I. Alkanes, $C_nH_{2n+2}$ (saturated hydrocarbons: no $C=C$ or $C≡C$)

*always 4 bonds on carbon

<table>
<thead>
<tr>
<th># Carbons</th>
<th>parent chain name</th>
<th>CH₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>ethane</td>
<td>CH₃CH₃</td>
</tr>
<tr>
<td>3</td>
<td>propane</td>
<td>CH₃CH₂CH₃</td>
</tr>
<tr>
<td>4</td>
<td>butane</td>
<td>CH₃CH₂CH₂CH₃</td>
</tr>
<tr>
<td>5</td>
<td>pentane</td>
<td>CH₃CH₂CH₂CH₂CH₃</td>
</tr>
<tr>
<td>6</td>
<td>hexane</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>heptane</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>octane</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>nonane</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>decane</td>
<td></td>
</tr>
</tbody>
</table>
A) Substituents

B) Other Groups: -F (fluoro), -Cl (chloro), -Br (bromo), -I (iodo),
-NO₂ (nitro), -NH₂ (amino), -OH (hydroxyl).

C) Naming: 1) Find the longest connected chain of carbon atoms (=skeleton).
2) Number the chain from #1→ end, starting with the end having the most
substituents. (Substituents should have the smallest number possible.)
3) Name:
(# of carbon)-(substituent) ….(parent chain)

Ex. 1) 3-methyl hexane
Ex. 2) 2-chloro-4-ethyl heptane
*List substituents in alphabetical order, not in order of numbers.

Ex. 3) 2,5-dibromo-3-methyl hexane
*For identical: 2 = di, 3 = tri, 4 = tetra

Ex. 4) 3,3-difluoro heptane
Ex. 5) cyclopropane

Ex. 6) 1-chloro-2-methyl cyclobutane

Ex. 7) Draw 2-chloro-3-isopropyl-5-methyl octane

Ex. 8) Draw 2-bromo-5-chloro-6,6-diethyl-3-methyl-4-tert-butyl nonane
II. Alkenes, C\textsubscript{n}H\textsubscript{2n} (unsaturated hydrocarbons, C=C)

A) Naming:
1) Find the longest carbon chain containing the double bond.
2) The double bond gets the smallest number possible.
   (other substituents don’t matter)
3) The smallest number of the double bond goes in front of the parent name.
   \[ \uparrow \]
   replace –ane with -ene
4) Treat substituents as before.

Ex. 1) 5-bromo-3-heptene

Ex. 2) 2,7-dichloro-6-ethyl-4-nonene
Ex. 3) Cis/Trans Isomers

\[
\text{cis-2-pentene} \quad \text{trans-2-pentene}
\]

Ex. 4) 2,4-hexadiene

Cycloalkenes:
Start numbering at the double bond and go across it, so that the nearest substituent has the lowest number possible.

Ex. 1) 3-chloro cyclopentene
\{3-chloro-1-cyclopentene (1 is understood, if not written)\}
III. Aromatic Compounds, $C_nH_n$
-6 member ring with alternating double bonds

**Each bond is 1 ½ bonds!**

Ex. 1)

1,2-dibromo benzene
ortho-dibromo benzene
$\sigma$-dibromo benzene

1-bromo-3-chloro benzene
meta-bromochloro benzene
m-bromochloro benzene

1-fluoro-4-iodo benzene
para-fluoroiodo benzene
p-fluoroiodo benzene

Ex. 2) 2-hydroxyl-3-methyl-5-propyl-1,3-cyclohexadiene
Ex. 2) 2-phenyl-undecane

- Toluene
- Phenol
- Ortho-xylene (2 methyls)
- Styrene
- Naphthalene
- Anthracene
-alkenes from before (C=C)

A) Alkynes

\[ \text{CH}_3-\text{C}≡\text{C}-\text{CH}-\text{CH}_3 \]

