Biomolecules

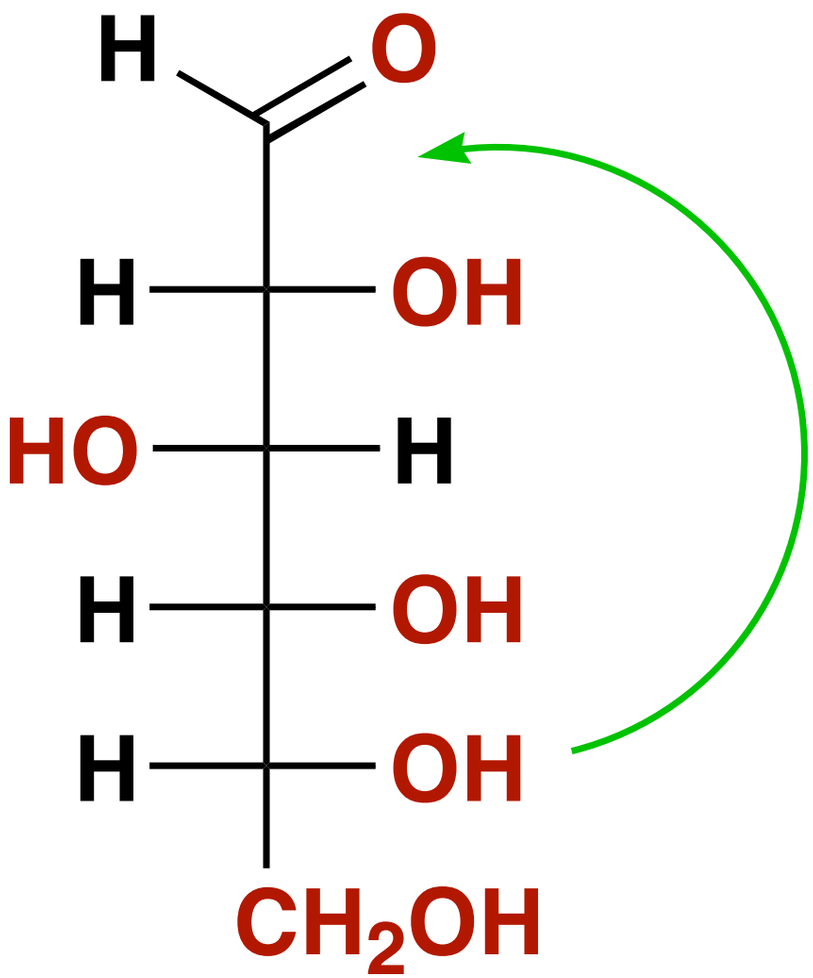
- Biological Systems (eg. life) encompass several different classes of molecules
- Carbohydrates / Sugars
- Fats / Lipids
- Amino Acids / Proteins
- Heterocyclic Bases (DNA)

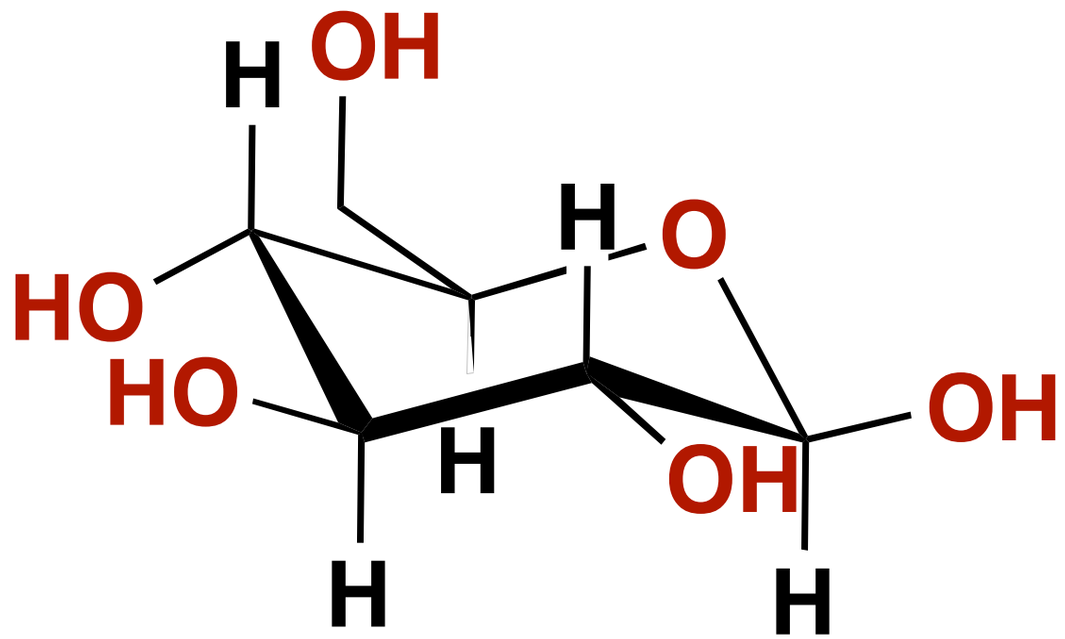
Carbohydrates - Chapter 25

- Carbohydrates - or Sugars are highly oxygenated organic molecules. They usually contain as many oxygens as carbon atoms.
- Key intermediates for Metabolism
- Polysaccharides are structural components of plants (cellulose)

