

Nucleic Acids

Nucleotide

DNA

Nucleic acid

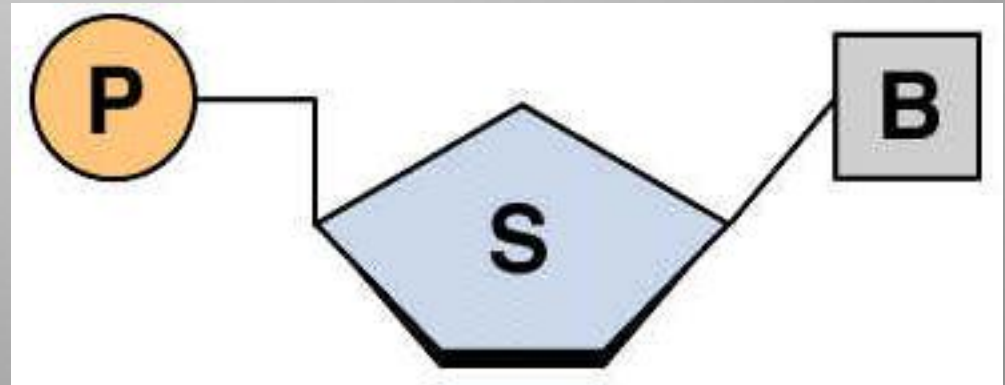
- Informational macromolecule
- Store hereditary information
- The only molecules in existence that can produce identical copies of themselves
- 2 types: DNA & RNA

Other Function

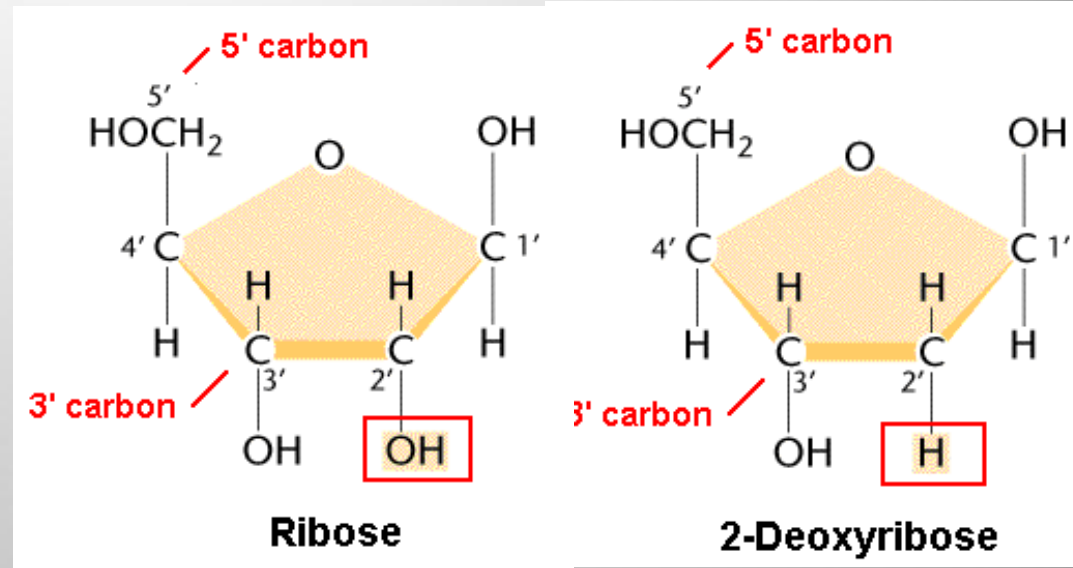
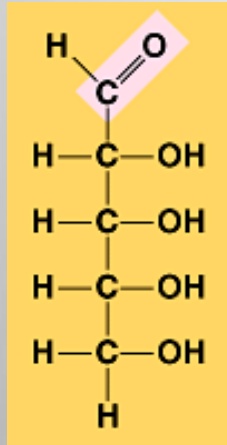
- Chemical energy (e.g. ATP)
- Combine with other groups to form enzymes (e.g. Coenzyme A comes from ADP)
- Signal molecule (e.g. cAMP)
- Evidence for evolution: more closely related species contain similar DNA sequences

Monomer: Nucleotide

- The single unit of nucleic acids is a **nucleotide**
- A **nucleotide** consists of 3 subparts:
 - Sugar (2 types)
 - Base (5 types)
 - Phosphate (1-3)



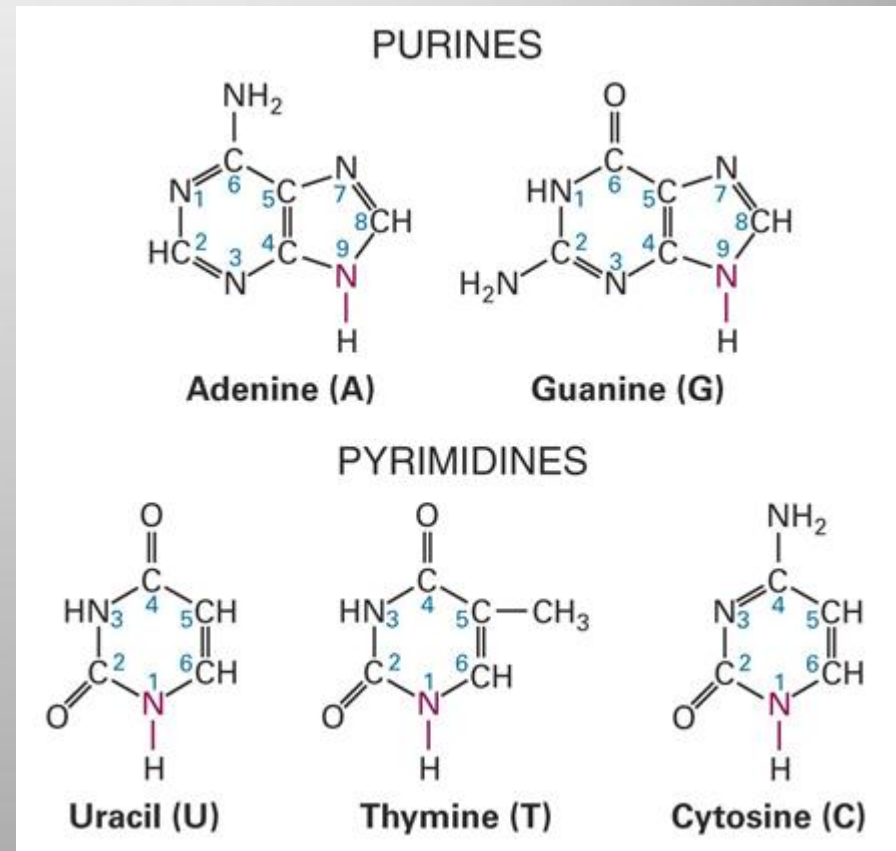
Pentose sugar



- 5 carbons:
 - Recall from linear carbohydrates
 - note the “prime” numbering system
- 2 types:
 - Ribose (for RNA)
 - Deoxyribose (for DNA): missing an oxygen at the 2' position

