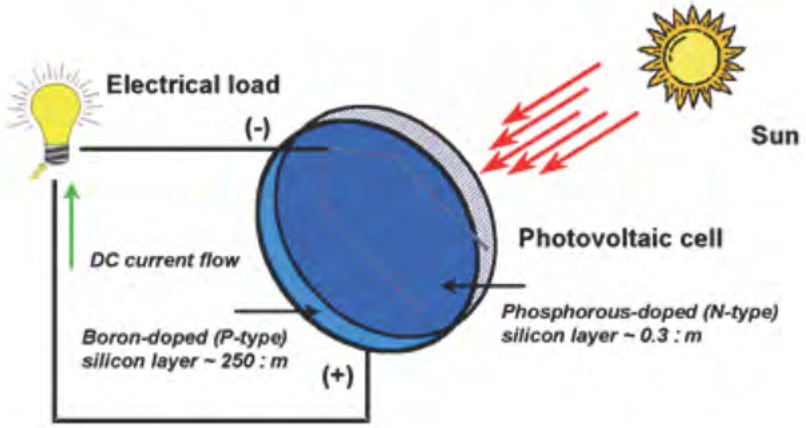


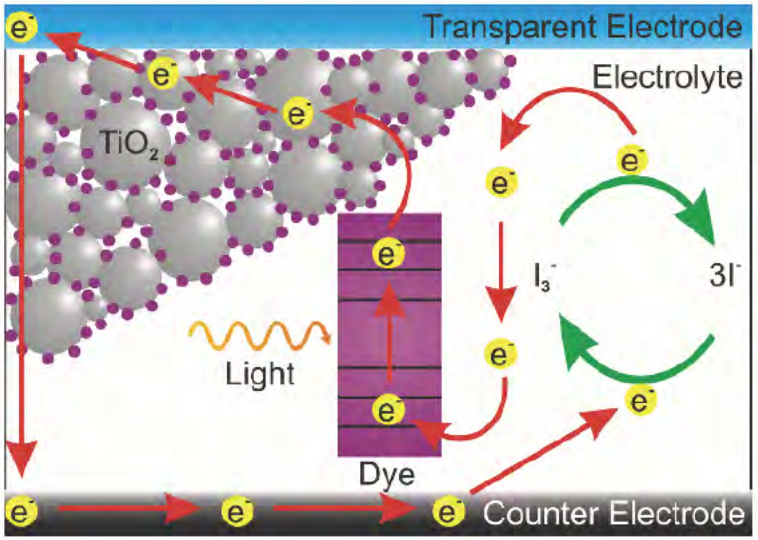


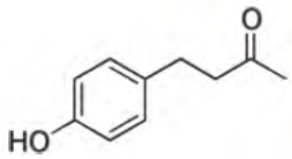


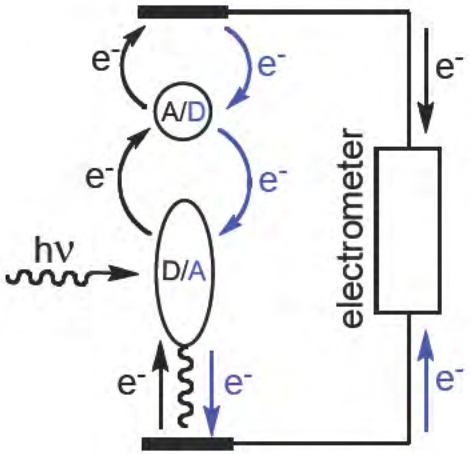
Energy Technology - Organic Thin-Film Photovoltaics