Sugar Structure

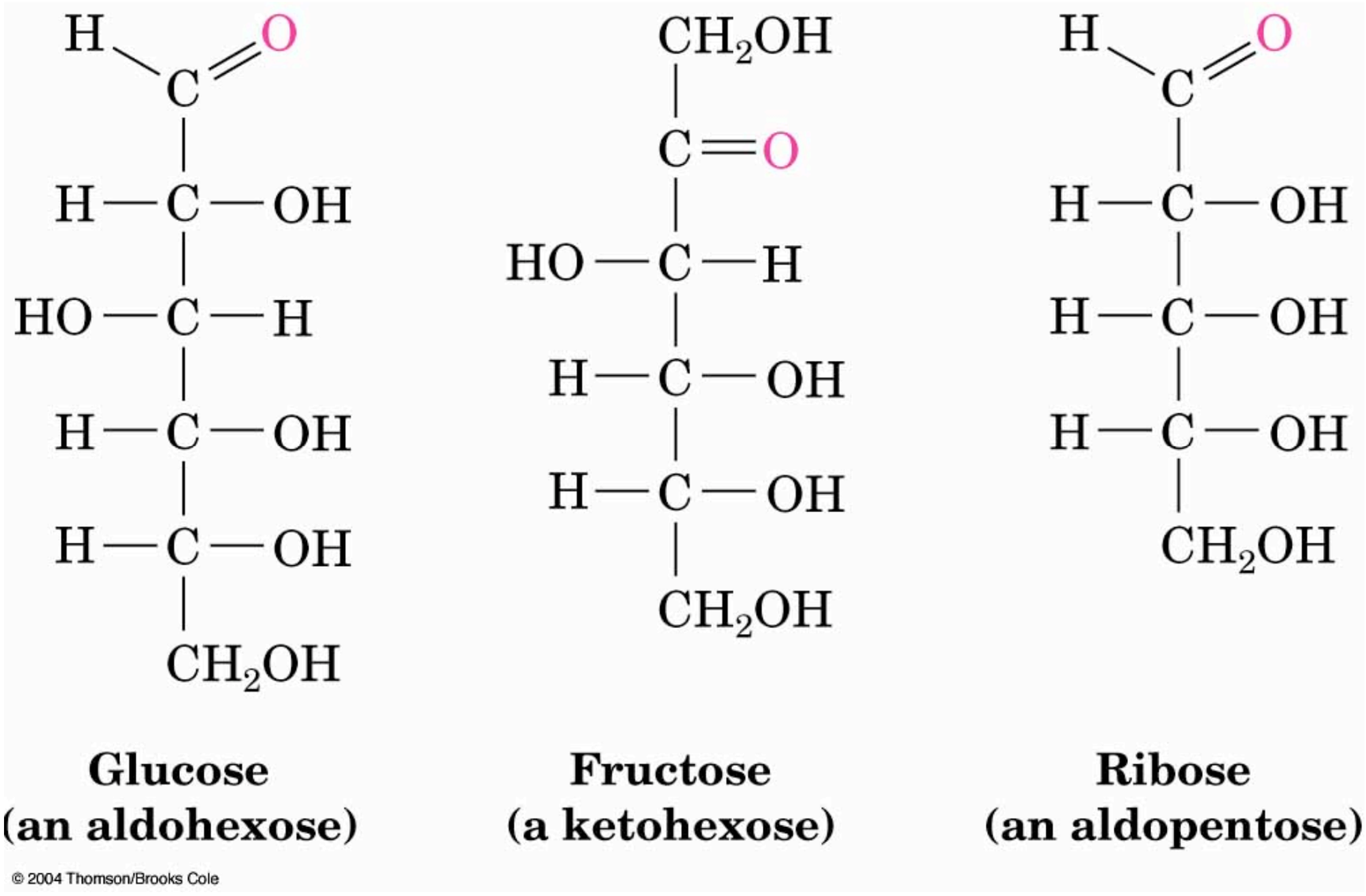
- Glucose





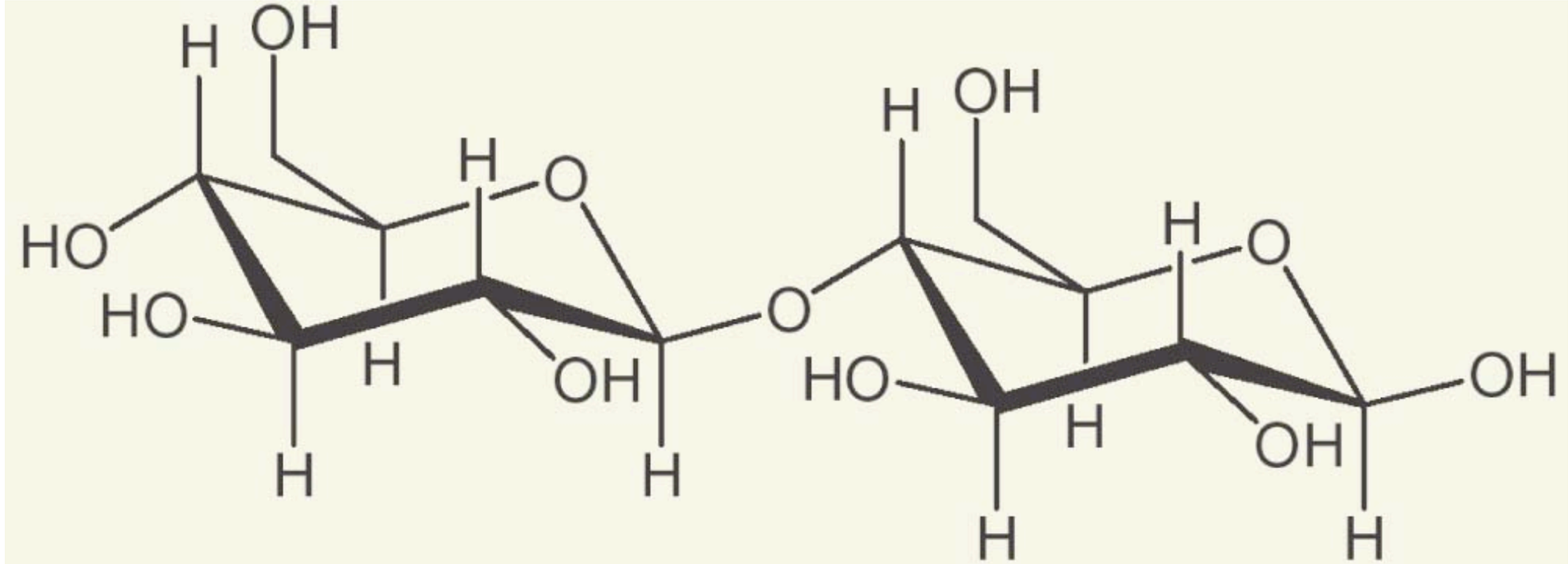
A number of kinds of sugars

- Sugars are classified based on their type of carbonyl (aldehyde or ketone) and the number of carbons



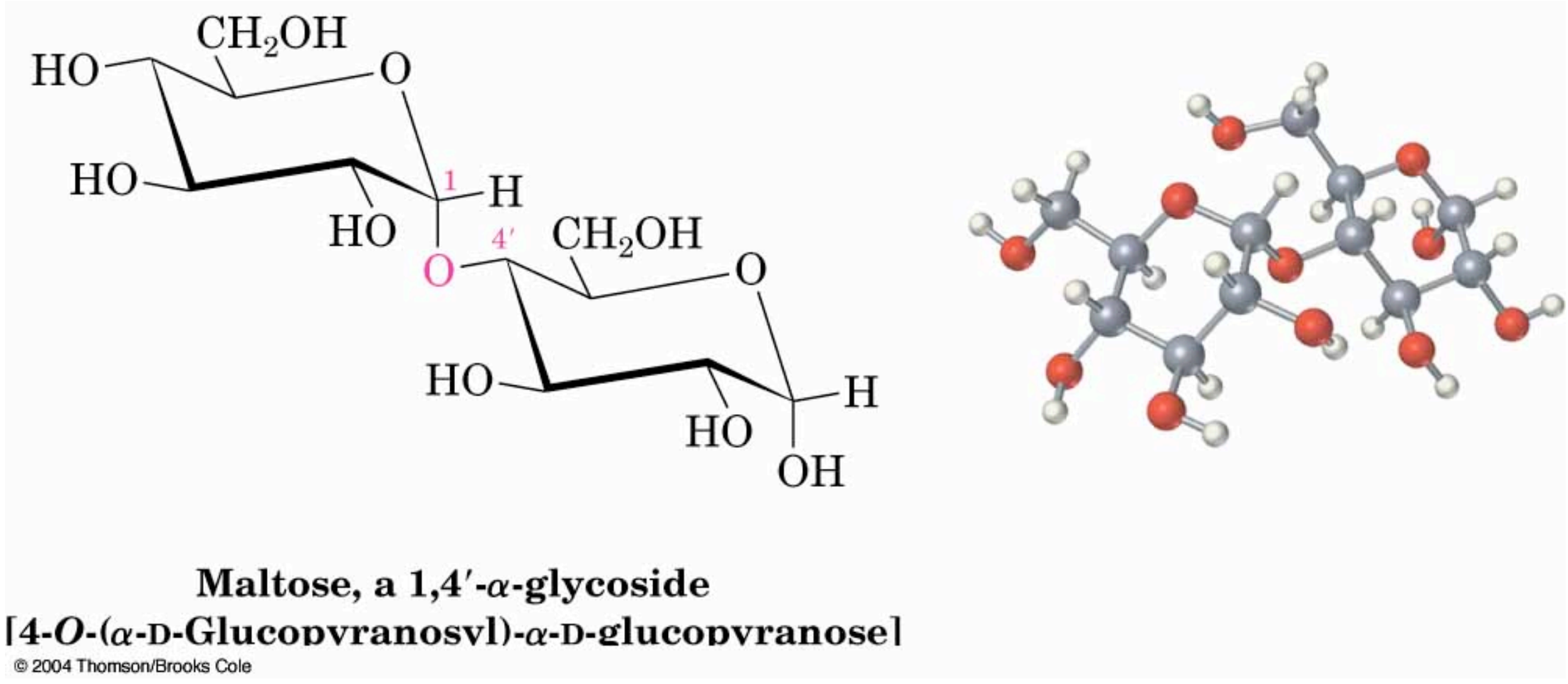
Polysaccharides

- Sugars can be linked by the acetal group
- A disaccharide
- Cellulose contains several thousand sugar units



Disaccharides

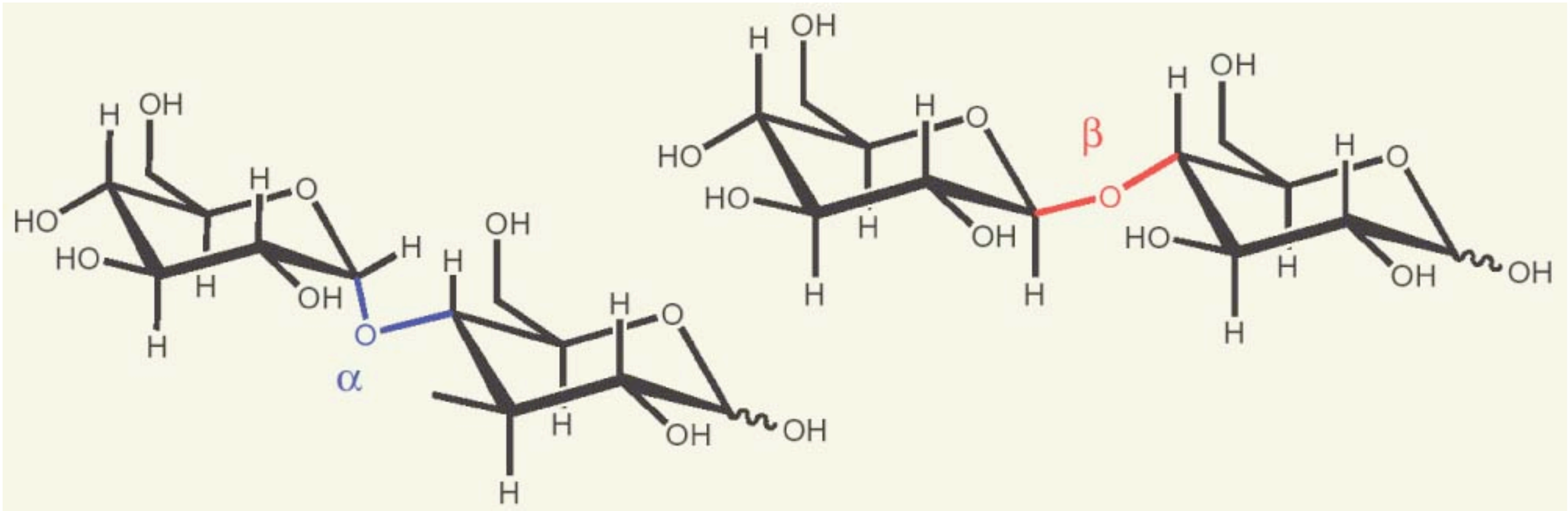
Maltose - (glucose-glucose)



Maltose, a 1,4′-α-glycoside
[4-*O*-(α-D-Glucopyranosyl)-α-D-glucopyranose]