Nitrogenous base

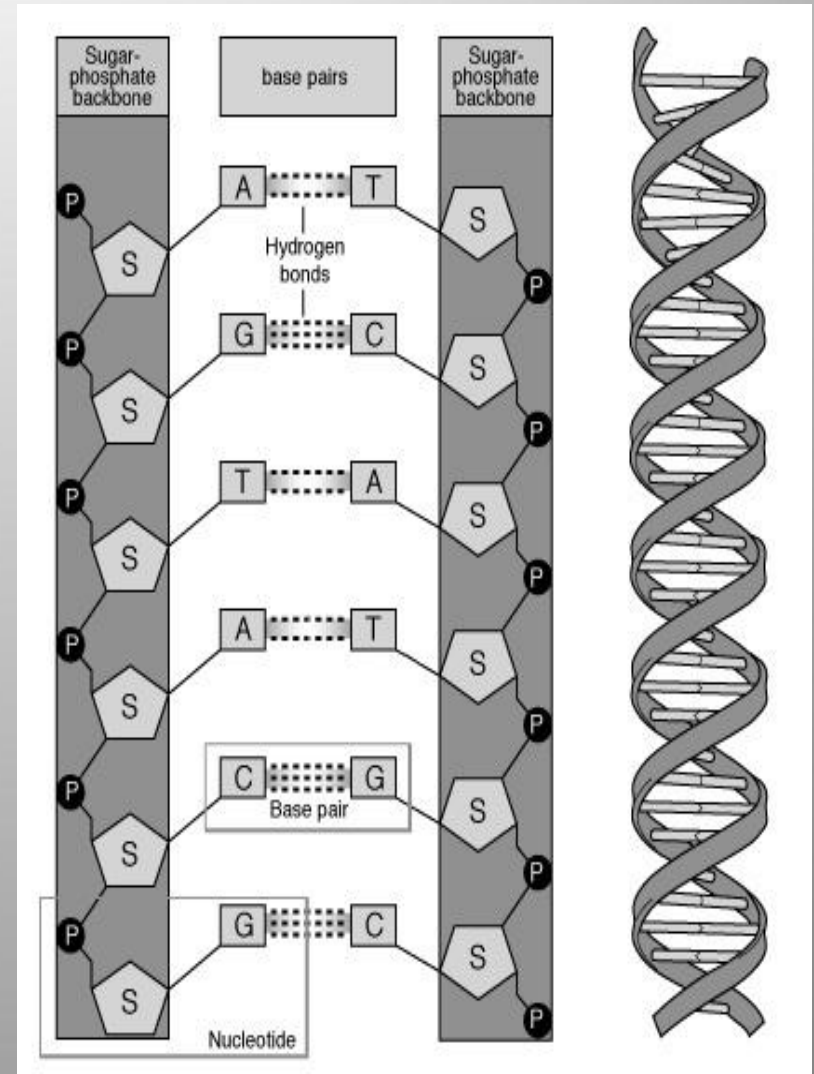
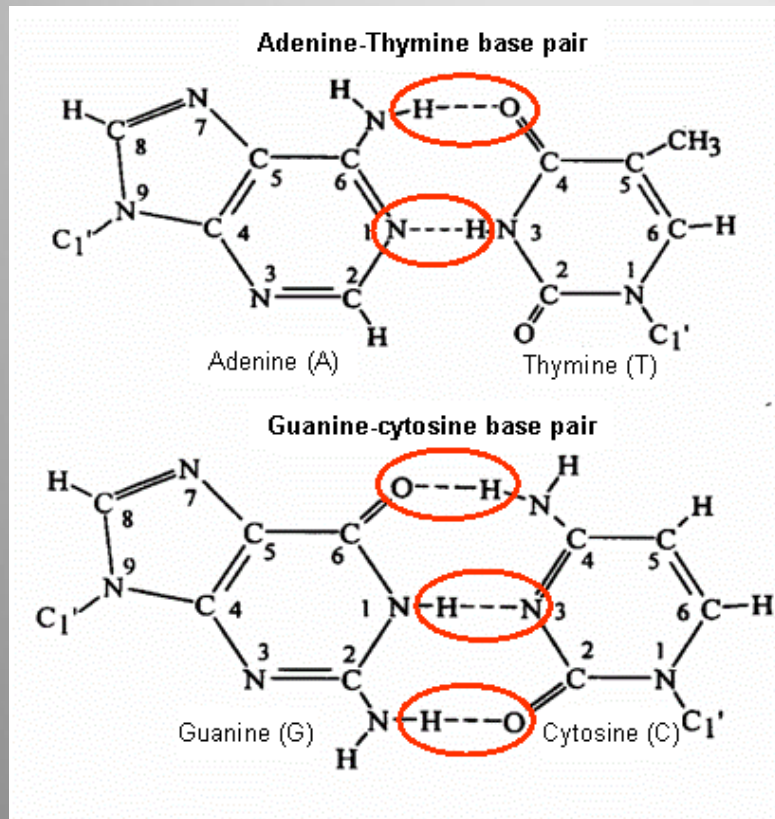
- Rings of C & N
- Purine:
 - 2 fused rings
 - A, G
- Pyrimidine
 - single 6 sided rings
 - C, T (DNA), U (RNA)



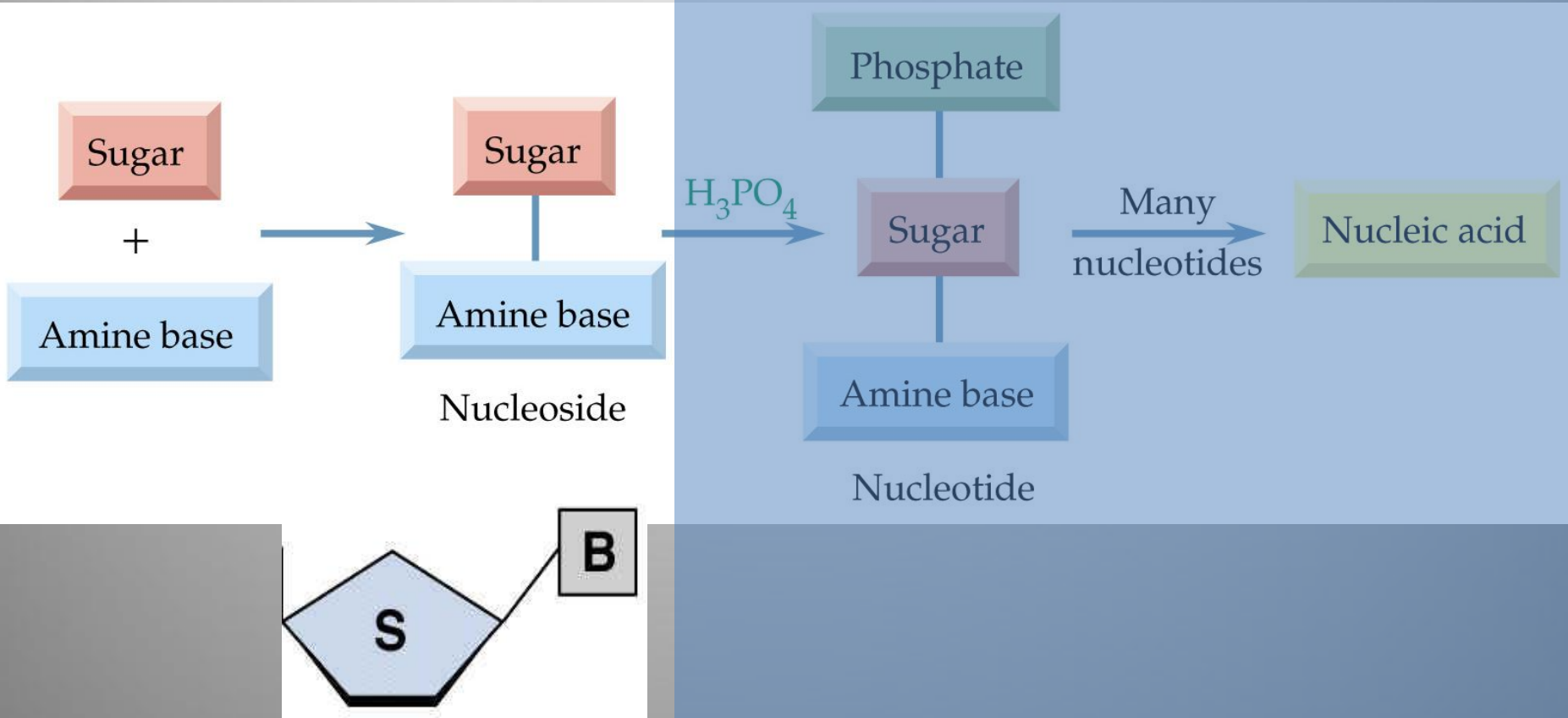
Nitrogenous base comparison

	Purine (large)	Pyrimidine (small)
2 H-bonds	A	T, U
3 H-bonds	G	C

A and T/U by 2 H- bonds G and C by 3 H-bonds

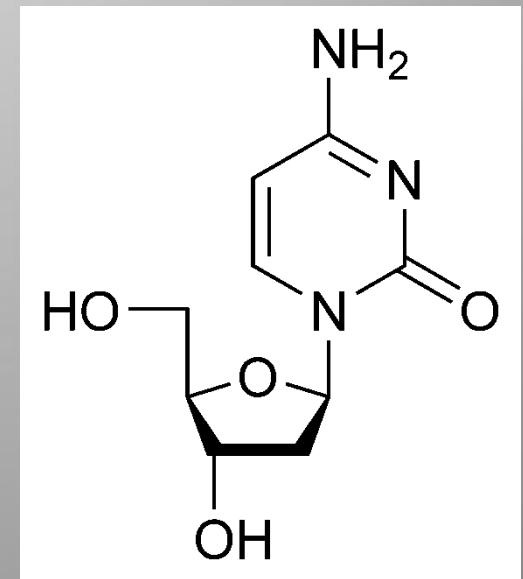
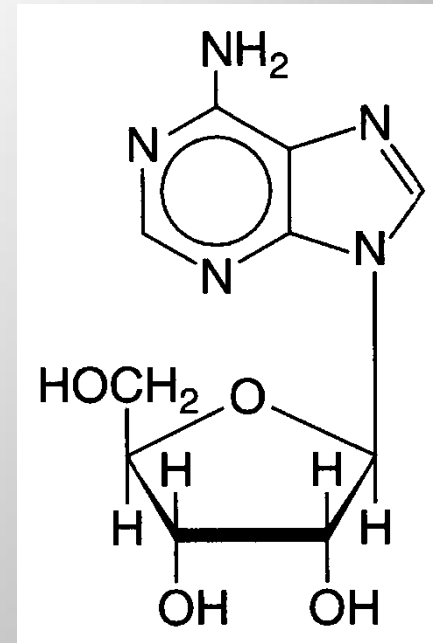