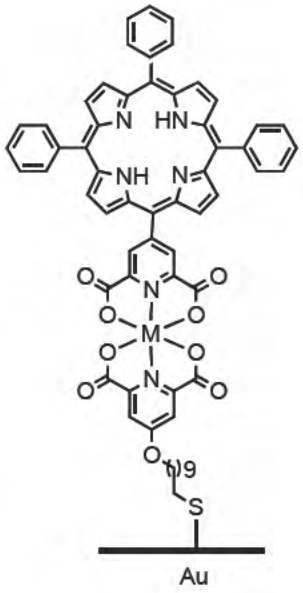


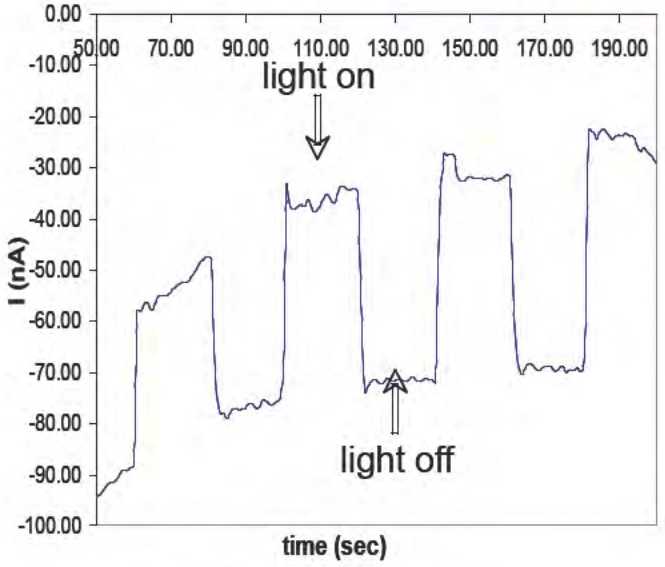




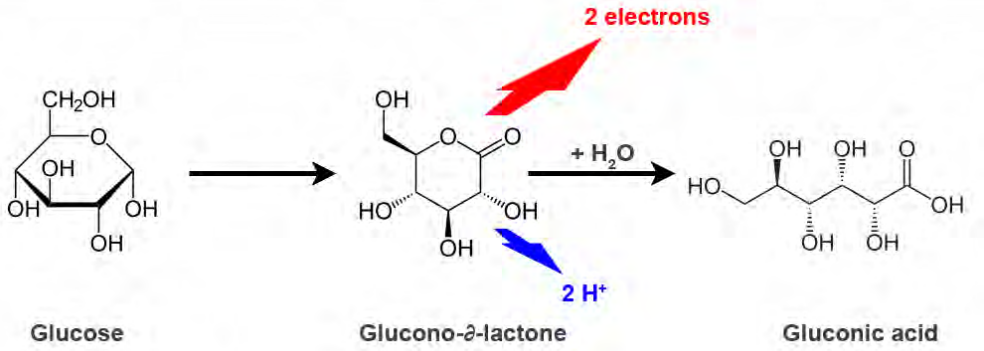


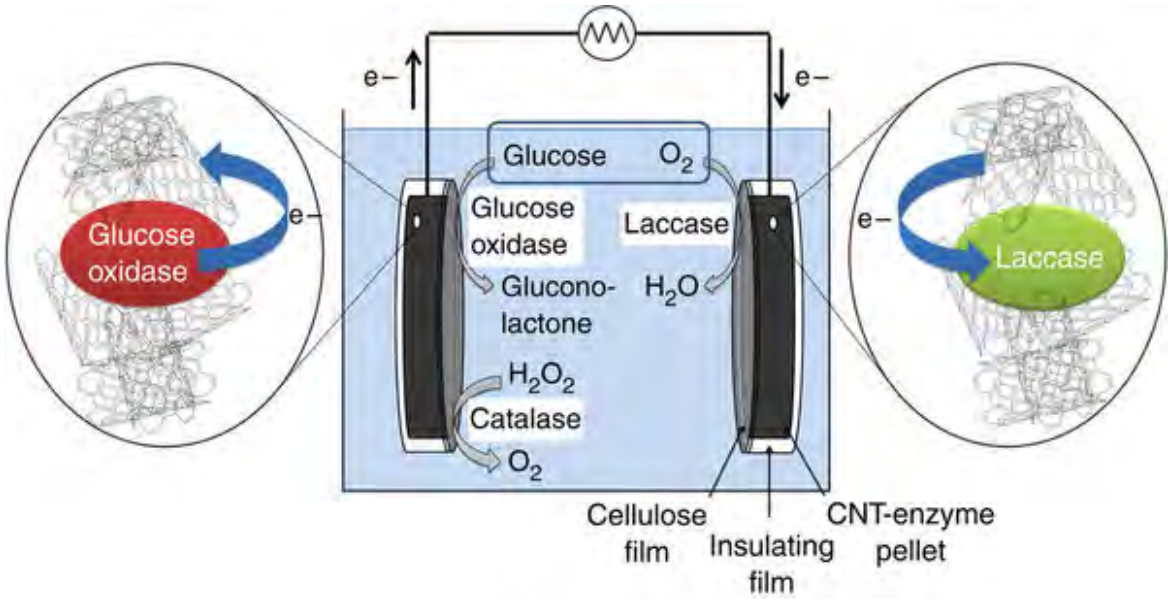


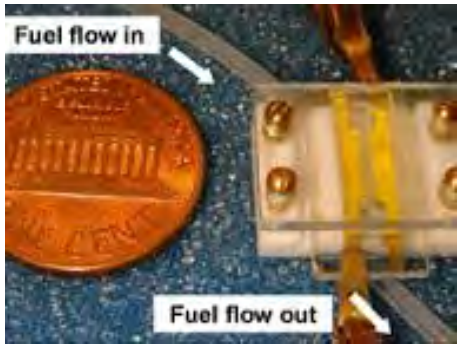


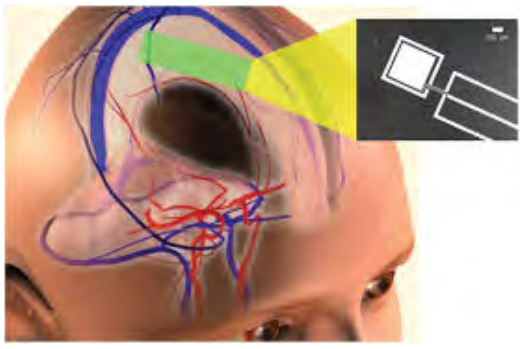


Energy Technology - Glucose Biofuel Cell

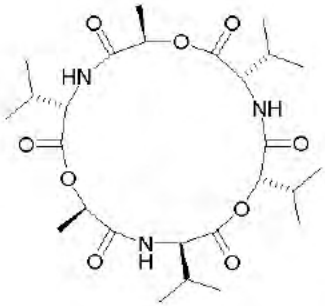




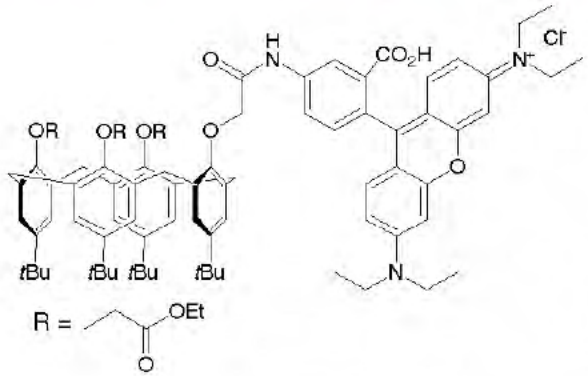




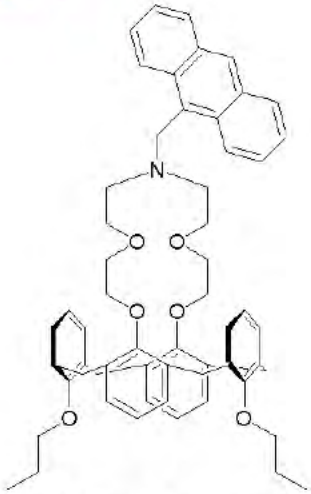
Medical Technology - Sensors