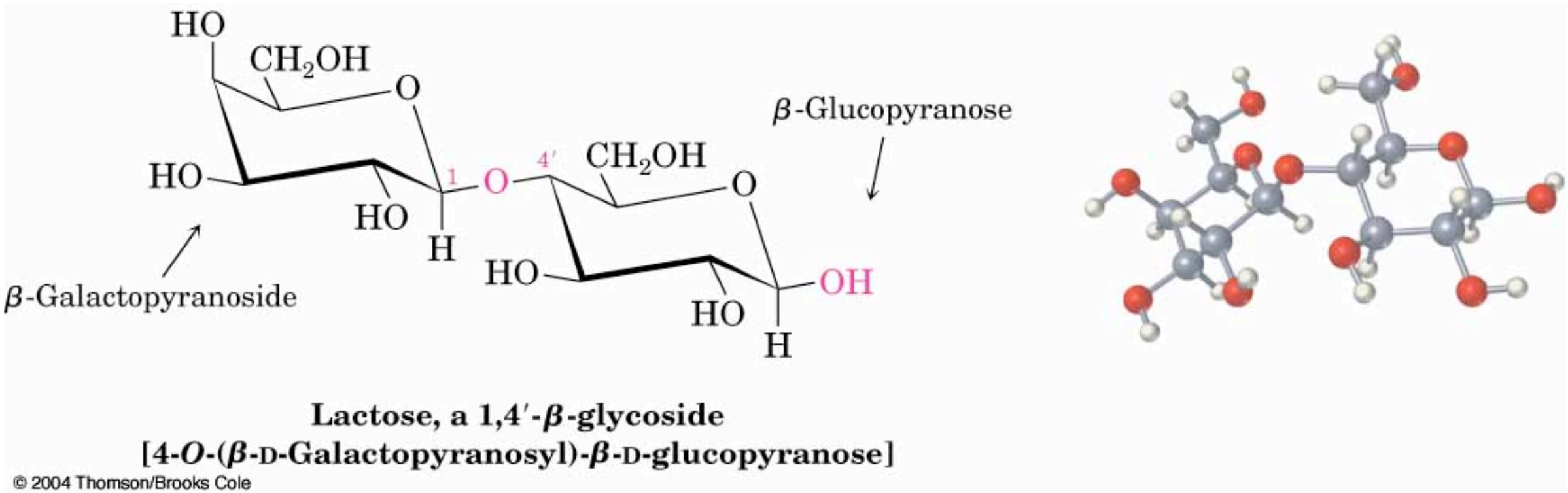
Disaccharides

- Cellobiose - cannot digest this



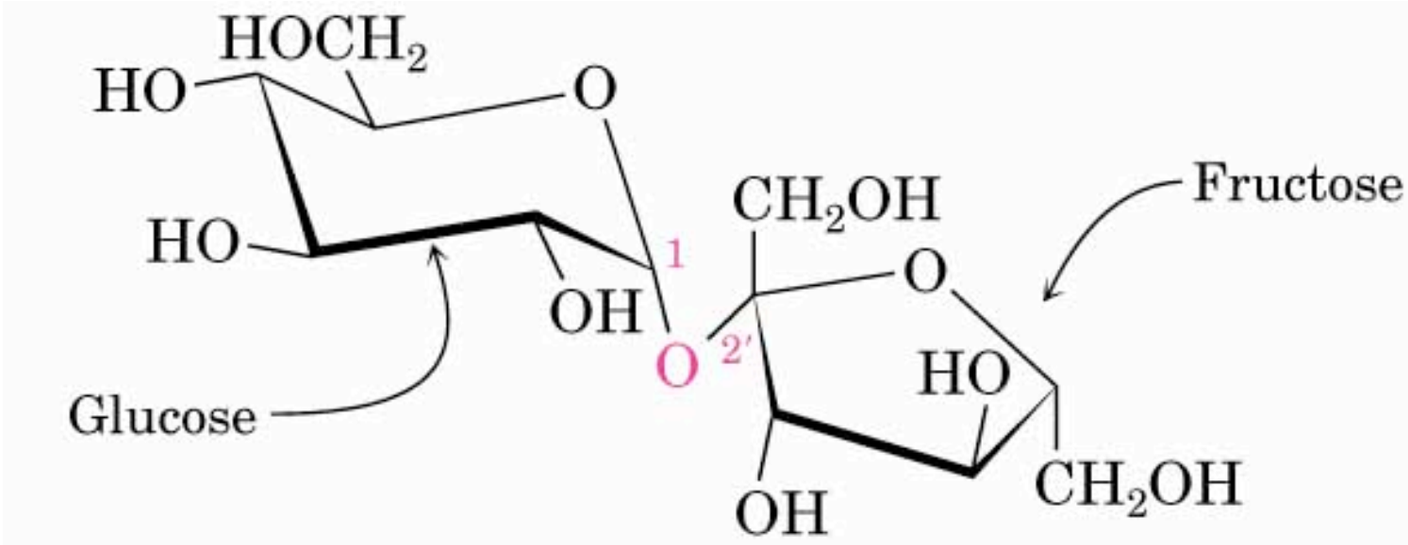
Disaccharides

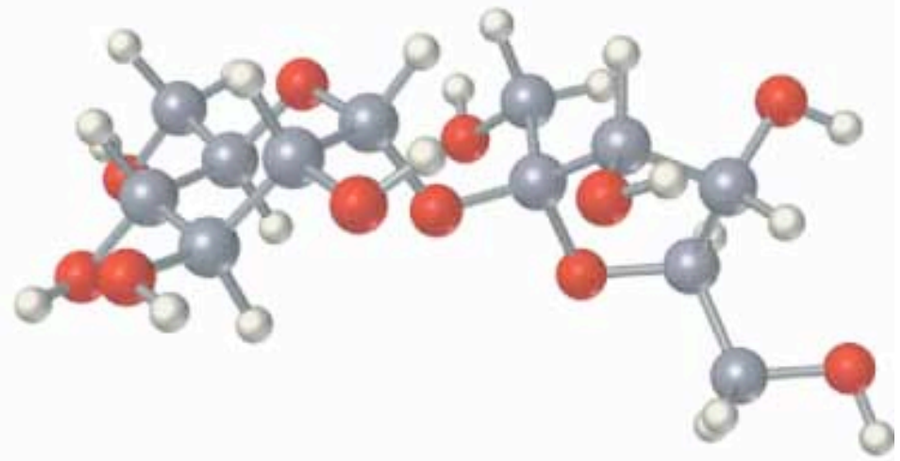
Lactose - (galactose-glucose)



Lactose, a 1,4′-β-glycoside
[4-*O*-(β-D-Galactopyranosyl)-β-D-glucopyranose]

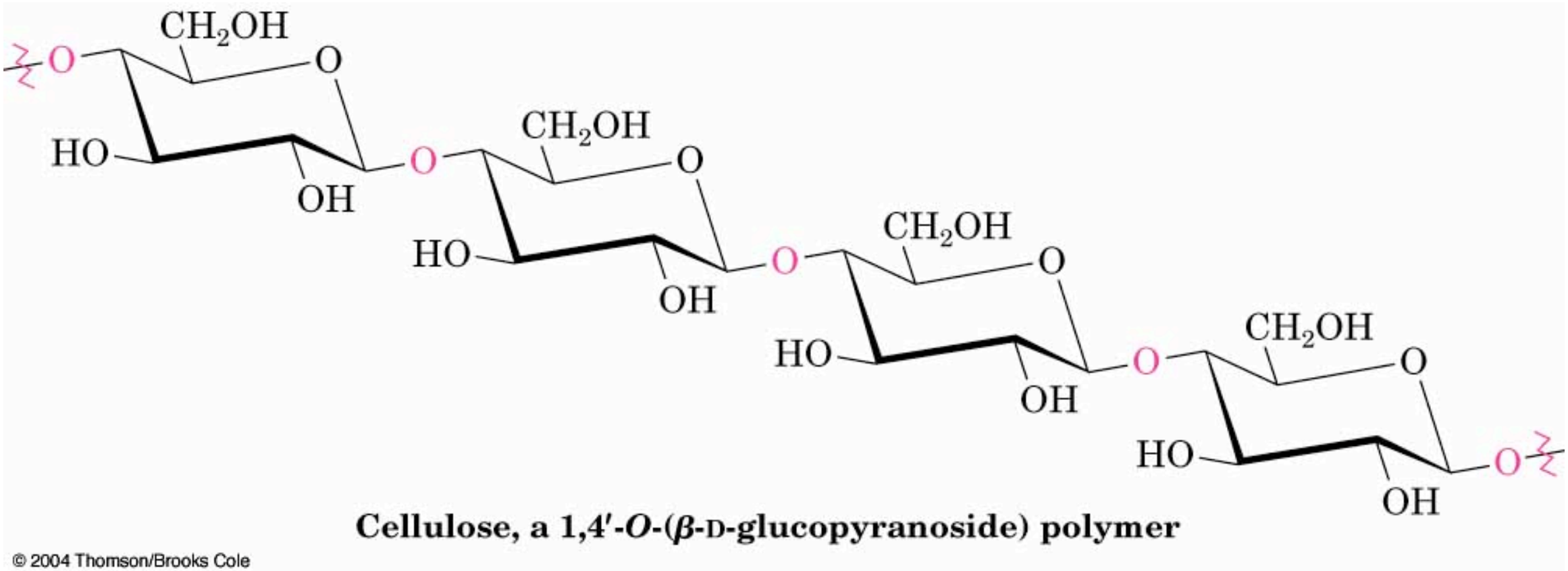
Sucrose - Table Sugar - (glucose-fructose)





Sucrose, a 1,2′-glycoside
[2-*O*-(*α*-D-Glucopyranosyl)-*β*-D-fructofuranoside]