Building the nucleic acid



Nucleoside

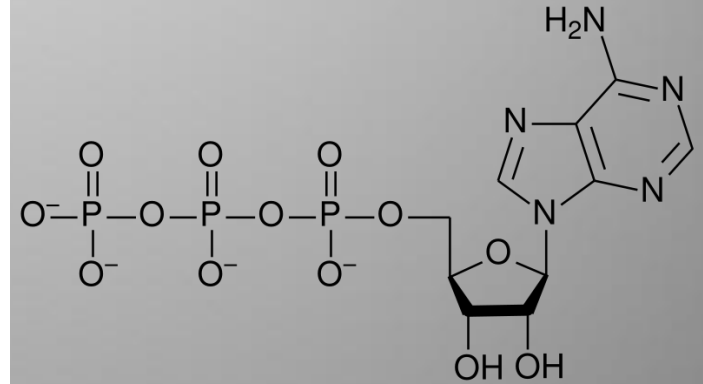
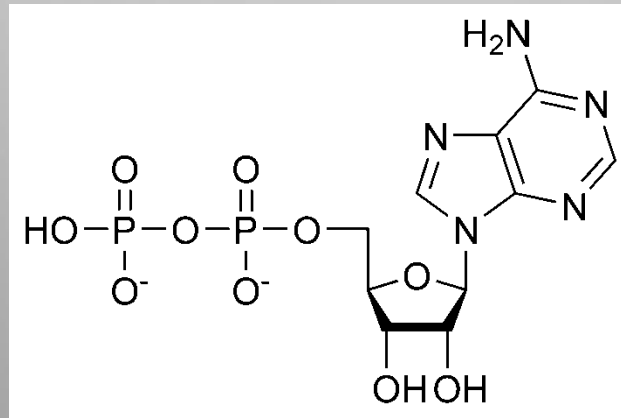
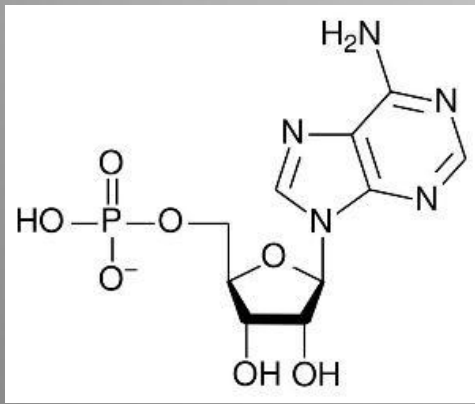
- Sugar + base connected by an N-glycosidic bond
- Condensation reaction between OH on 1' (anomeric) carbon of the sugar and H on base



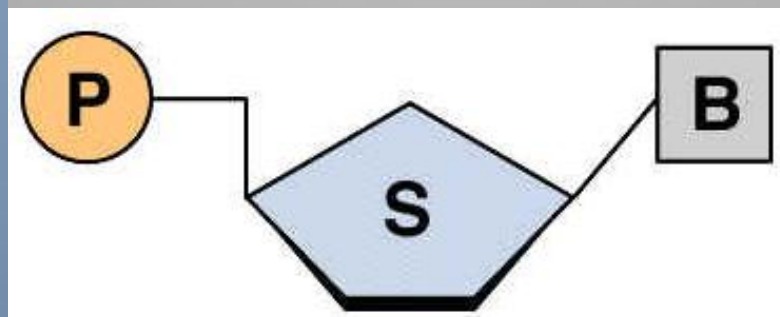
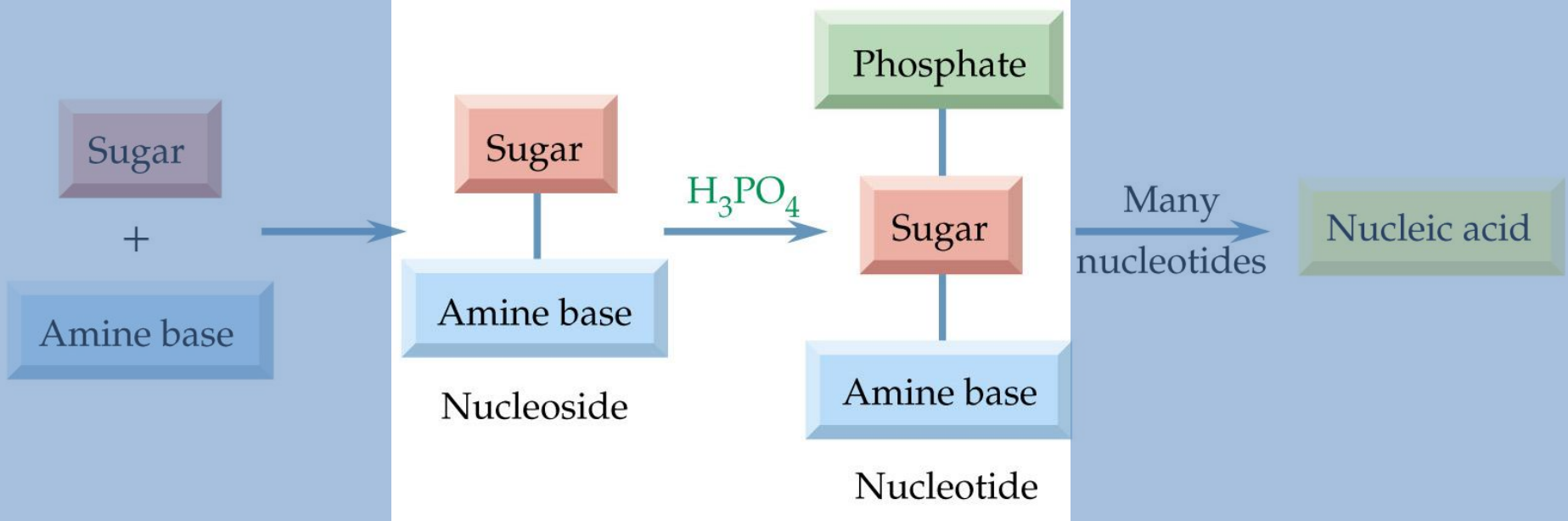
- Name of base changing ending
 - Adenine → adenosine
 - Guanine → guanosine
 - Cytosine → cytidine
 - Thymine → thymidine
 - Uracil → uridine
- May need a deoxy prefix if sugar is a deoxyribose
 - (e.g. deoxycytidine)

Phosphate

- Anywhere from 1-3 phosphate molecules
- Attached to sugar at 5' carbon
- Naming system uses prefix: mono, di, tri