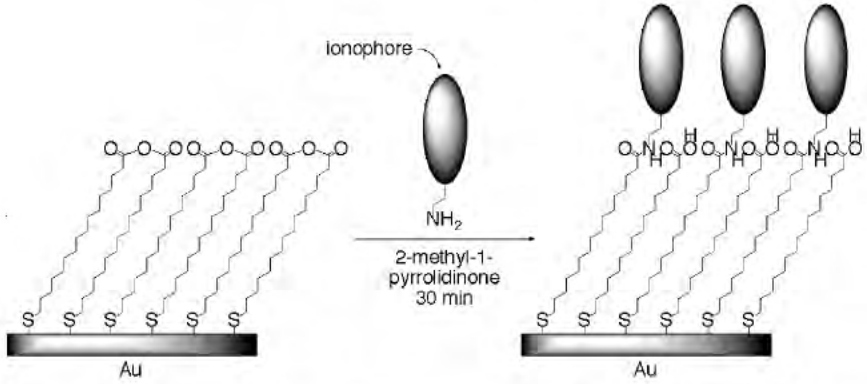
ammonium ionophore

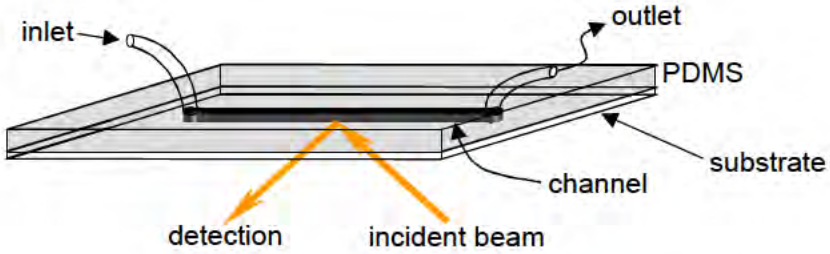


sodium ionophore



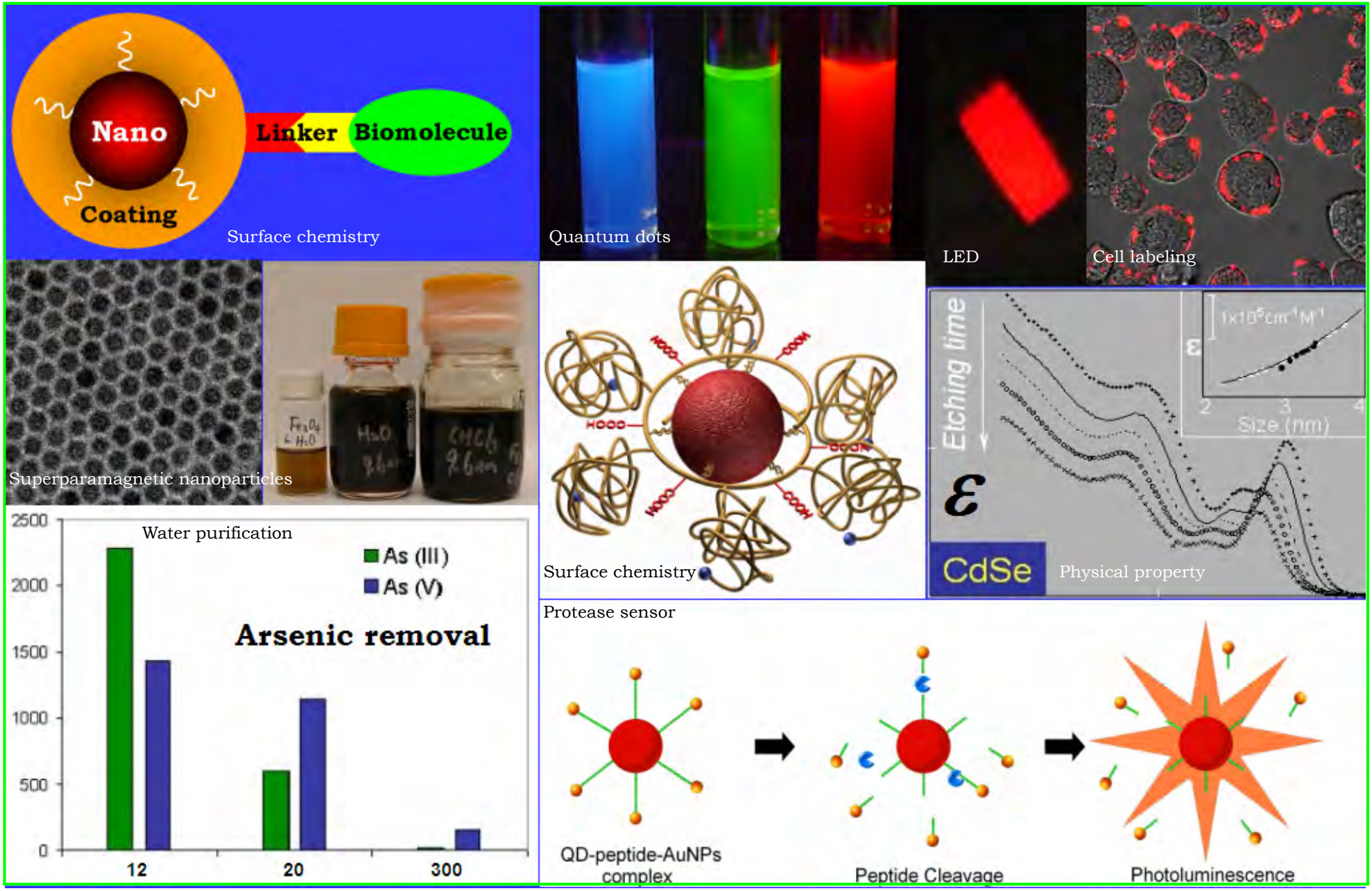
potassium ionophore



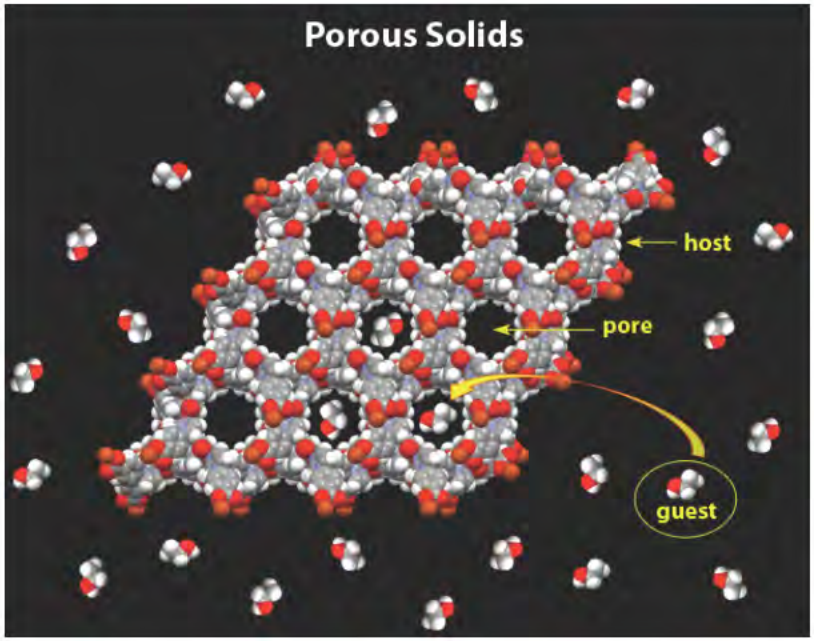


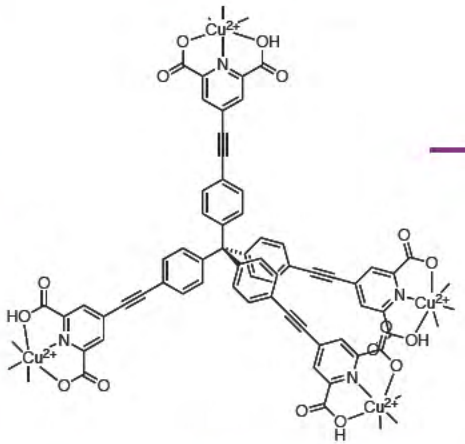
Glucose Sensor

Biomedical Technology - Imaging, Drug Delivery, Remediation



Porous Materials - Separation, Storage, Purification of Molecules

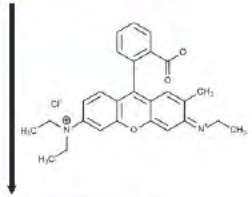


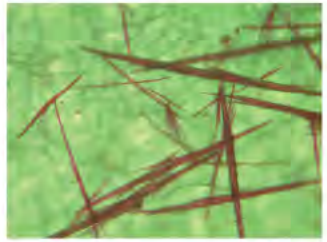