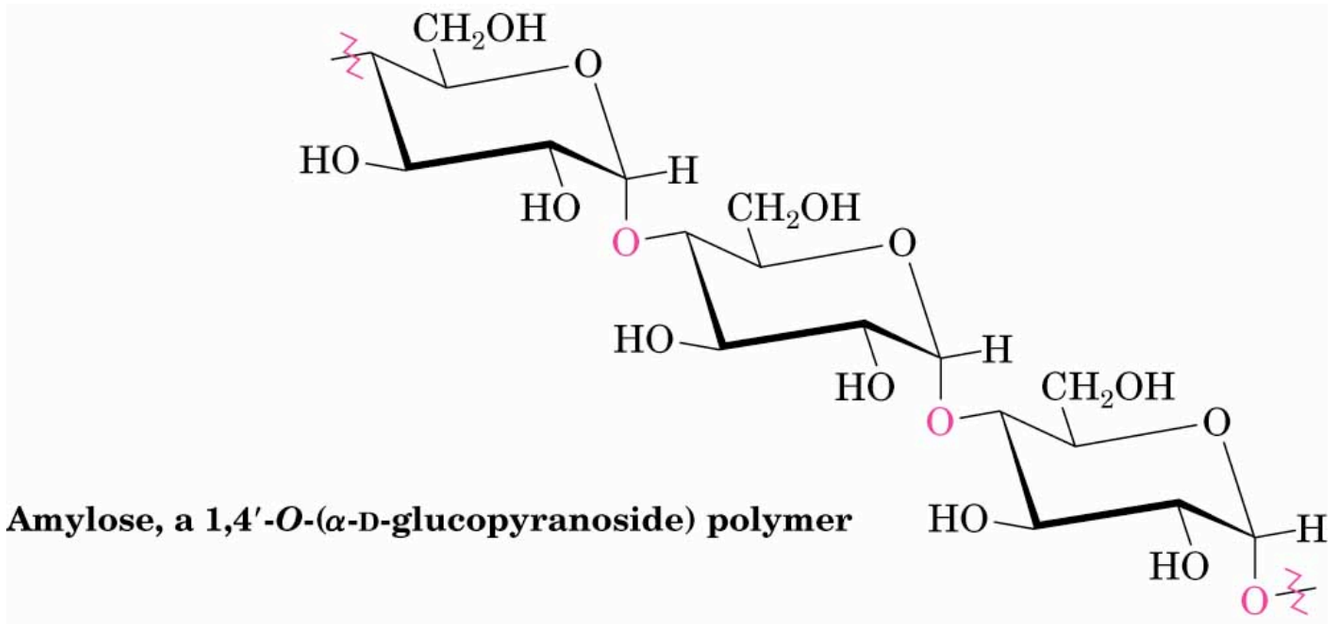
Cellulose



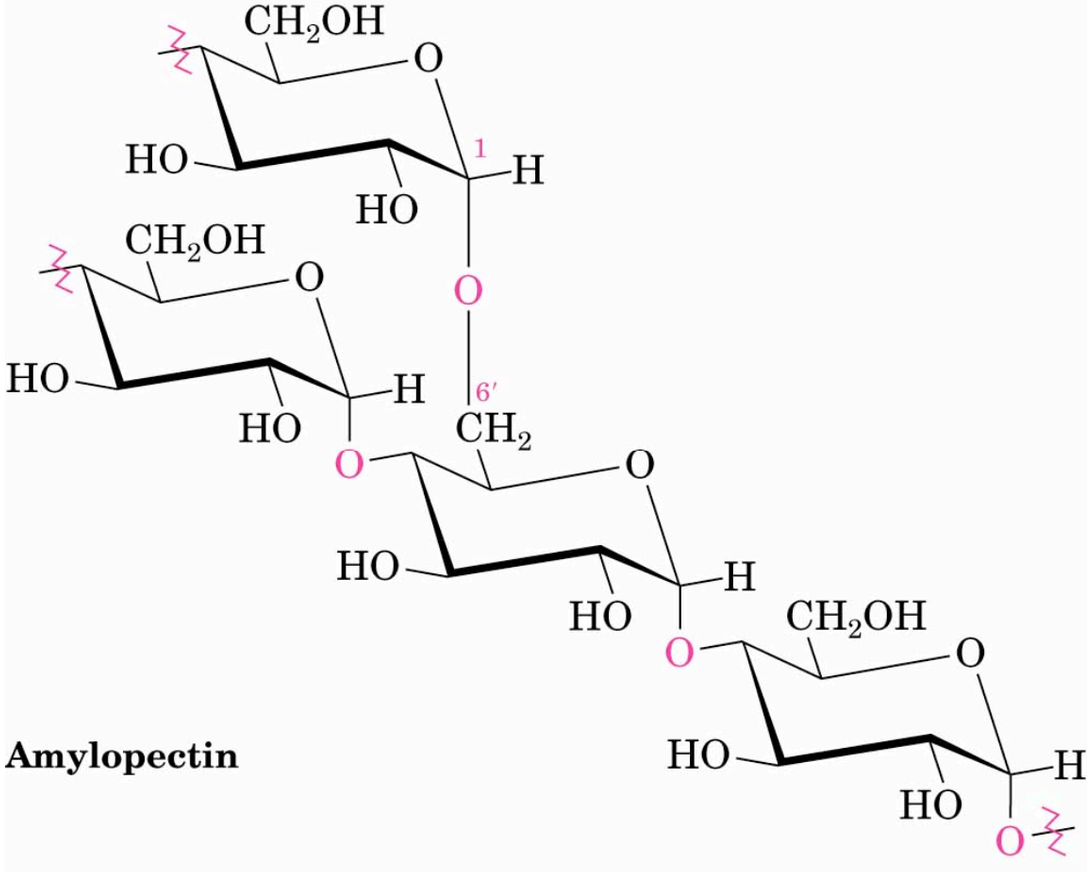
Cellulose, a 1,4′-*O*-(*β*-D-glucopyranoside) polymer

Polysaccharides

Starch



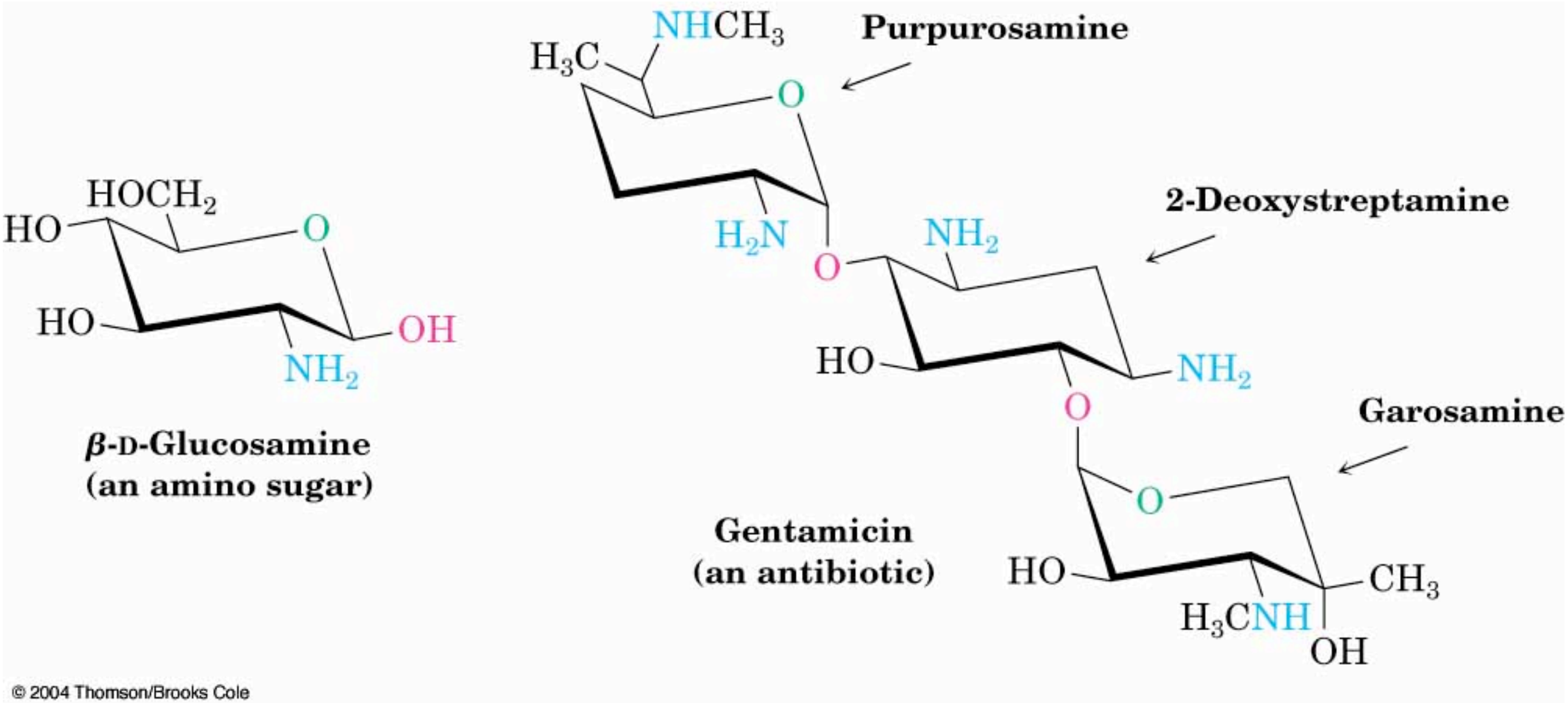
Amylose, a 1,4′-*O*-(α-D-glucopyranoside) polymer