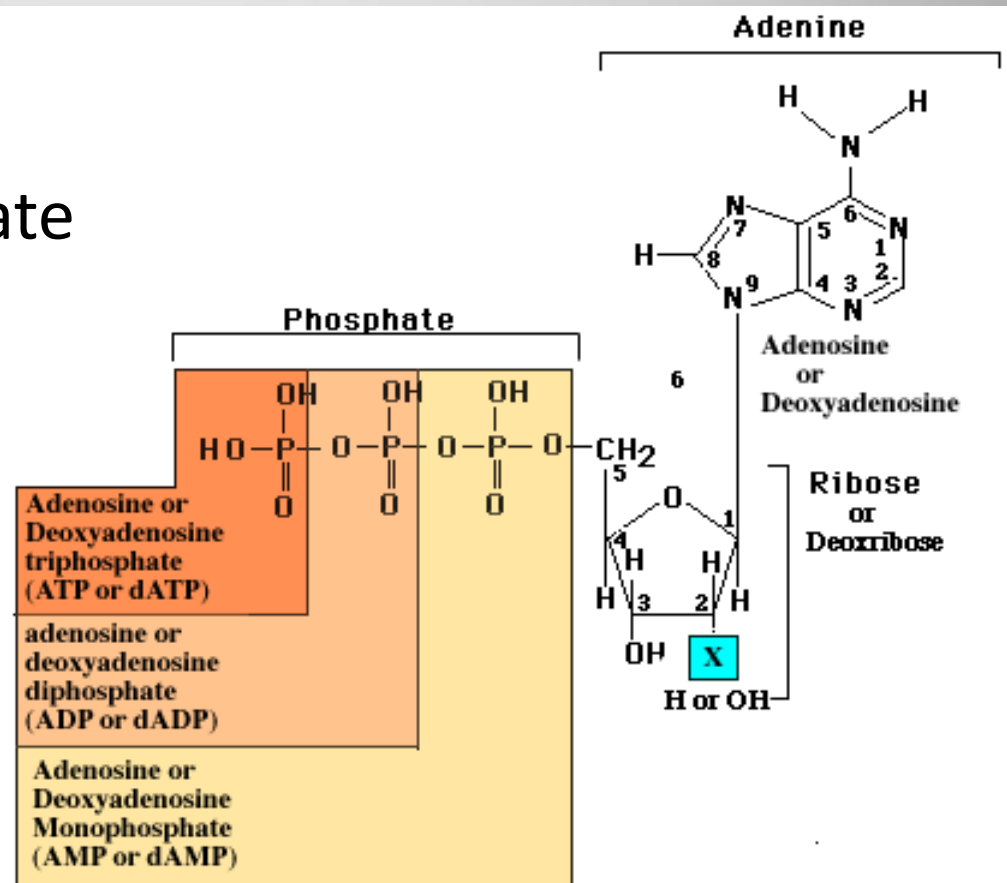
Building the nucleic acid



Naming a nucleotide

- Nucleoside name + prefix-phosphate
- 3 letter short forms
 - e.g. ATP

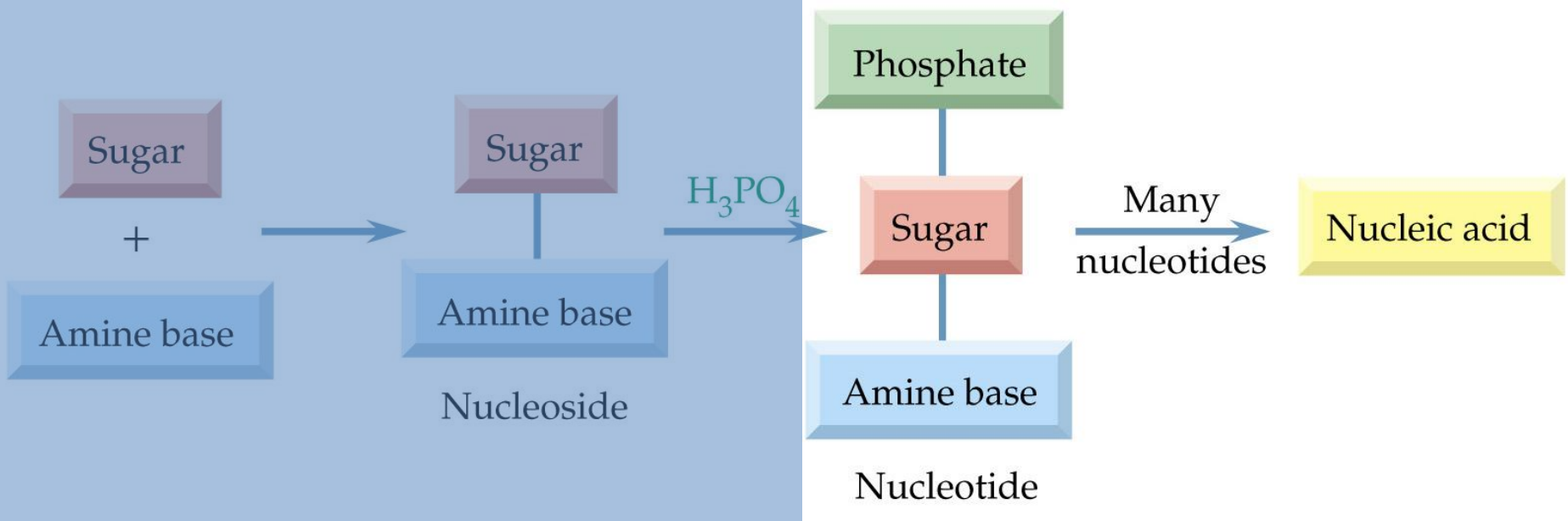
Adenosine Triphoshate



Nucleotide Nomenclature

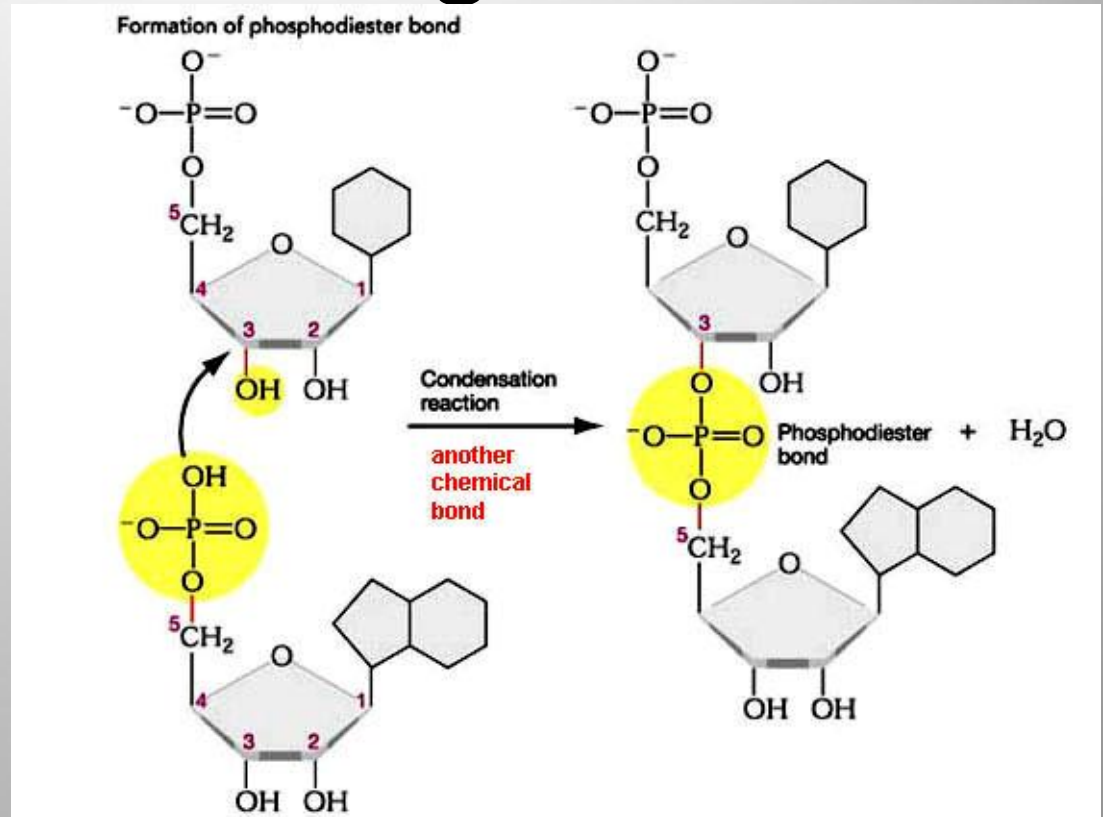
- Practice: Write the full and 3 letter short form name for a nucleotide that has a pyrimidine base that forms 3 H-bonds, a ribose sugar and 2 phosphate groups
- Practice: Write the full and 3 letter short form name for a nucleotide that has a purine base that forms 3 H-bonds, a deoxyribose sugar and 1 phosphate group