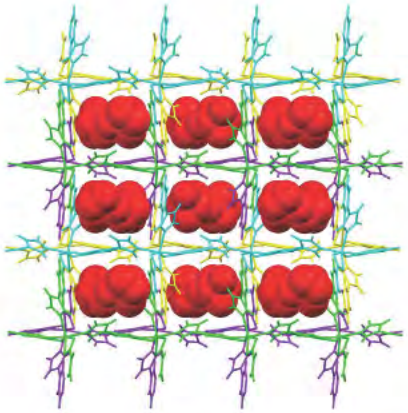
= tetrahedral linker ● = metal

organic building block

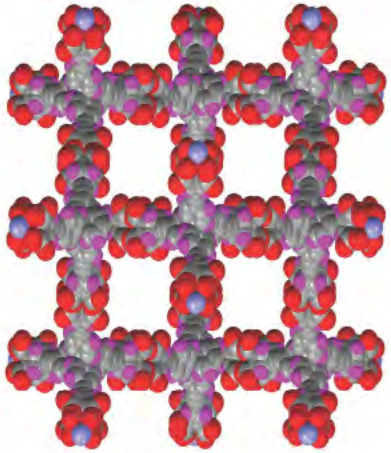
framework





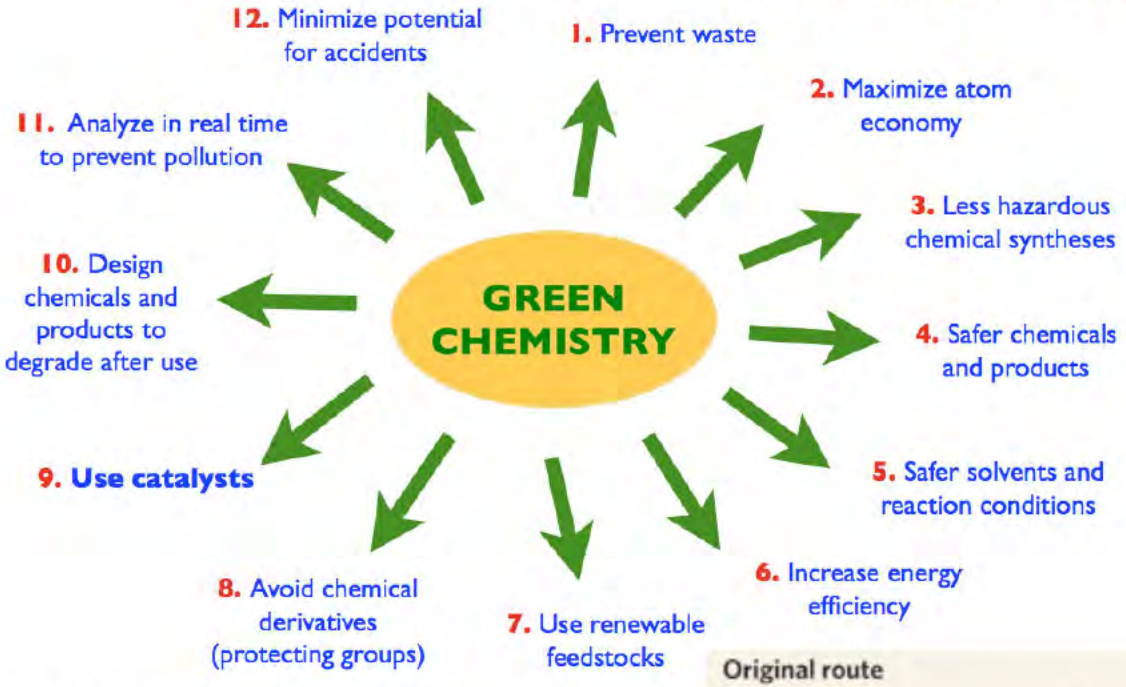


guest molecules sorbed inside

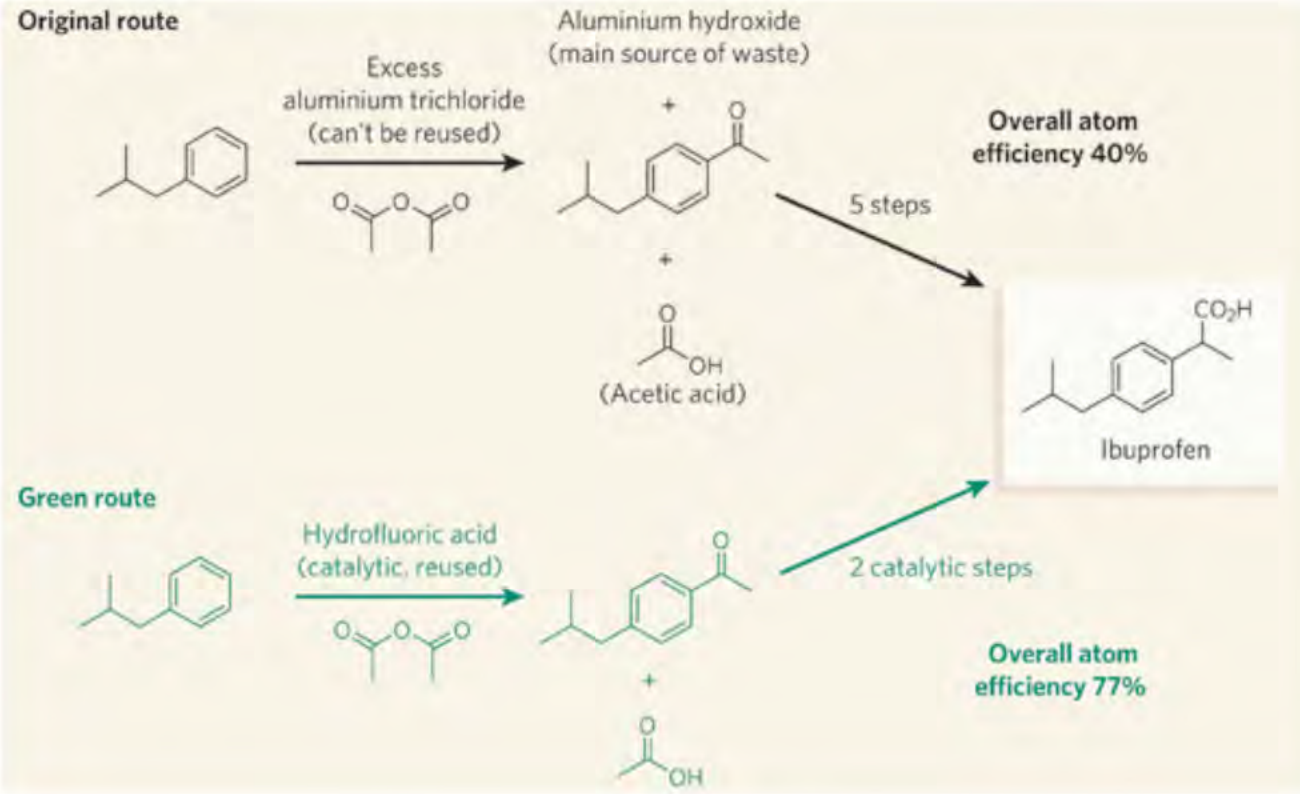


porous solid

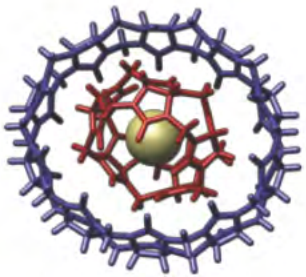
Green Chemistry

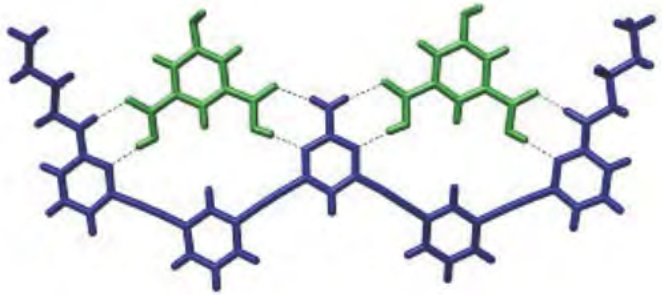


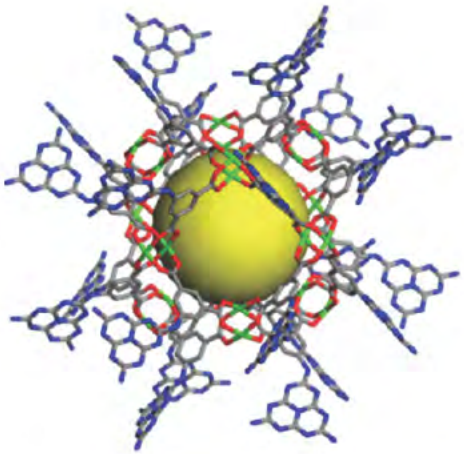
Anastas and Warner (1998)

