Lecture 3
Biopolymers

- Carbohydrates
- Nucleic Acids
- Proteins
Functional Group Summary

Alcohol

Ether

Thiol

Aldehyde

Ketone

Phosphate

Carboxyl

Ester

Amide
A carboxylic acid and an amine combine through a condensation reaction to form a...

- Carboxylic acid
- Amine
- Amide
- Ester
- Ether
- Ketone

25%  1. Amide
25%  2. Ester
25%  3. Ether
25%  4. Ketone
Condensation Reaction

- For instance, nylon is a polyamide
Monosaccharides

- 20 natural kinds, mostly in 2 types
  - **Pentoses** (5 carbons – ribose)
  - **Hexoses** (6 carbons – glucose, fructose)
- Hexoses can have either 5 or 6-member rings
- All have an ether O in the ring
  - Ether is the starting point for numbering

![Molecular structures of ribose, fructose, and α-glucose](image)
Monosaccharides (part deux)

- Each has several possible isomers
  - Starch (yummy) contains $\alpha$-glucose
  - Cellulose (yucky) contains $\beta$-glucose

Note little typo in book in Fig 13-16
Polysaccharides

- Monomers are joined by condensation reaction to make an ether linkage
  - The ether O is called the glycosidic oxygen
- Important class of molecules
  - Storage of carbohydrates (starches, glycogen)
  - Structural materials (cellulose, chitin)

Cellulose and chitin are made from β-glucose – they form sheets interconnected by either H-bonds or amide bonds.

Starch is made from α-glucose and forms long strands that clump together.
Importance of Nucleic Acids

- All genetic information is stored by DNA
- RNA transmits that information from the nucleus out to the cytoplasm, where proteins are synthesized
- RNA is primary component of ribosome
- RNA also important in regulation and a number of other roles
- Accuracy is important. Sickle-cell results from a one AA mutation
Nucleic acid structures

Note purine/pyrimidine typo in book figure 13-22

- G
- A
- T/U
- C

- Individual nucleic acids are connected by sugars and phosphate groups.
  - Sugar part of linkage is either ribose or deoxyribose
What type of chemical reaction joins two DNA monomers together?

| 25% | 1. Free-radical |
| 25% | 2. Redox       |
| 25% | 3. Substitution|
| 25% | 4. Condensation|
Nucleic acid structures

- Addition of sugar and phosphate result in the monomer units for polymeric DNA and RNA.

The order of nucleic acids is called the primary structure or the sequence.

(ACGT in this example)
Secondary Structures

- Double-helix structure of DNA elucidated in 1953 by Watson & Crick (data from Wilson & Franklin)
- Earlier Chargaff showed that ratios of A:T = 1 and C:G = 1
- Hydrogen bonds drive ‘base pairing’—Called Watson-Crick pairs
- H-bonds hold two strands together very specifically—allows damage to be sensed and repaired
- Dispersive interactions from the bases ‘stacking’ on one another is also very important to stability of double-helix
RNA forms various structures

- Less tendency to ‘pair’
- More flexibility
- Variety of structures allows variety of function
- Structure and function are intimately connected in all of biology

Transfer RNA – carries amino acid monomer to ribosome

HIV-1 initiation complex
Amino Acids

- 20 different monomers, differ only in ‘sidechain’
- Sidechains differ in polarity (hydrophobicity), charge, size – Chemistry!

Polar side chains:

- Serine (Ser)
- Threonine (Thr)
- Aspartic acid (Asp)
- Glutamic acid (Glu)
- Asparagine (Asn)
- Glutamine (Gln)
- Cysteine (Cys)
- Lysine (Lys)
- Arginine (Arg)
- Histidine (His)
- Tyrosine (Tyr)

Nonpolar side chains:

- Glycine (Gly)
- Alanine (Ala)
- Valine (Val)
- Isoleucine (Ile)
- Leucine (Leu)
- Methionine (Met)
- Phenylalanine (Phe)
- Tryptophan (Trp)
- Proline (Pro)
Primary Structure

- Condensation rxn makes polyamides (like nylon, kevlar)
- Order of AAs is called the primary structure or the (protein) sequence
- Small proteins are called peptides
  - Many modern drugs are peptides, or peptide-like
Secondary Structure

• The 3-D structure that an amino acid makes with its neighbors is called the secondary structure
• Two most common types
  – Helix, or $\alpha$-helix
  – Sheet, or $\beta$-sheet
Tertiary Structure

• How pieces of secondary structure pack together
• Usually a mix of multiple kinds of secondary structure
• Remember: structure ↔ function
Today

• Seminar this afternoon

Monday

• Finish CAPA #3
• READ Chapt 14