Building the nucleic acid



Nucleotide Chain: Single strand

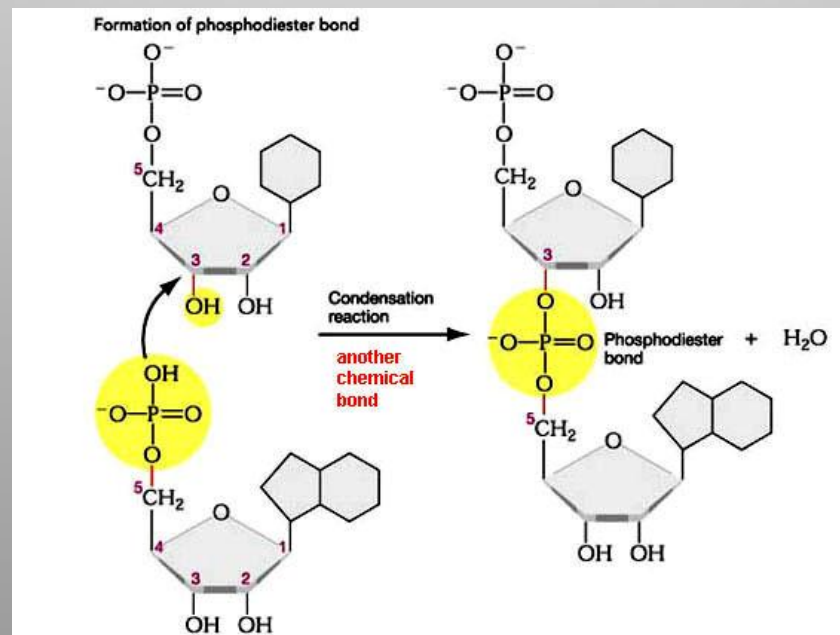
- Identify the 2 major groups involved in the reaction to form a nucleic acid chain
- What is the name of the reaction?
- **Phosphodiester** bond formed



Phosphodiester Bond

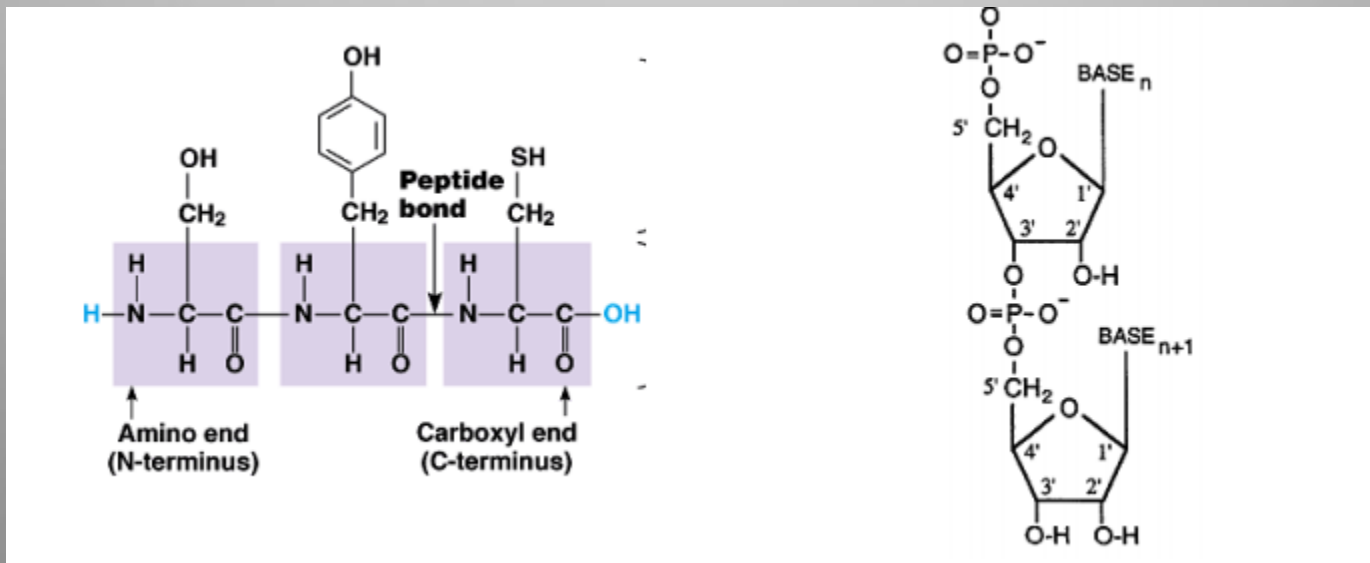
Condensation reaction between

- pentose sugar 3' OH group of one nucleotide
- 5' phosphate group of another nucleotide



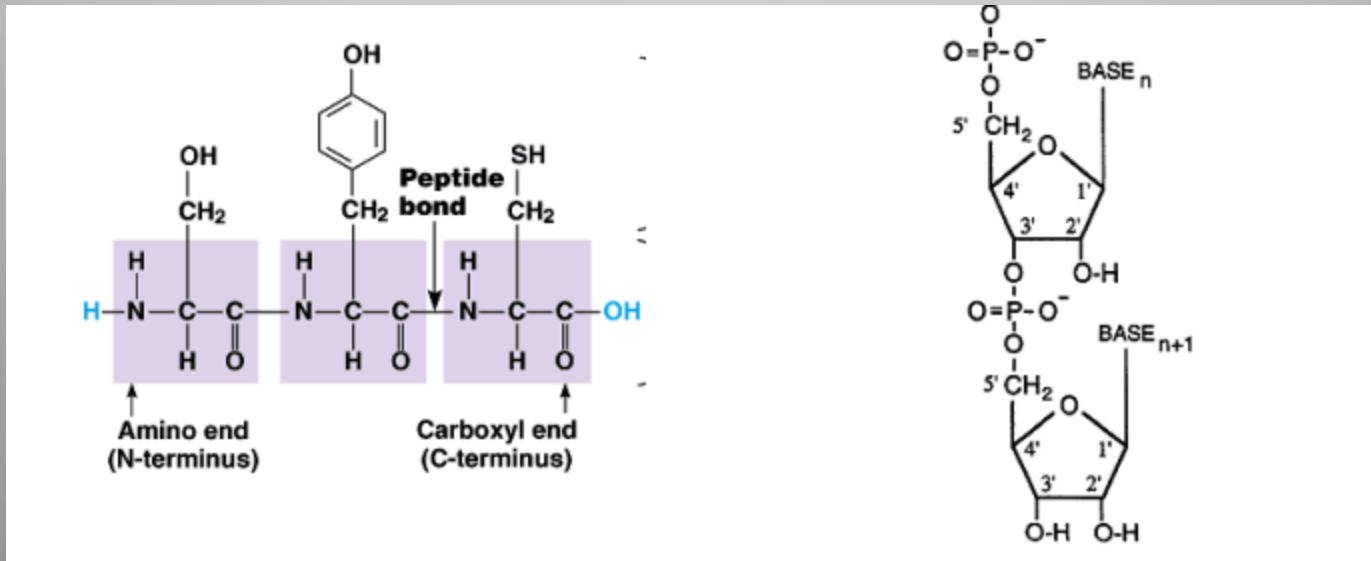
Nucleotide Chain: Structure

- Recall: What makes up the polypeptide backbone? What groups are hanging off?
- What makes up the nucleotide chain backbone? What groups are hanging off?