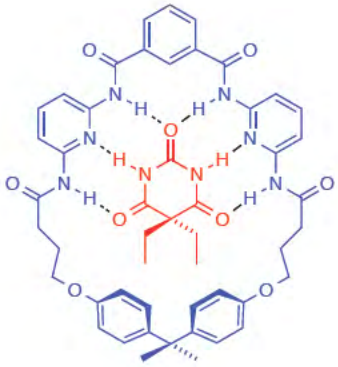


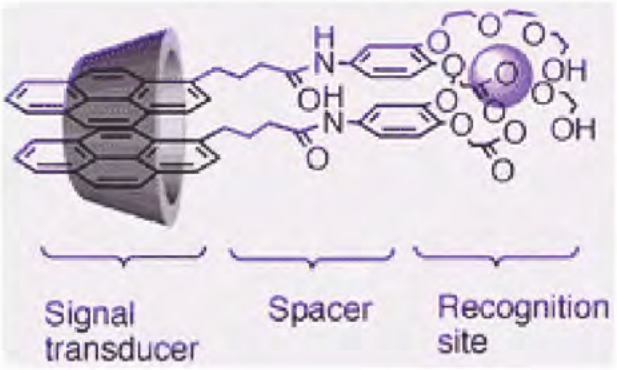
Supramolecular Chemistry - Complex Functional Materials