Amylopectin

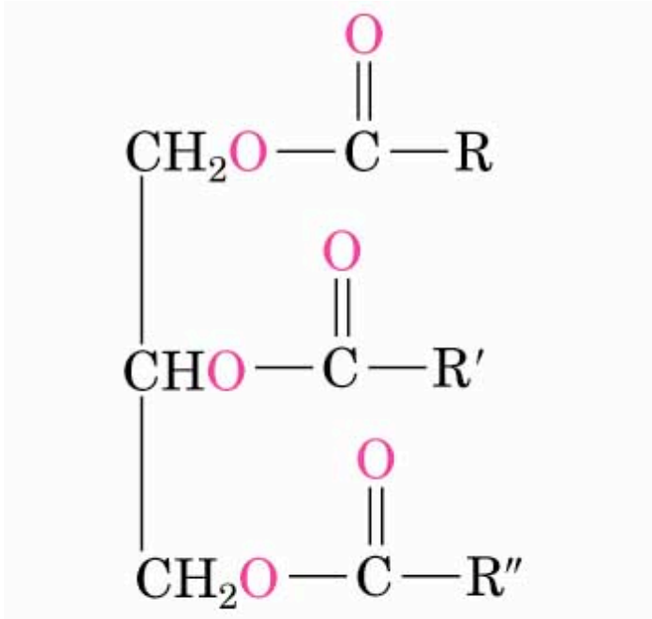
Amino Sugars

- One OH Group is replacec by an amine
- Often found on cell surfaces

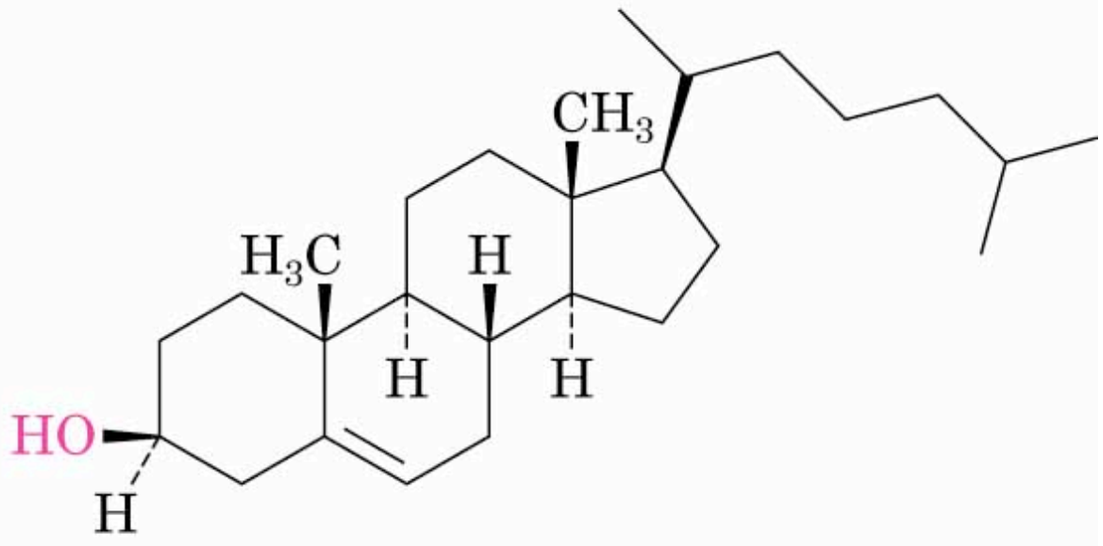


Lipids - Chapter 27

- Natural materials that have mostly hydrocarbon - very non-polar
- Lipids includes fats, oils, waxes, and other hormones and vitamins
- Lipids are important constituents of cell walls



Animal fat—a triester
(R, R′, R″ = C_{11}–C_{19} chains)