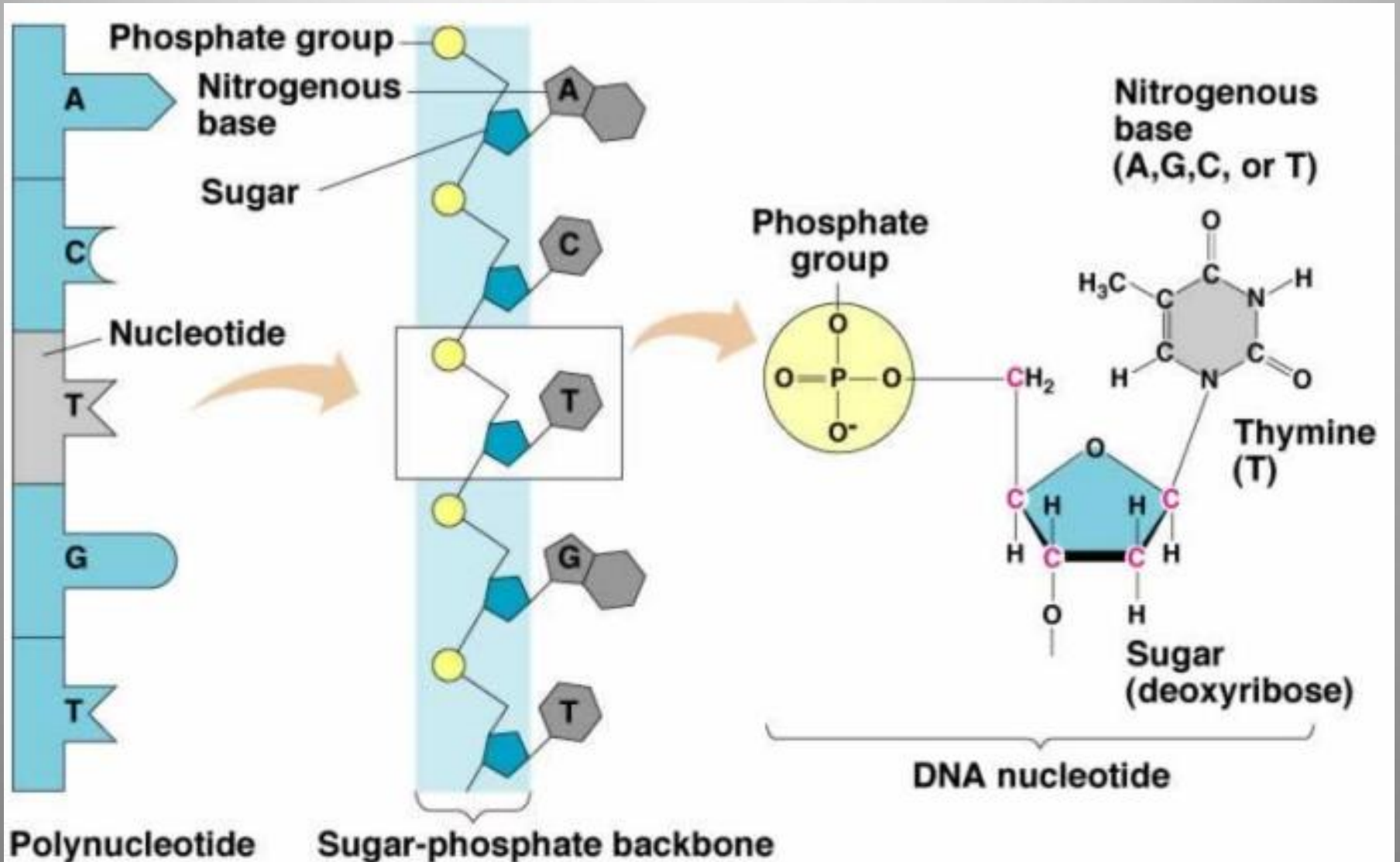


Nucleotide Chain: Direction of Growth

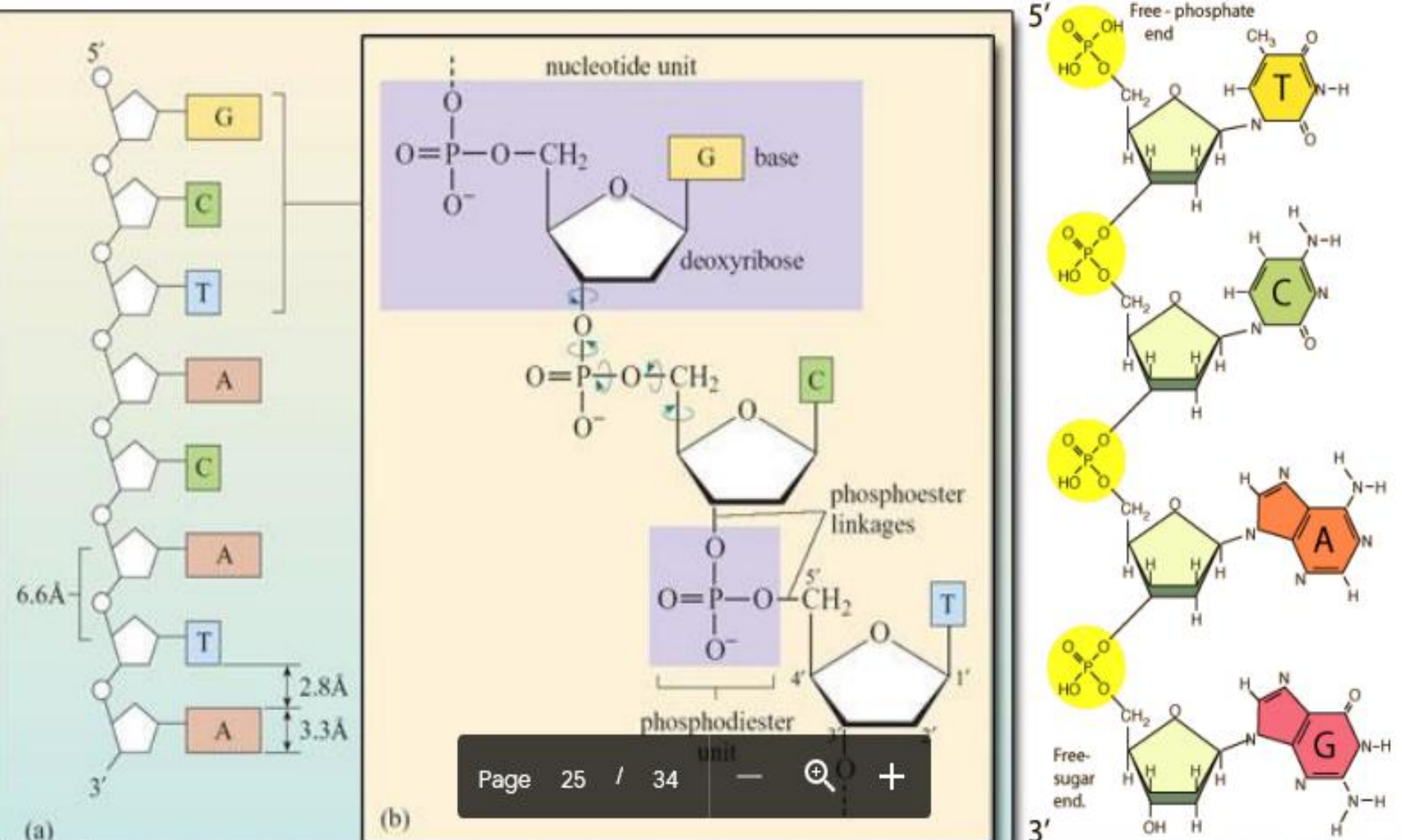
- Recall: What direction does a polypeptide chains grow in?
- What direction does the nucleotide grow in?