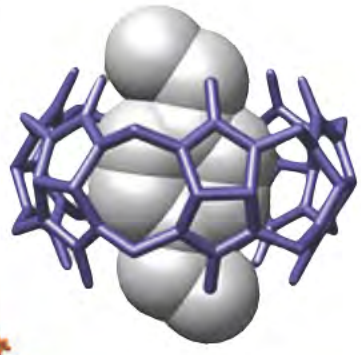


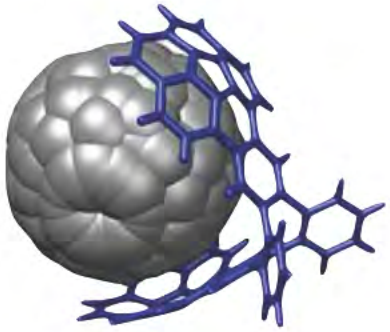


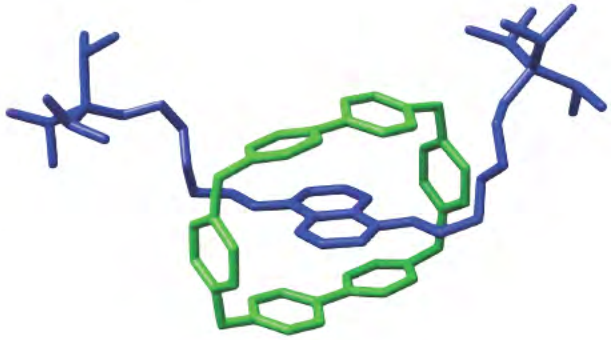


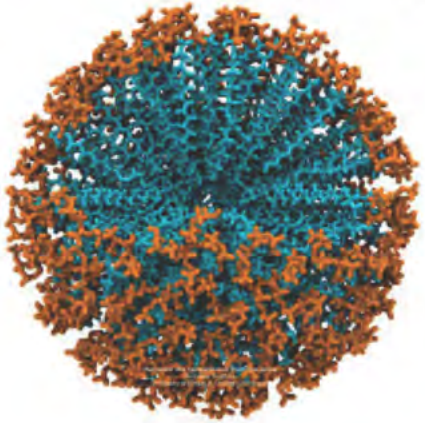




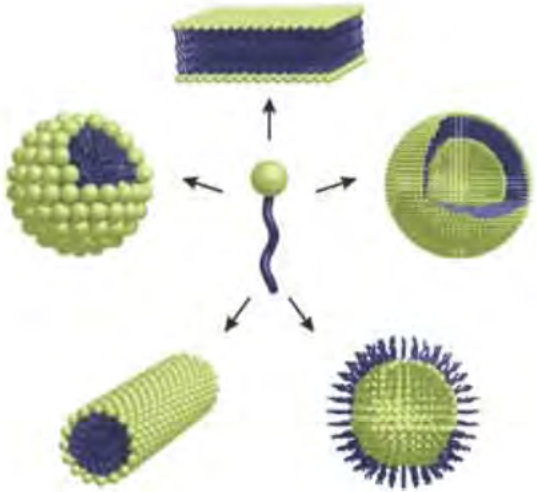


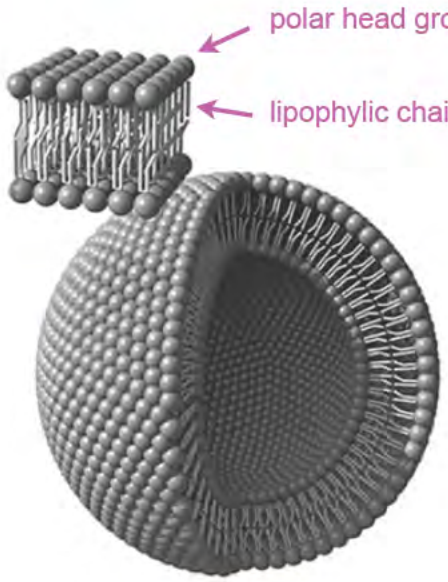




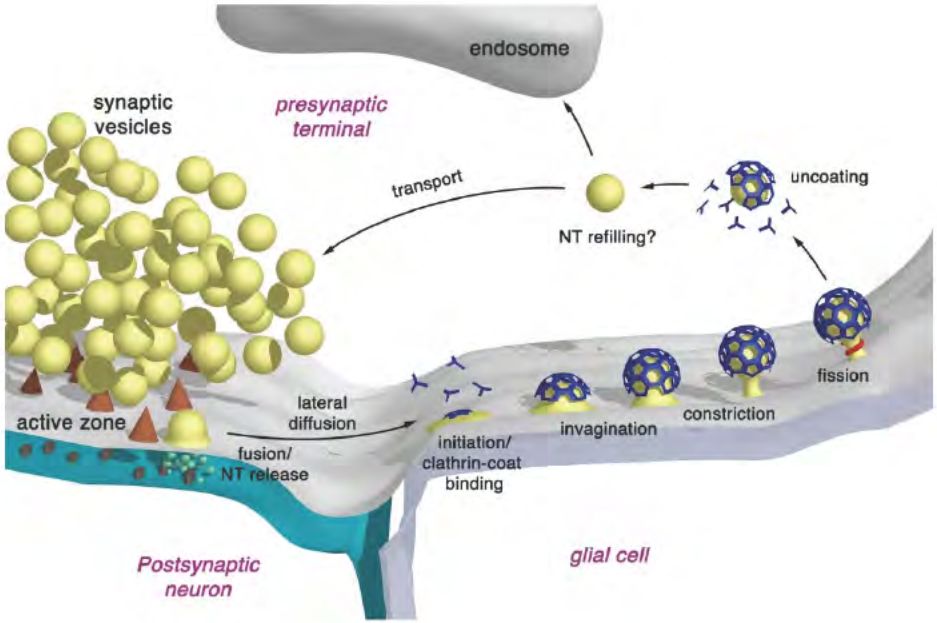


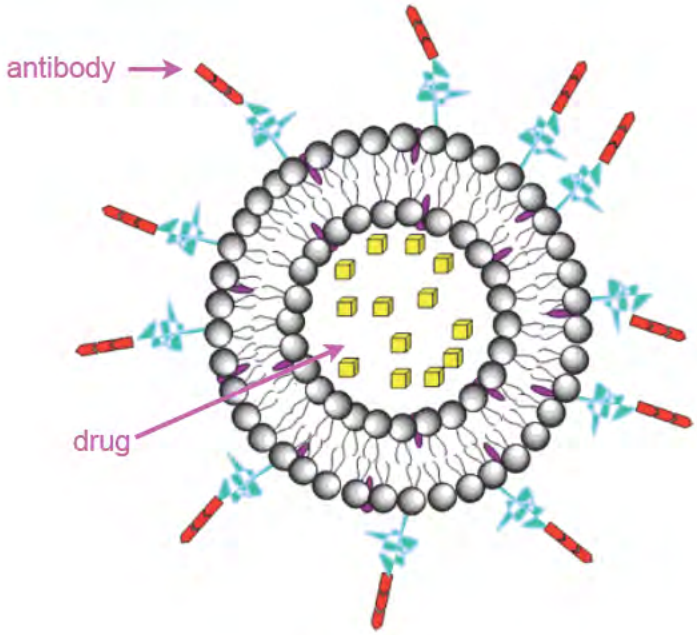
Supramolecular Capsules for Molecular Storage & Delivery

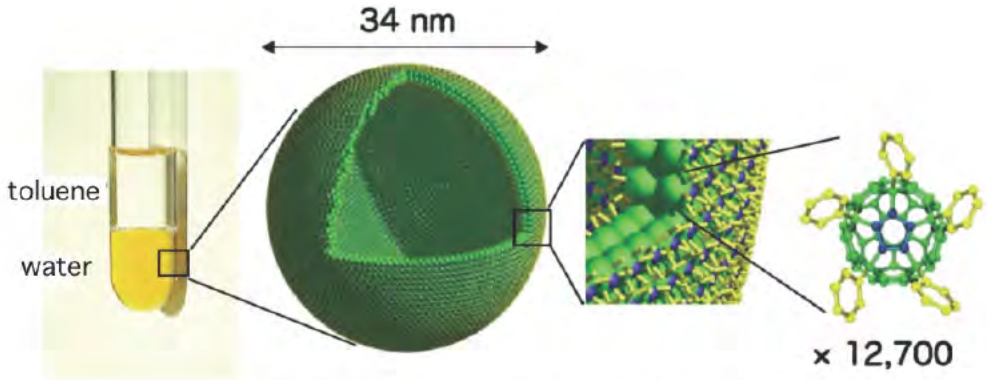




vessicle





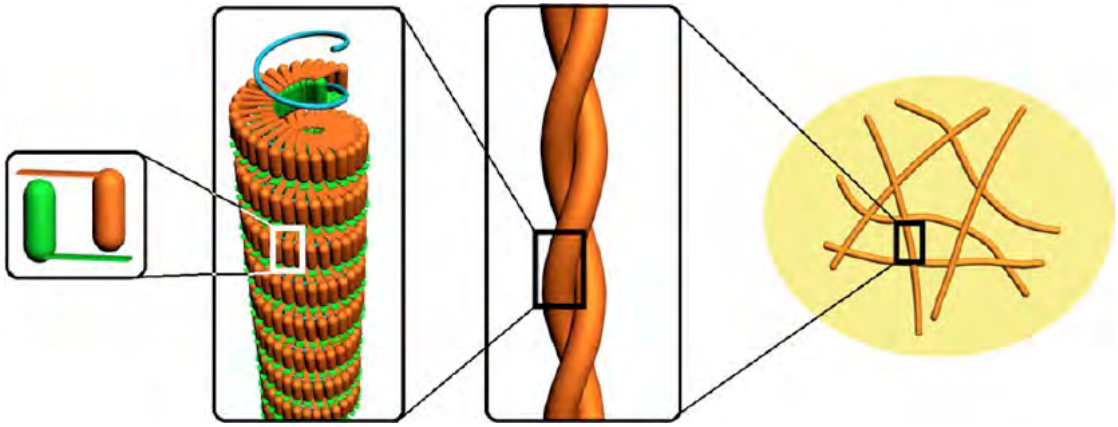


FULLERENE BILAYER VESICLE

Ferrocenoyl Phenylalanine: A New Strategy Toward Supramolecular Hydrogels with Multistimuli Responsive Properties

Zhifang Sun, Zhengyuan Li, Yonghui He, Rujuan Shen, Liu Deng, Minghui Yang, Yizeng Liang, and Yi Zhang

Publication Date (Web): August 11, 2013 (Article ASAP)
DOI: 10.1021/ja403345p, *J. Am. Chem. Soc.* **2013**, *135*, 13379−13386



"...a fluorenyl aromatic group could contribute to gelation via the formation of intermolecular π–π stacking interactions..."

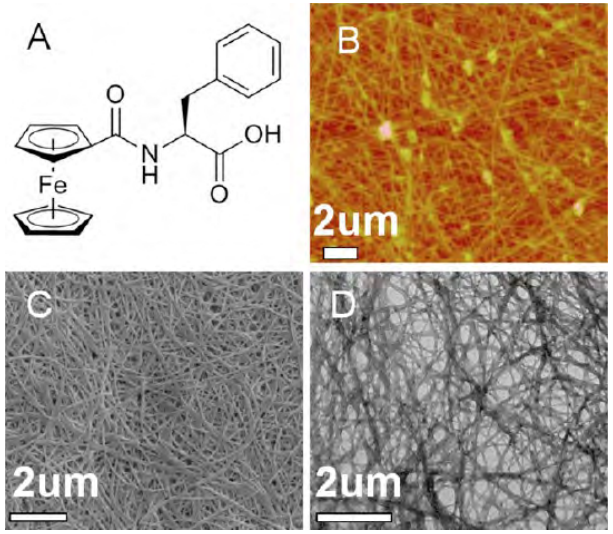


Figure 1. (A) Chemical structure of the gelator Fc-F. (B-D) AFM, SEM, and TEM images of the cryo-dried hydrogel, respectively.

