LIPIDS, FATS, AND STEROIDS

Lipids

- Energy storage in cell membrane and regulators of cell metabolism.
- Lipids are hydrophobic biological compounds that are insoluble in water, but soluble in nonpolar solvent such as benzene, chloroform and ether.
- They are present in the nonaqueous biological phase such as plasma membrane.
- Cells can alter the mix of lipids (lipoproteins and lipopolysaccharides) in their membrane
  - to compensate for changes in temperature or
  - to increase their tolerance to the presence of chemical agents such as ethanol.

Fatty acids

- The major component in most lipids
- Made of a straight chain of hydrocarbon (hydrophobic) group, with a carboxyl group (hydrophilic) at the end.
- A typical saturated fatty acid has the form of

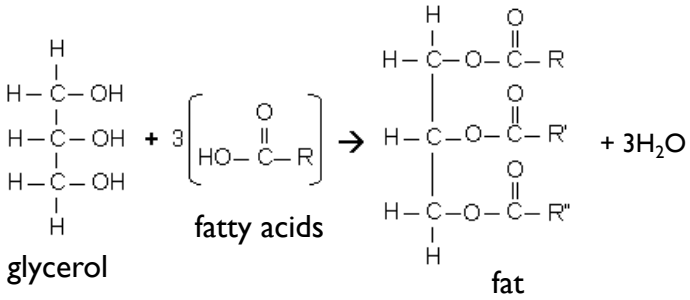
  $CH_3–(CH_2)_n–COOH$

  where (*n*) is typically between 12 and 20.
- Unsaturated fatty acid contain double –C=C– bond such as oleic acids:

  $CH_3–(CH_2)_7–HC{=}CH–(CH_2)_7–COOH$

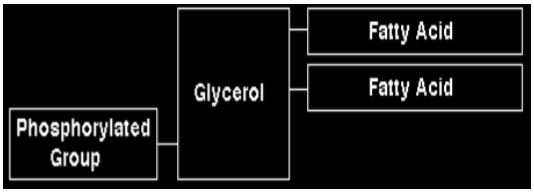
Fats

- Lipids that can serve as biological fuel-storage molecules.
- Esters of fatty acids with glycerol



Phospholipids

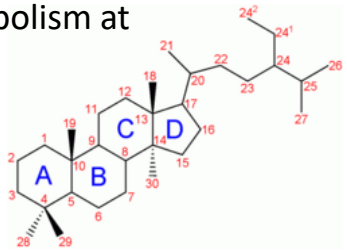
- **Phospholipids** such as glycerophospholipids are built on a glycerol core to which are linked two fatty acid-derived "tails" by ester linkages and one "head" group by a phosphate ester linkage.



- Phospholipids are key components to control the entry or exit of molecules in the cell membrane.

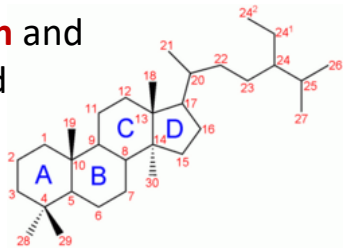
Steroids

- A lipid characterized by a carbon skeleton with four fused rings.
- Different steroids vary in the functional groups attached to these rings.
- Naturally occurring steroids are hormones that are important regulators of animal development and metabolism at very low concentrations (~ 10^{-8} M)



Steroids

- **Cholesterol** is a well known steroid presents in membranes of animal tissues.
  - It is a precursor of many steroids.
- **Cortisone** is an anti-inflammatory used to treat rheumatoid arthritis and some skin diseases.
- Derivatives of **estrogen** and **progesterone** are used as contraceptives.