Nucleotide chain: Single strand

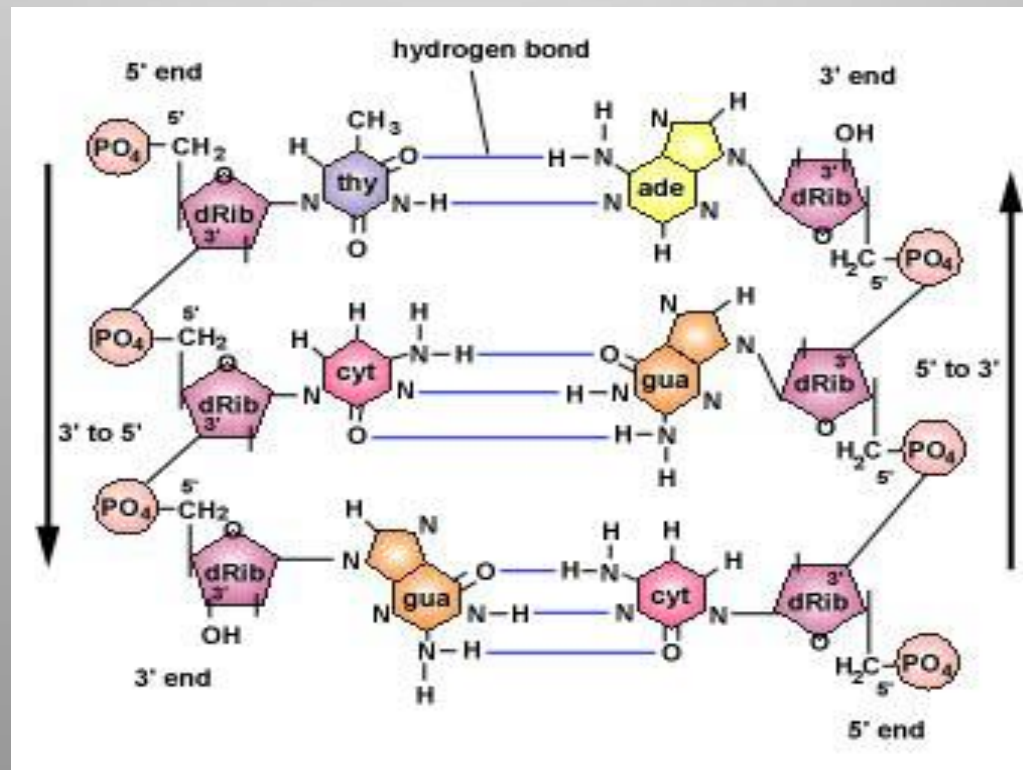


5' → 3' Growth of Single Strand



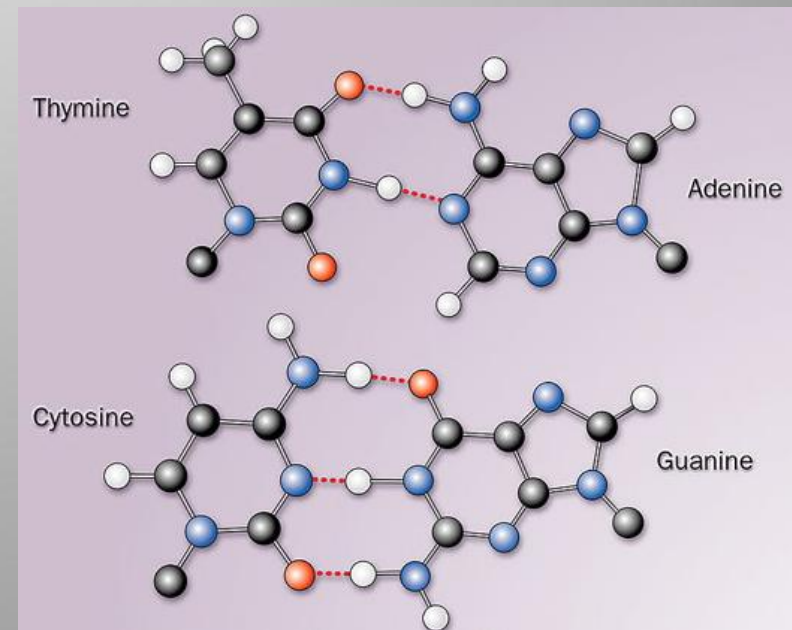
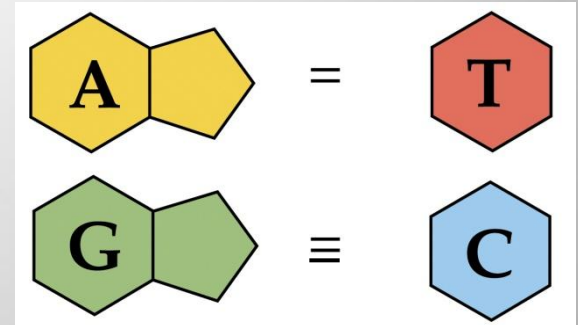
DNA forms double helix

- 2 strands held together by interactions between two base pairs
- Note: 5' → 3' orientation
- Anti-parallel nature of strands



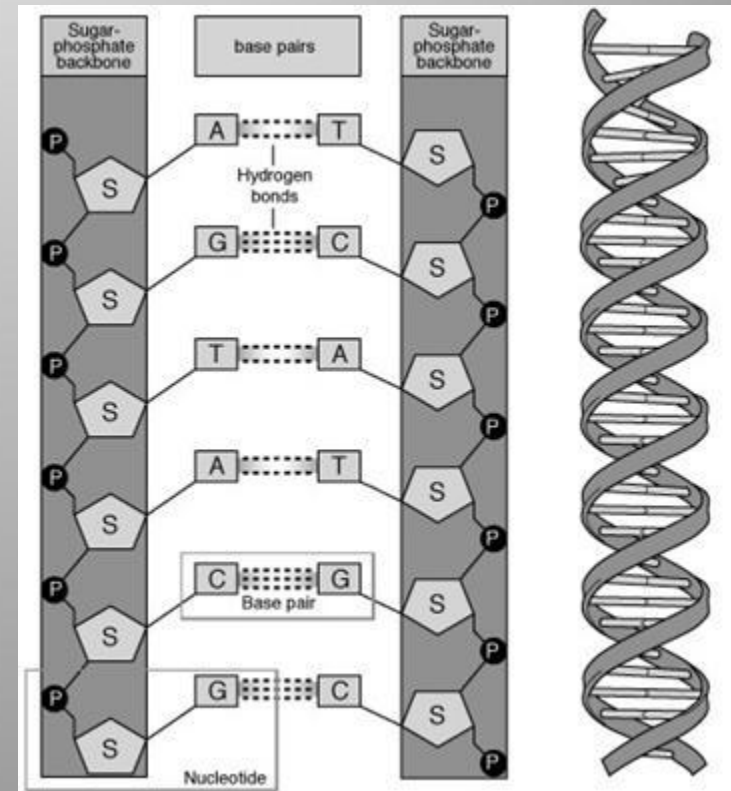
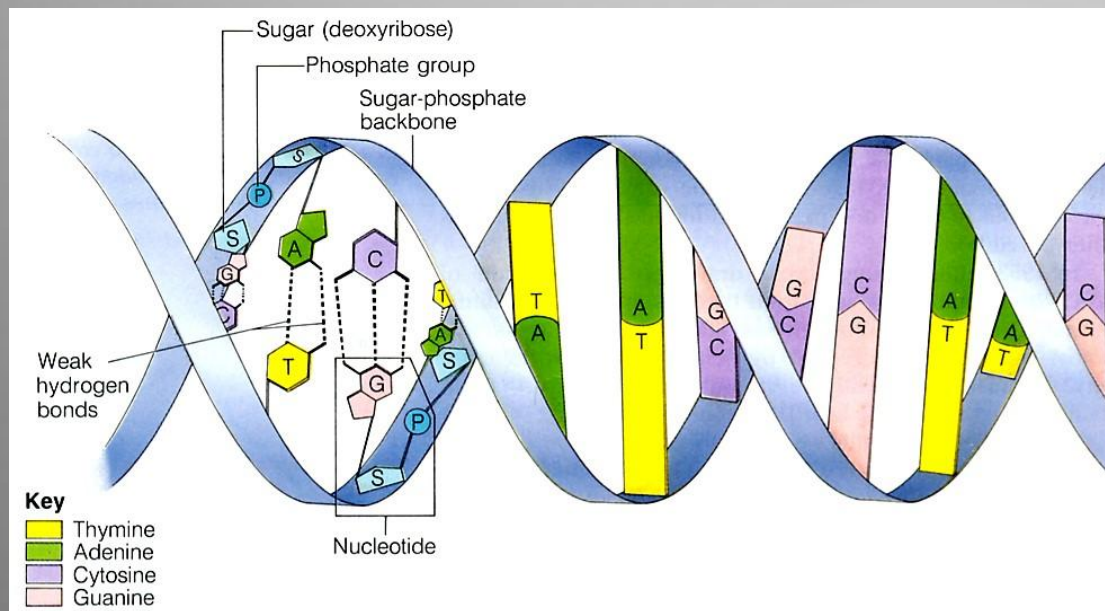
Base pairing

- Pairs have same number of hydrogen bonds
 - A-T makes 2 H-bonds
 - G-C makes 3 H-bonds
- Pairs are different sizes:
 - Always a purine + pyrimidine