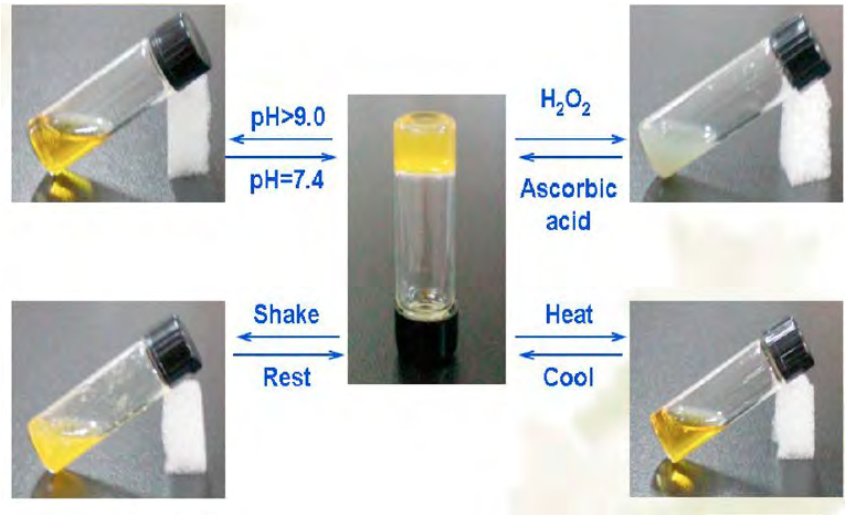
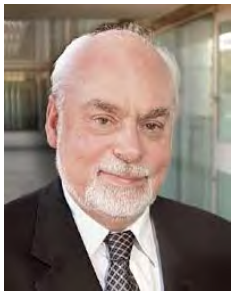


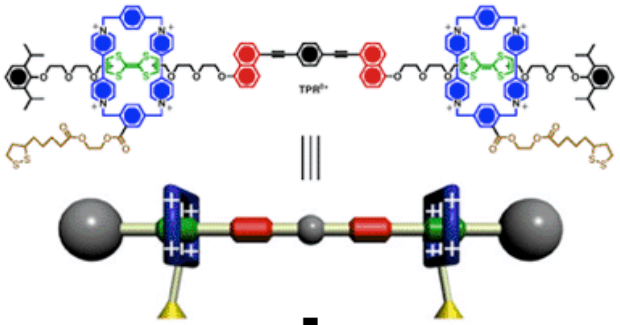
Figure 3. Reversible gel−sol transitions of the supramolecular hydrogel triggered by multiple stimuli (pH, chemical redox reaction, shear stress, and temperature, respectively).



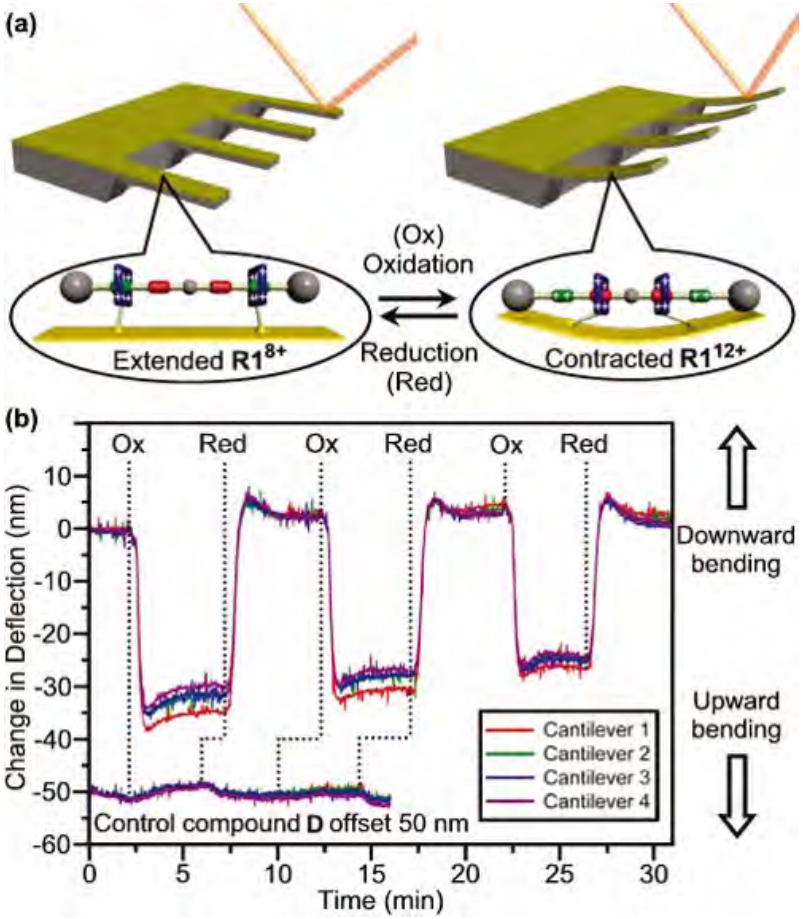
A nanomechanical device based on linear molecular motors

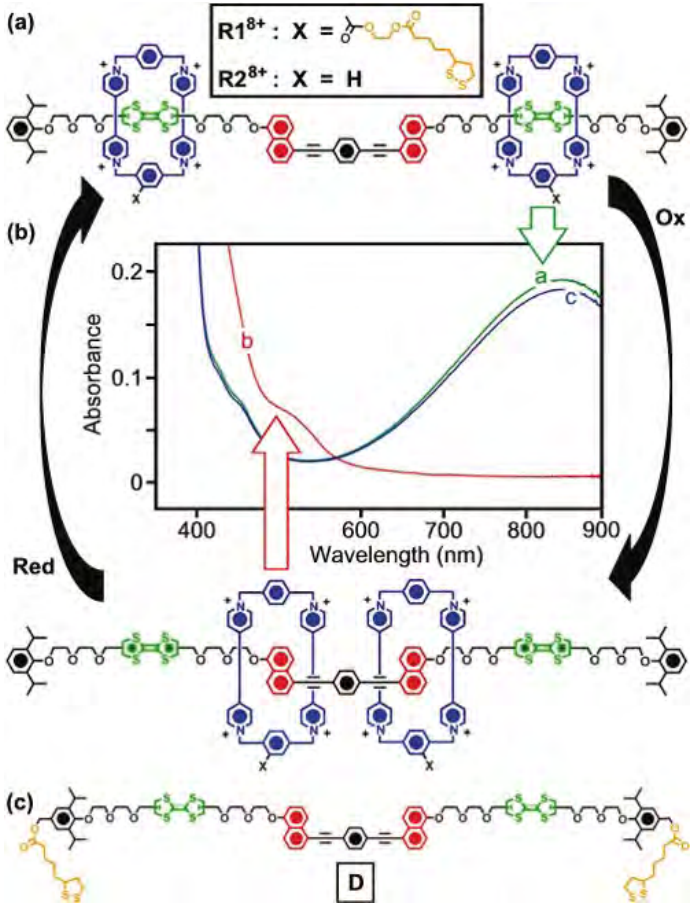
Tony Jun Huang, Branden Brough, Chih-Ming Ho, Yi Liu, Amar H. Flood, Paul A. Bonvallet, Hsian-Rong Tseng, J. Fraser Stoddart, Marko Baller and Sergei Magonov