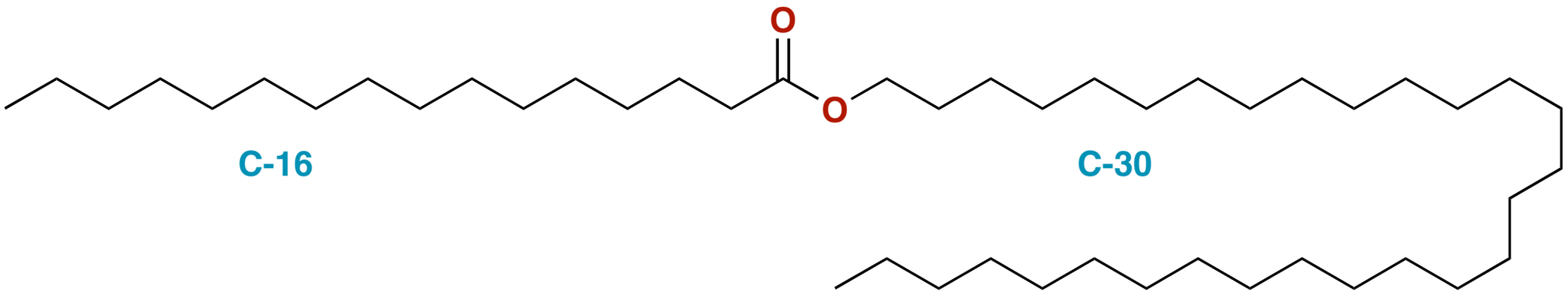


Cholesterol

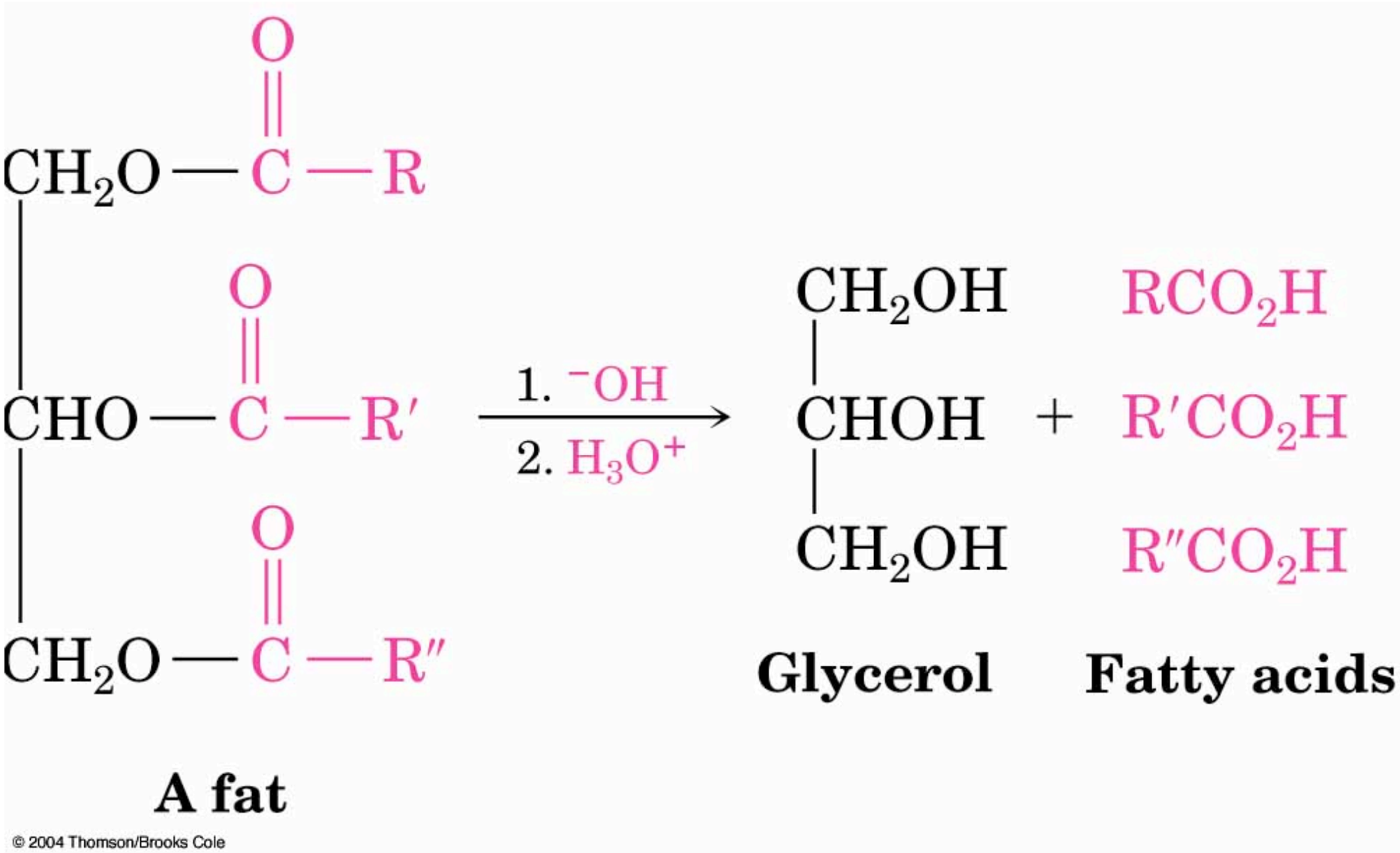
Waxes

- Waxes are esters made from very long carboxylic acids and alcohols

A wax from Beeswax

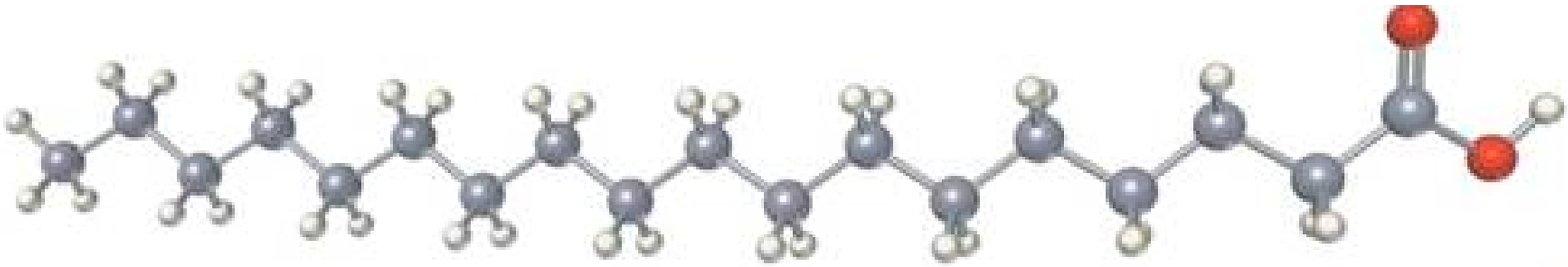


- Fats and Oils (solid and liquid)
- Fatty acid esters with triglycerol



Saturated Fats

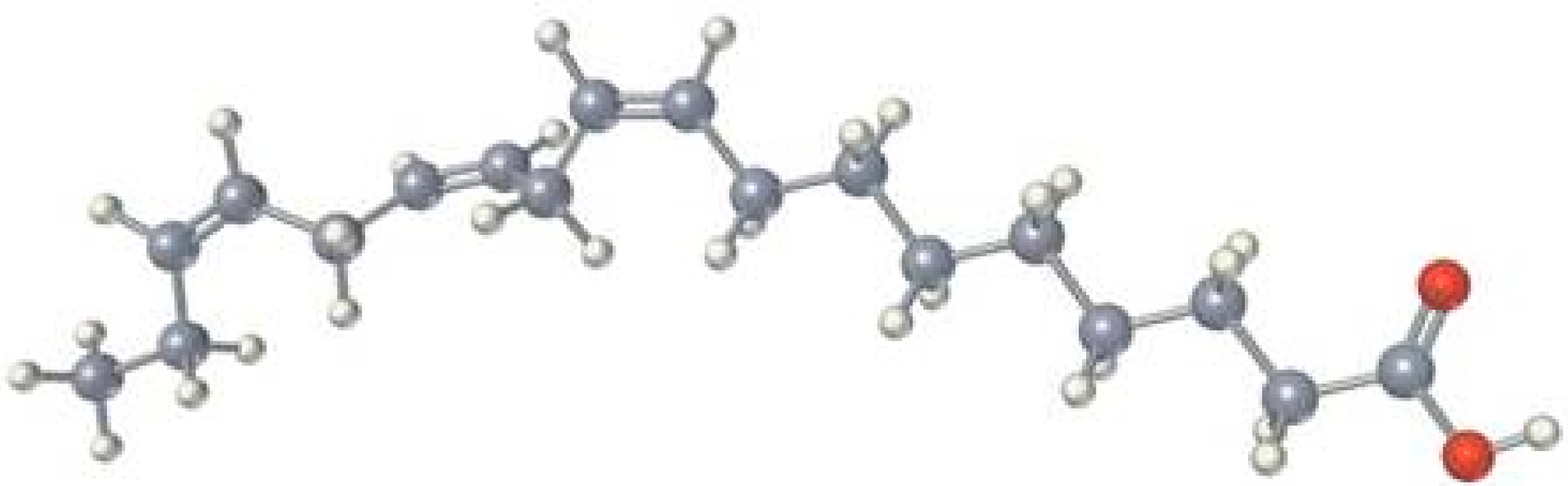
- Saturated alkane chains - Usually produced in animals

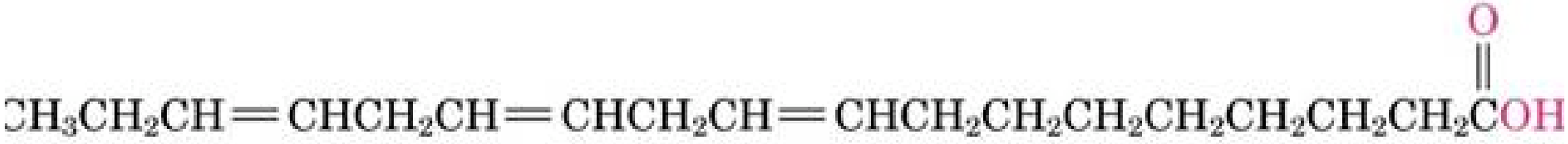


Stearic acid

Unsaturated Fatty Acids

- Contain one (monounsaturate) or more (polyunsaturated) alkenes in the hydrocarbon chains.

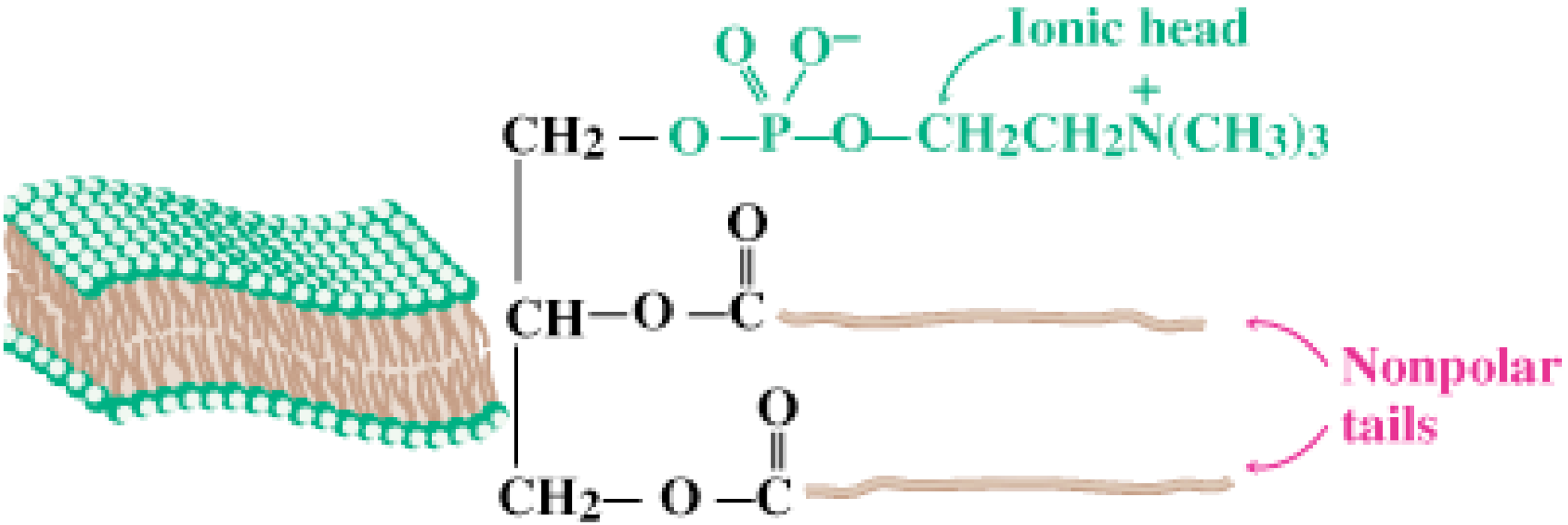




Linolenic acid, a polyunsaturated fatty acid (PUFA)

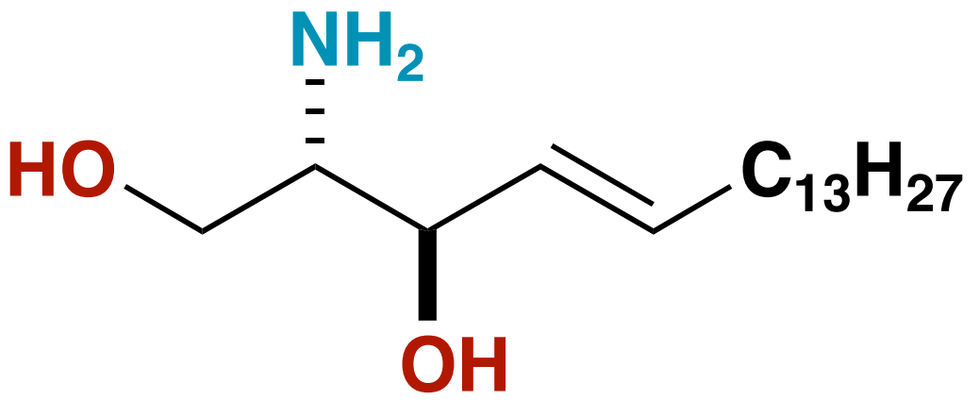
Phosphoglycerides

- Create cell membranes

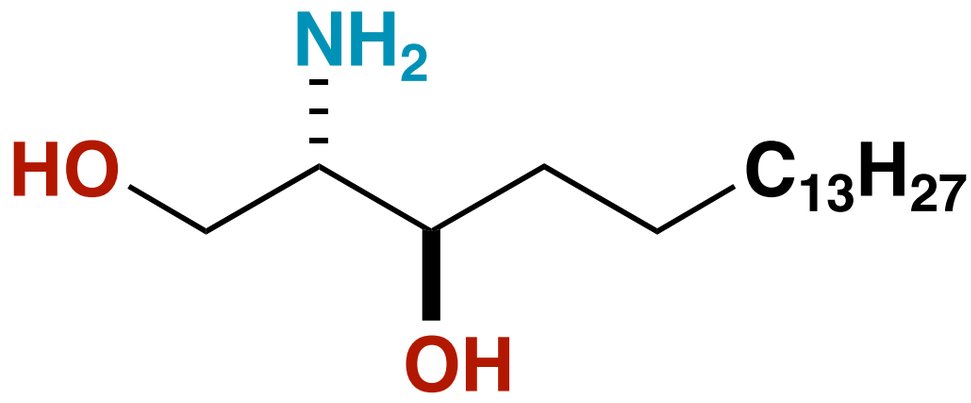


Sphingolipids

- Constituents of Cell Membranes - Anchors sugars to the surface of a cell
- High amount found in brain and nerve tissues