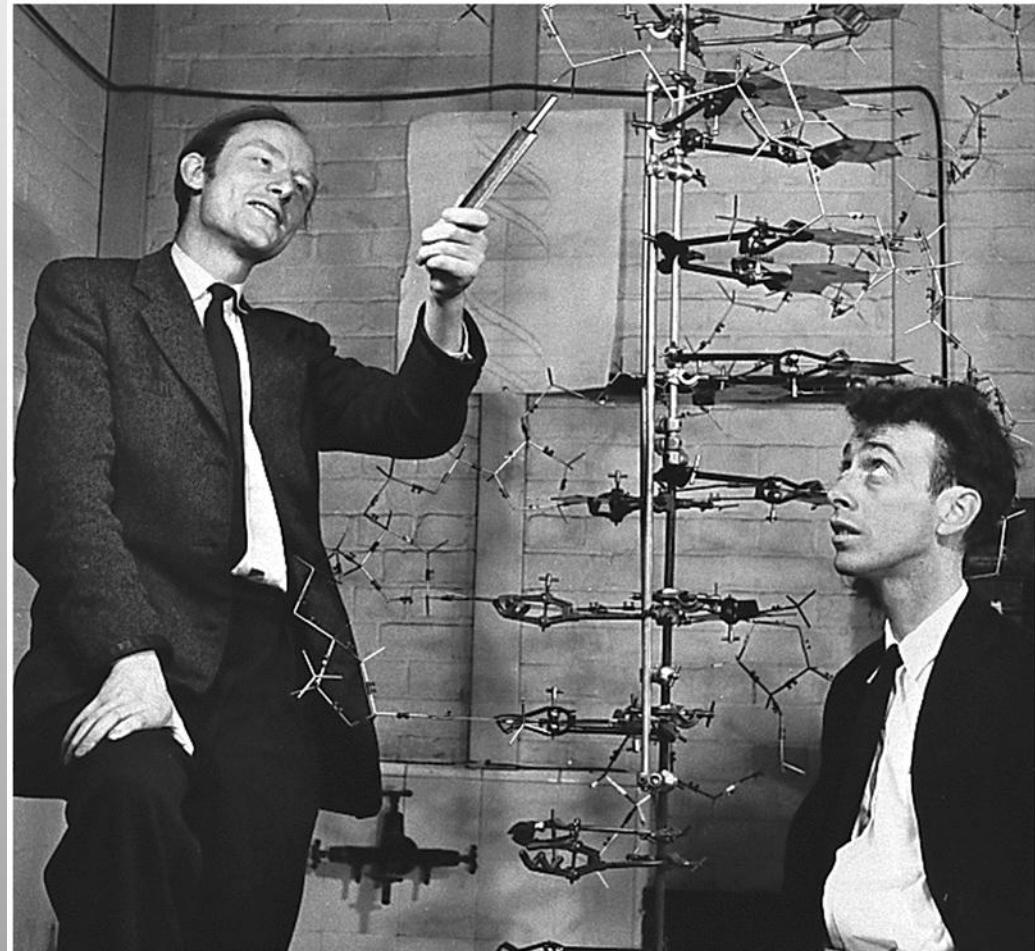
DNA ladder analogy

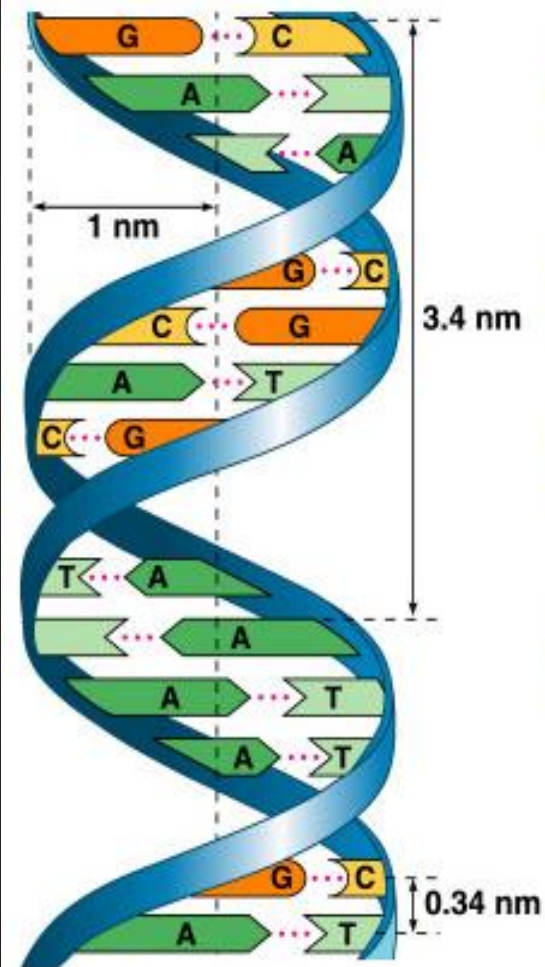
- Sides of the ladder: Sugar phosphate backbone (phosphodiester bonds)
- Rungs: hydrogen bonding between base pairs



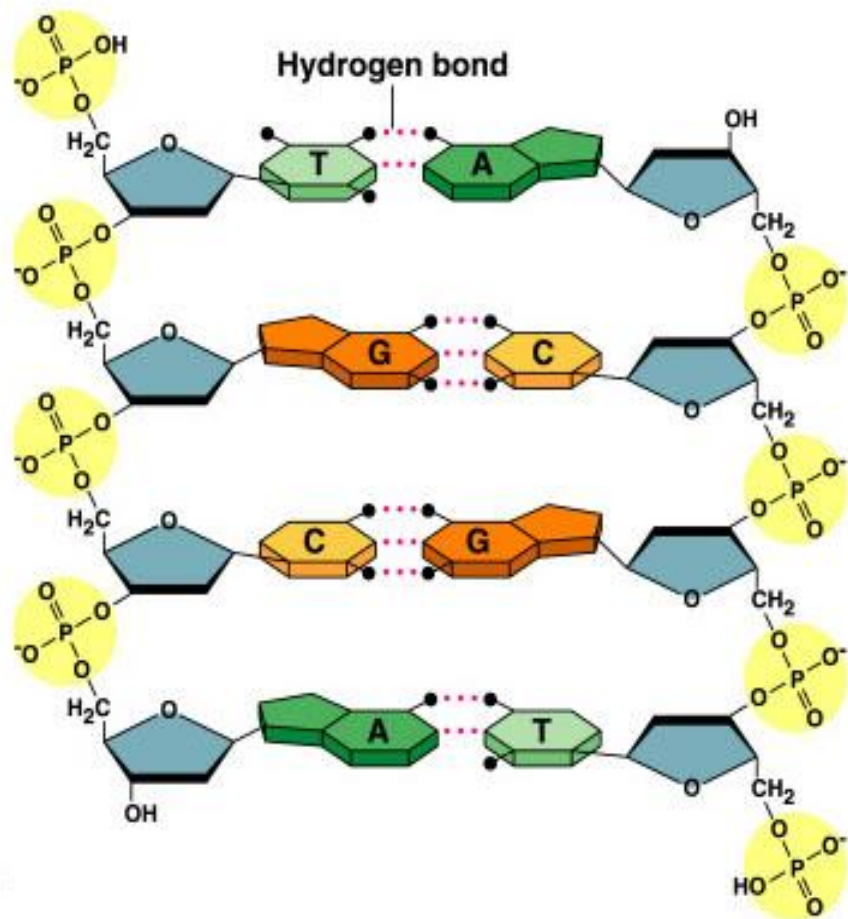
DNA helix structure

- Watson & Crick
- Rosalind Franklin

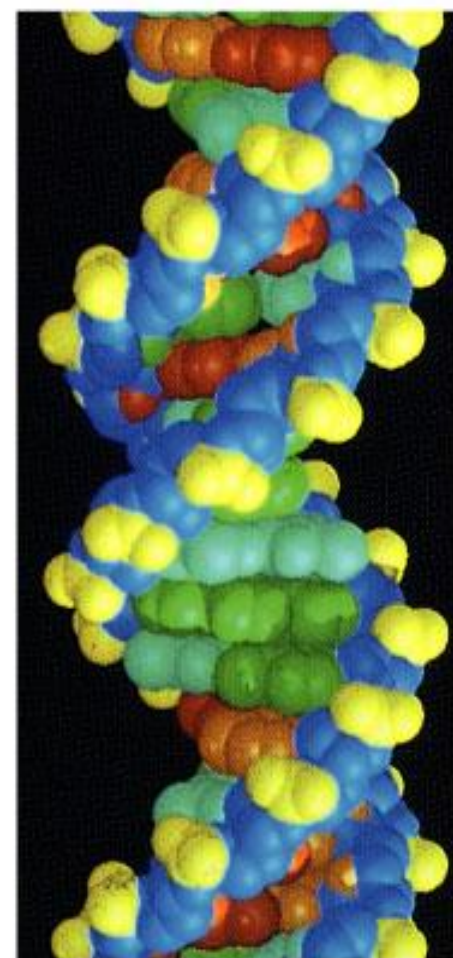




(a) Key features of DNA structure



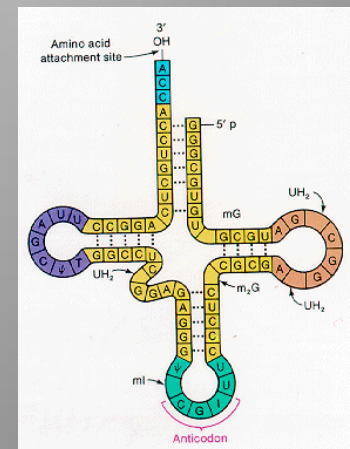
(b) Partial chemical structure



(c) Space-filling model

RNA

- Exists in 3 forms: mRNA (messenger), tRNA (transfer), rRNA (ribosomal)
- Single stranded
- But also exists in a helix:
 - DNA-mRNA helix during transcription
 - tRNA structure allows H-bonding between nucleotides within the same tRNA strand



Compare DNA & RNA

	DNA	RNA
Sugar		
Base		
strand		

Compare DNA & RNA

	DNA	RNA
Sugar	Deoxyribose	ribose
Base	A, T, C, G	A, U, C, G
strand	Double helix	Usually single