Ex. 1) 4-nitro-2-pentyne

B) Alcohols

\[ \text{R-OH} \]

\[ \text{CH}_3 \quad \text{OH} \quad \text{CH}_3 \]

\[ \text{CH}_3-\text{CH}-\text{CH}-\text{CH}_2-\text{CH}-\text{CH}_3 \]

← \( \text{R} \) equals the carbon/hydrogen chain

*OH gets the smallest number

Ex. 1) 2,5-dimethyl-3-hexanol

C) Ethers

\[ \text{R'-O-R} \]

\[ \text{CH}_3-\text{CH}_2-\text{O}-\text{CH}_2-\text{CH}_2-\text{CH}_3 \]

short chain, oxy, then long chain

Ex. 1) ethoxypropane

D) Aldehydes

\[ \text{R'-C-H} \]

\[ \text{CH}_3-\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{C}-\text{H} \]

Ex. 1) 5-bromo hexanal
E) Ketones

C=O gets the smallest # possible

Ex. 1) 7-bromo-3-nonanone

F) Carboxylic Acids

Ex. 1) 2,3-dimethyl pentanoic acid

G) Esters

Ex. 1) methyl propanoate

↑ substituent
H) Amides

\[ \text{peptide bond} \]

Ex. 1) N,N-methyl ethyl propanamide

I) Amines

Ex. 1) 2-amino-5-methyl heptane
   1° (primary) amine

Ex. 2) N-ethyl propanamine
   2° (secondary) amine

Ex. 3) N-propyl, N-isopropyl butanamine
   3° (tertiary) amine
I. Proteins
The 20 amino acids are the building blocks of all proteins.

- carboxylic acid

amino acid \( R = H, \text{CH}_{3}, \text{etc.} \) (see textbook for amino acids)

- peptide linkage (amide)

This molecule is a dipeptide, a natural polymer.

Collagen is 3 protein chains twisted together to form a super helix.
(H-bonding occurs between the chains.)

The amino acid cystein, \( R = \text{CH}_{2}\text{SH} \) can form links between chains too.
a.a.\(-\text{CH}_{2}\text{S}\text{S} -\text{CH}_{2}\text{a.a.} \) (The disulfide linkage is a true bond, unlike a H-bond.)

Proteins: Include collagen (tendons, muscles), hemoglobin (carries O\(_2\) in blood), antibodies, enzymes, some hormones etc.
II. Carbohydrates
such as starch and cellulose are polymers of simple sugars (monosaccharides).

↑ fructose (honey, fruit), glucose, ribose, galactose

sucrose (table sugar) is a disaccharide of glucose and fructose.

D-glucose  D-fructose

The orientation of the attack determines α or β.

Starch (plant carbohydrate reservoir) is a polymer of α-D-glucose. Cellulose (plant fiber, cotton) is a polymer of β-D-glucose.
III. Lipids (Fats, Fatty Acids)  \( \text{CH}_3(\text{CH}_2)_n\text{CO}_2\text{H} \)

- \( n = 16 \) stearic acid  **saturated fats (alkanes- full of hydrogen)
- \( n = 2 \text{ & } 4 \) butter  **unsaturated fats (alkenes- hydrogen can add on C==C)
- \( n = 18 \) peanut oil
- \( n = 10 \) coconut oil

IV. Nucleic Acids

- DNA  deoxyribonucleic acid (molecular masses = several billion g/mol)
- RNA  ribonucleic acid (20,000 – 40,000 g/mol)

These sugars are bonded together with phosphate linkages to bases and the bases stick together to make a double helix.
For cell division:

1) DNA has a double helix with complementary bases on the two strands. (cysteine – guanine, and thymine – adenine)

2) The DNA unwinds and each half gets new partners, thus the DNA is replicated to transfer the genetic code when the cell divides.

Protein Synthesis:
1) Part of the DNA, a gene, holds the codes for a specific protein.
2) A complementary m-RNA (messenger) strand is copied and transferred to the cytoplasm. A t-RNA (transfer) finds bases and makes a protein complementary to the m-RNA. (It makes a copy of the part of the DNA that was copied, like a copying machine.)

*End of Notes*