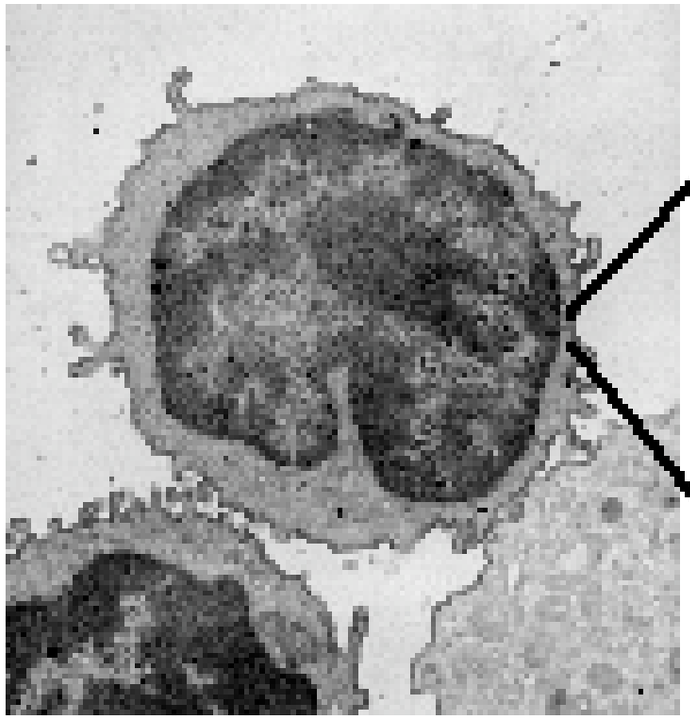


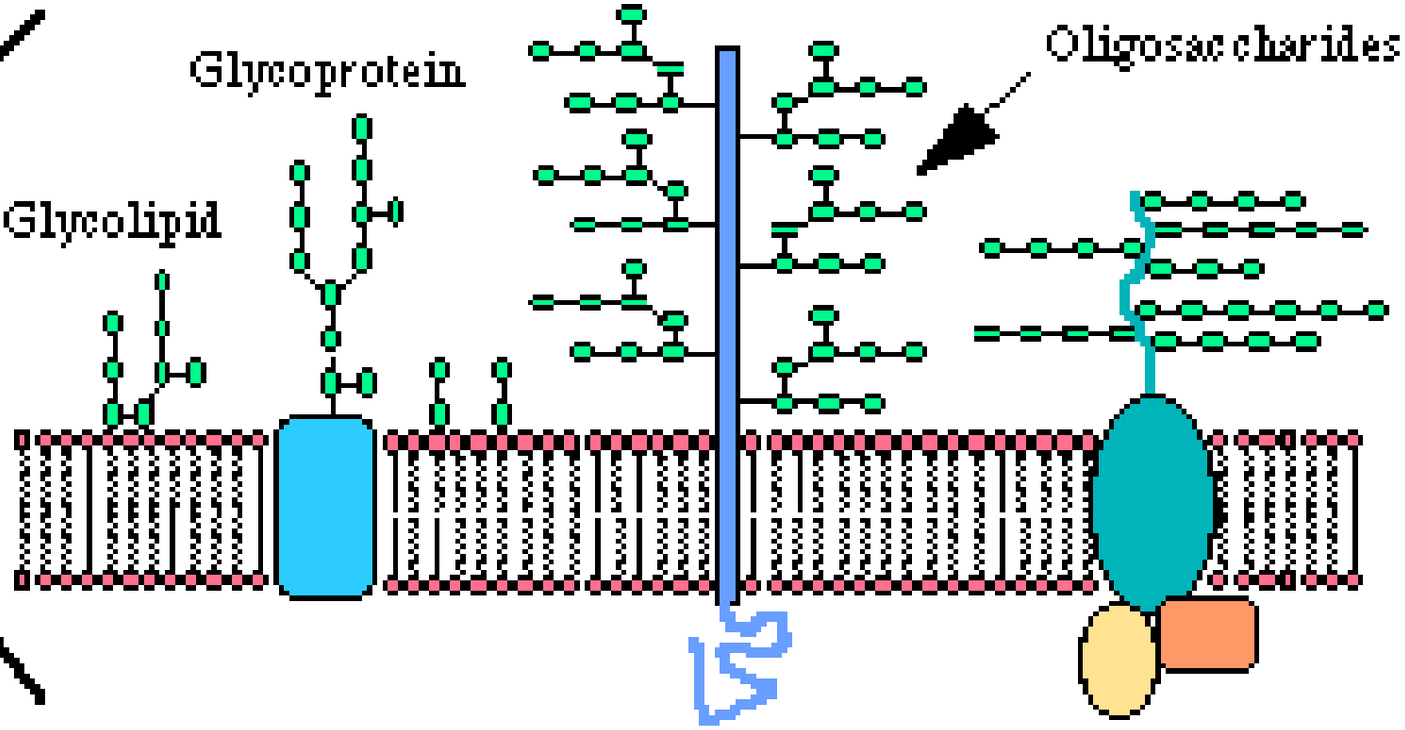
D-*erythro*-sphingosine

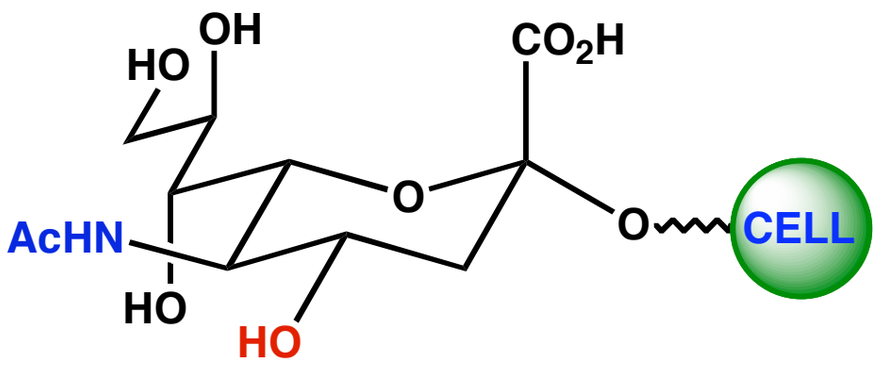


D-*erythro*-sphinganine

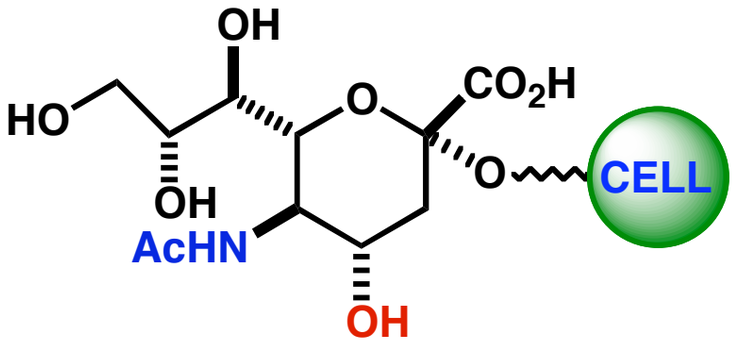
Influenza



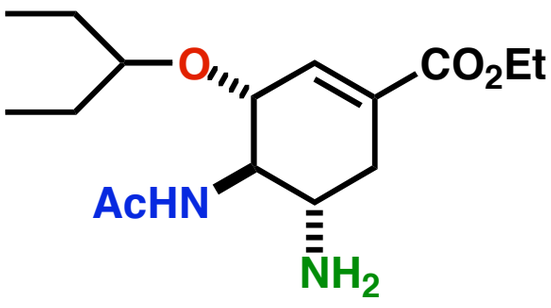




Sialic Acid

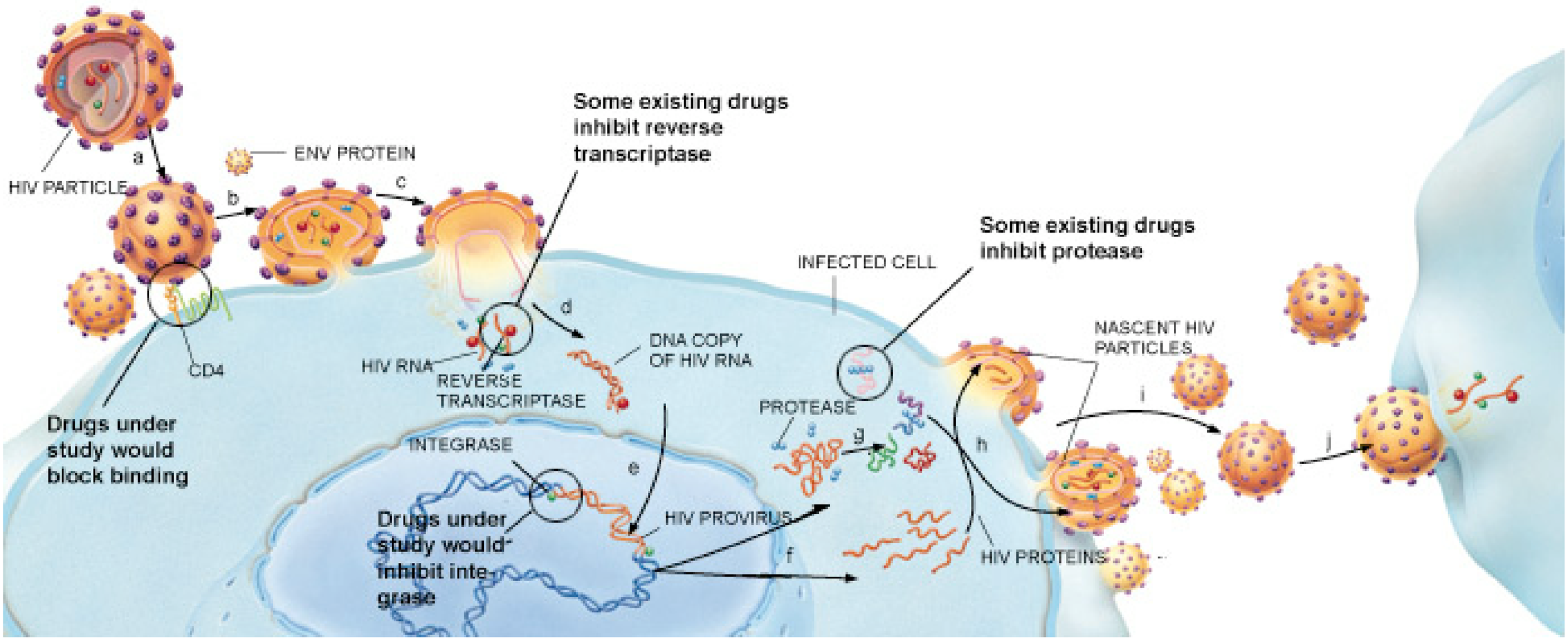


Sialic Acid

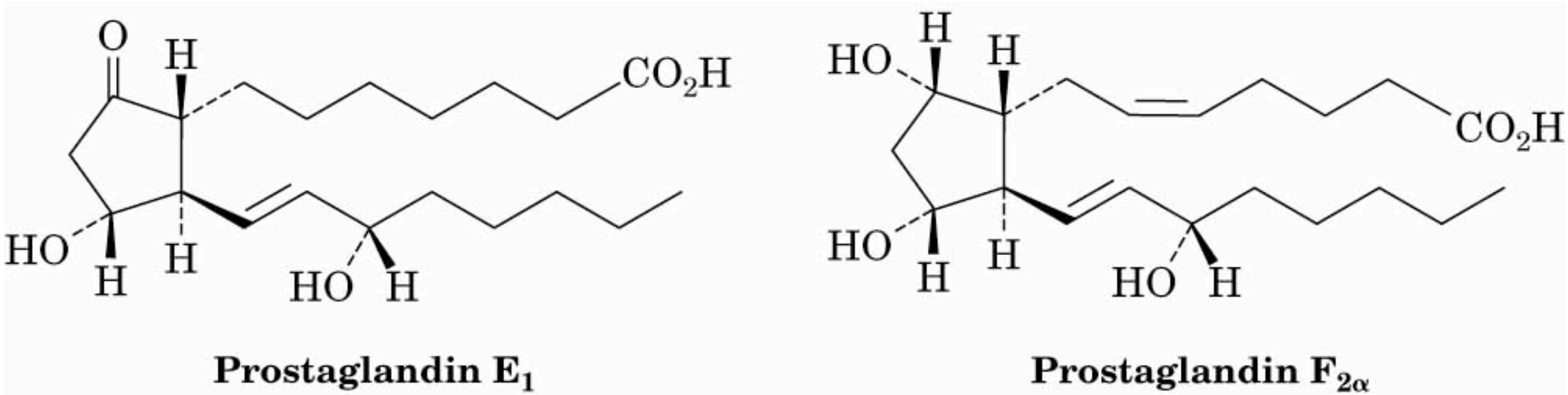


GS-4104

Lifecycle


HIV PARTICLE
a
ENV PROTEIN
b
c
Some existing drugs inhibit reverse transcriptase