Appl. Phys. Lett., 2004, 85, 5391-5393



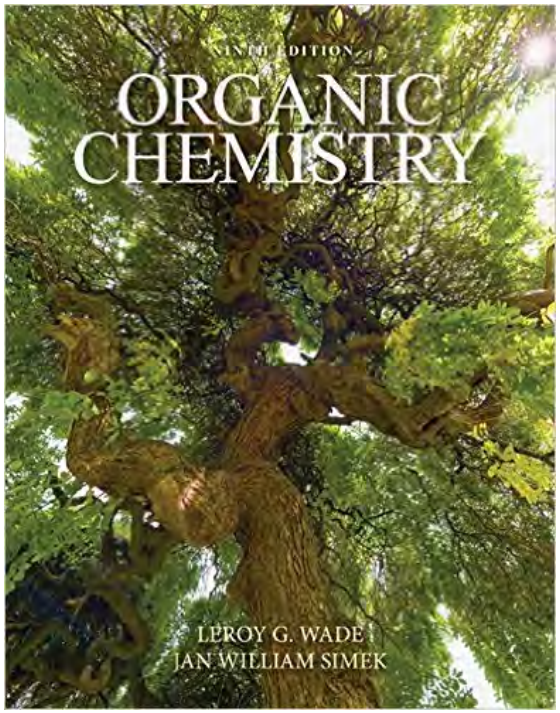
An array of microcantilever beams, coated with a self-assembled monolayer of bistable, redox-controllable [3]rotaxane molecules, undergoes controllable and reversible bending when it is exposed to chemical oxidants and reductants. Conversely, beams that are coated with a redox-active but mechanically inert control compound do not display the same bending. A series of control experiments and rational assessments preclude the influence of heat, photothermal effects, and pH variation as potential mechanisms of beam bending. Along with a simple calculation from a force balance diagram, these observations support the hypothesis that the cumulative nanoscale movements within surface-bound "molecular muscles" can be harnessed to perform larger-scale mechanical work.



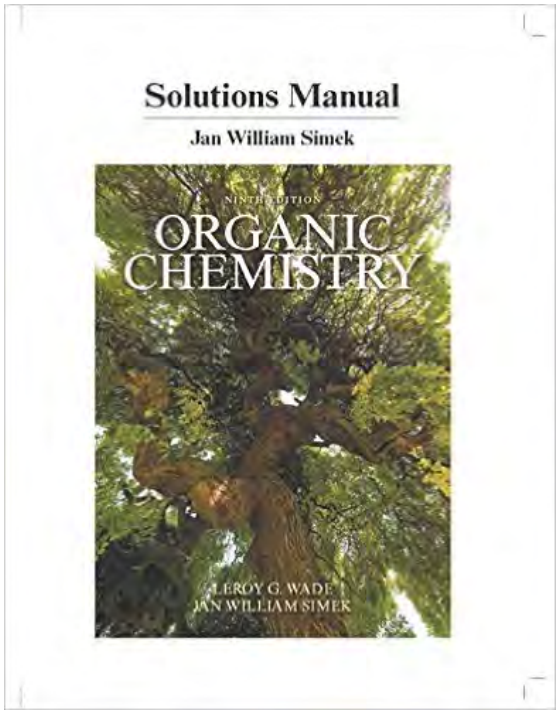


Materials for the Course

Text

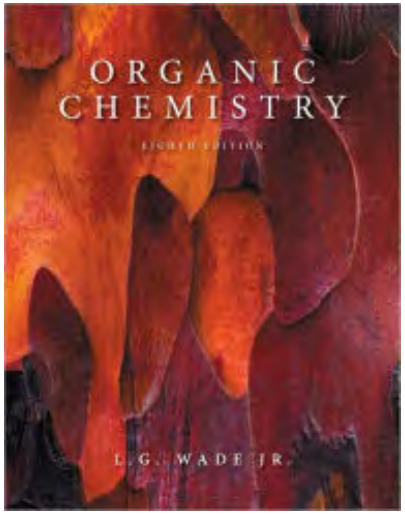


Wade, 9th Edition (required)



optional

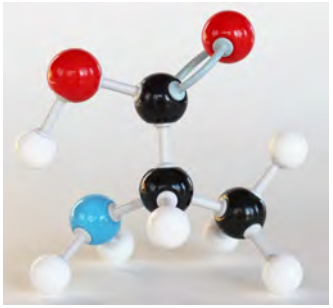
Can I use the 8th Edition?



Wade, 8th Edition

Molecular model kit: optional, but highly recommended

- Book Store
- Amazon



Duluth Labs Organic Chemistry Molecular Model Student Kit

MM-003 ($25)
ISBN-13: 978-0-9988678-0-9

MM-004 ($35)
ISBN-13: 978-0-9988678-1-6

Course Web Site

Canvas

All material for the course is posted

- syllabus
- lecture presentations in class
- handouts
- problem sets & solutions
- exams & solutions
- grades

Material in lectures will be presented using a combination of slides and chalk talks at the board

All presentations will be posted by chapter as PDF files

I recommend that you bring a laptop or tablet, or print PDF files of presentations and bring them to class

Topics Covered in CH2310

Chapter 1: Introduction and Review

Review on your own*

Chapter 2: Structure and Properties of Organic Molecules

Review on your own.* We'll go over some of this material as needed throughout the term

We'll start here

Chapter 3: Structure and Stereochemistry of Alkanes

Chapter 4: The Study of Chemical Reactions

We'll work this material into the context of Chapters 5-8

Chapter 5: Stereochemistry

Chapter 6: Alkyl Halides: Nucleophilic Substitution and Elimination

Chapter 7: Structure and Synthesis of Alkenes

Chapter 8: Reactions of Alkenes

Reading & Problems Sets

Reading

- You are responsible for all of the material in Chapters 1-8 and supplemental material covered in class or posted on the web site.
- We'll cover the most important concepts/material in lecture.
- It's difficult to do well in organic chemistry if you don't read the text!!!

Problem Sets

- Available on the course web site.
- Problem sets are not collected or graded.
- Set aside time each day to work on problems.
- Problems sets will include problems at the end of each chapter as well as additional problems I may provide.

I strongly encourage you to work on additional problems that have not been assigned to test your confidence at problem solving.

Exams & Final Grade

Exams

Three 50-minute exams will will count 100 points for a total of 300 possible points

Exam 1:	Wednesday, November 7
Exam 2:	Wednesday, November 28
Exam 3:	Friday, December 14

Final Grade

Your grade for the course will be calculated based on 300 total possible points for the four exams using the cutoffs indicated below.

A: 100-87% (300-261 total points)
B: 86-77% (260-231 total points)
C: 76-62% (230-186 total points)
NR: < 62% (185-0 total points)

Extra Help

Alli Ross

MASH Sessions:	Mondays	4 PM	Academic Resources Center (ARC)
	Tuesdays	7 PM	Exam Proctoring Center (EPC)
	Wednesdays	7 PM	Exam Proctoring Center (EPC)
	Thursdays	4 PM	Academic Resources Center (ARC)

One-on-one Tutoring: By appointment at http://tutortrac.wpi.edu

Why should I take CH2320 & CH2330?

A little about me….