NUCLEIC ACIDS, RNA, AND DNA

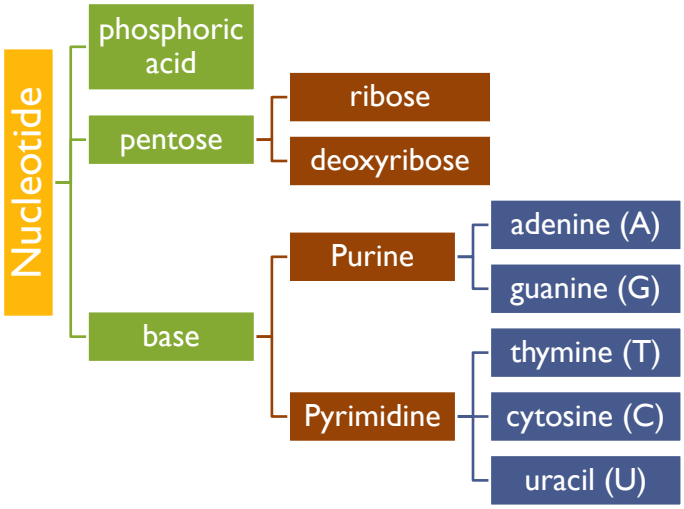
Nucleic Acids, RNA, and DNA

- **Nucleic acid** is a complex, high-molecular-weight biochemical macromolecule composed of nucleotide chains.
- The most common nucleic acids are:
  - Deoxyribonucleic acid (DNA) that stores and preserves genetic information
  - Ribonucleic acid (RNA) that plays a central ole in protein synthesis
- Nucleic acids are found in all living cells.

Nucleotides

- **Nucleotides** are the building blocks of DNA and RNA.
- **Nucleotides s**erve as molecules to
  - store energy and
  - reducing power.

Nucleotides Components



Nucleotides Storing Energy

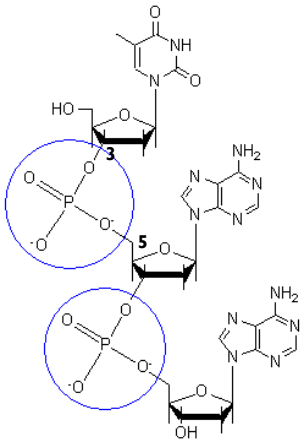
- Adenosine triphosphate (ATP) and guanosine triphosphate (GTP) are the major sources of energy for cell work.
  - The phosphate bonds in ATP and GTP are high-energy bonds.
  - The formation of phosphate bonds or their hydrolysis is the primary means by which cellular energy is stored or used.

Nucleotides Reducing Power

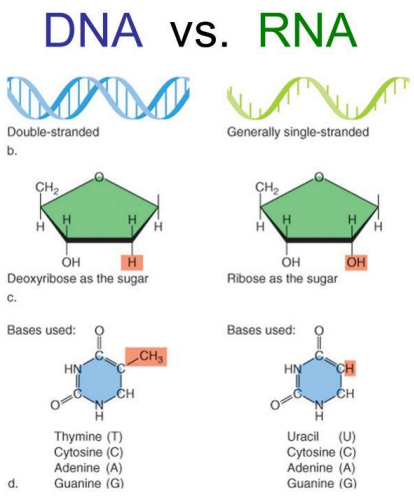
- The two most common carriers of reducing power are nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP).
  - Cells store and release hydrogen atoms from biological oxidation-reduction reactions by using those nucleotide derivatives (NAD and NADP).

Nucleotides as Monomers

- Nucleotides are important monomers.
- DNA and RNA are formed by the condensation of nucleotides.
- The nucleotides are linked together between the 3' and 5' carbons' successive pentose (sugar) rings by phosphodiester bonds

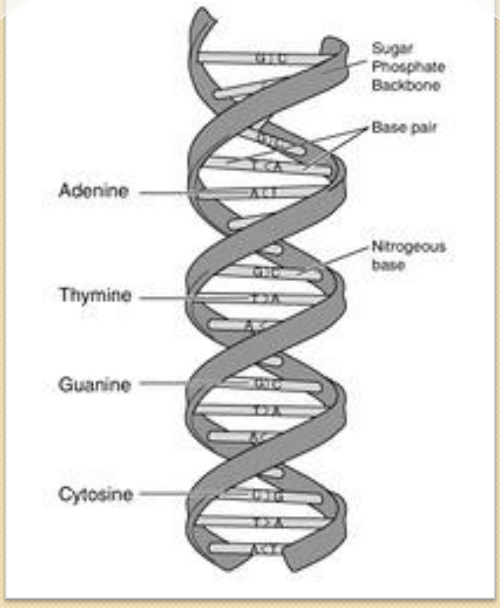


DNA and RNA Comparison



Deoxyribonucleic Acid (DNA)

- Deoxyribonucleic acid (DNA) is formed by condensation of deoxyribonucleotides.
- DNA is a very large threadlike macromolecule (MW, $2x10^9$ D in E. coli).
- DNA molecules are two stranded and have a double-helical three-dimensional structure.
- The **sequence of base** in DNA carries genetic information.
- The sugar an phosphate groups perform structural role.
- DNA contains adenine (A) and guanine (G), thymine (T) and cytosine (C).



DNA Double-helical Structure

Double Helical DNA Structure

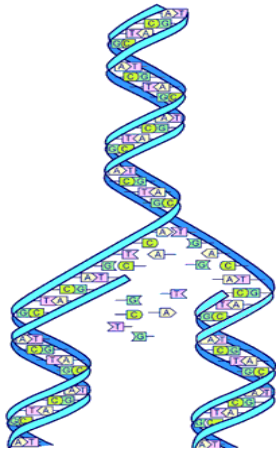
- The phosphate and deoxyribose units are on the outer surface, but the bases point toward the chain center. The plane of the bases are perpendicular to the helix axis.
- The diameter of the helix is 2 nm, the helical structure repeats after ten residues on each chain, at an interval of 3.4 nm.

Double Helical DNA Structure

- The two chains are held together by hydrogen bonding between pairs of bases:
  - Adenine (A) ↔ Thymine (T) by two H-bonds
  - Guanines (G) ↔ Cytosine (C) by three H-bonds
- The sequence of bases along a DNA strand is not restricted in any way, although each strand must be complementary to the other. The precise sequence of bases carries genetic information.

DNA Replication

- Regeneration of DNA from original DNA segments.



http://highered.mcgraw-hill.com/sites/0072437316/student_view0/chapter14/animations.html#

DNA Replication

- DNA helix unzips and forms two separate strands.
- Each strand will form a new double strands.
- The two resulting double strands are identical, and each of them consists of one original and one newly synthesized strand.
  - This is called semiconservative replication.
- The base sequences of the new strand are complementary to that of the parent strand.

Ribonucleic Acid (RNA)

- **Ribonucleic acid (RNA)** is formed by condensation of ribonucleotides.
- RNA is a long, unbranched macromolecule and may contain 70 to several thousand nucleotides.
- RNA molecules are usually single stranded.
- RNA contains adenine (A), guanine (G), cytosine (C) and uracil (U).
- A $\leftrightarrow$ U, G $\leftrightarrow$ C are present in some double helical regions of t-RNA.

Classification of RNA

- **Messenger RNA (m-RNA):** synthesized on chromosome and carries genetic information to the ribosomes for protein synthesis.
  It is a large molecule and has short half-life.
- **Transfer RNA (t-RNA):** a relatively small and stable molecule that carries a specific amino acid from the cytoplasm to the site of protein synthesis on ribosomes.
- **Ribosomal RNA (r-RNA):** the major component of ribosomes, constituting nearly 65%. r-RNA is responsible for protein synthesis.
- **Ribozymes:** RNA molecules that have catalytic properties.

Summary of Cell Construction

Biopolymers	protein	Carbohydrates (polysaccharides)	DNA	RNA	lipids
subunit					
bonds for subunit linkage					
functions					
Characteristic three-D structure					