INFECTED CELL
Some existing drugs inhibit protease
CD4
HIV RNA
REVERSE TRANSCRIPTASE
d
DNA COPY OF HIV RNA
NASCENT HIV PARTICLES
Drugs under study would block binding
INTEGRASE
PROTEASE
g
h
i
j
e
HIV PROVIRUS
Drugs under study would inhibit integrase
f
HIV PROTEINS

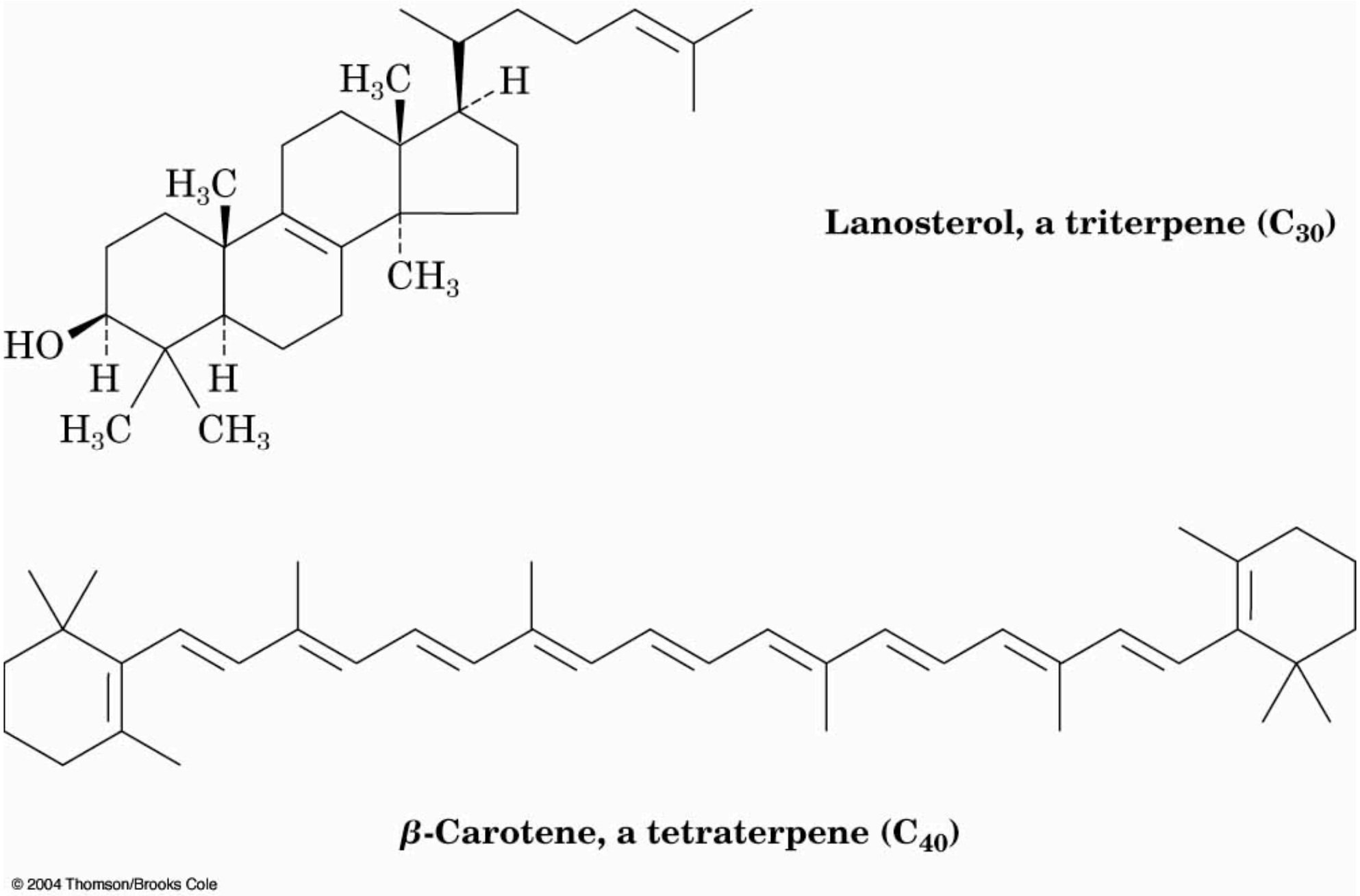
- Many physiological effects - Hormones



Prostaglandin E_1

Prostaglandin $F_{2\alpha}$

Mostly Hydrocarbons - many biological functions

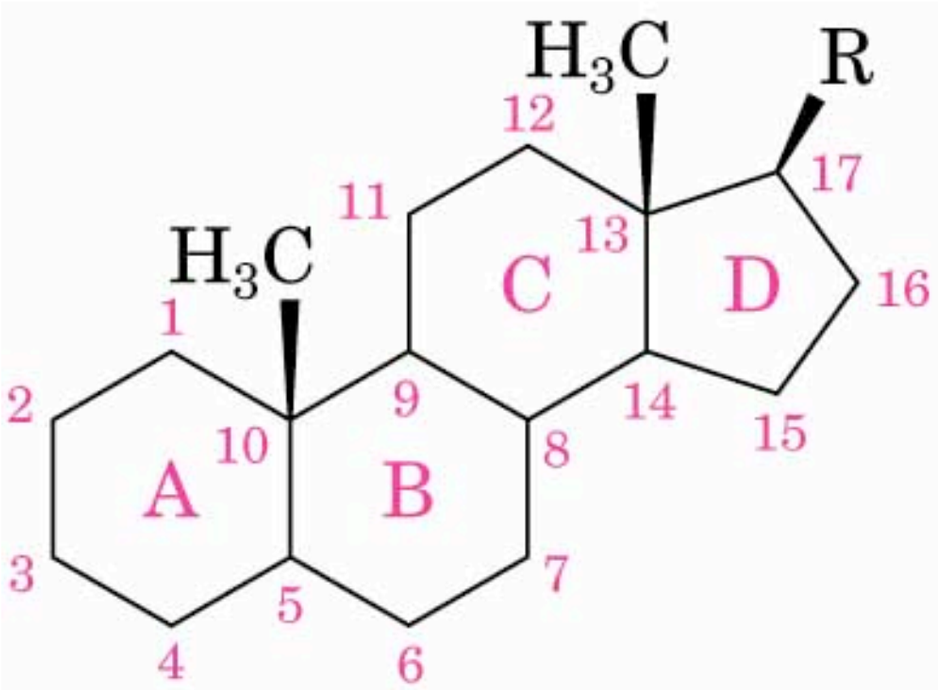


Lanosterol, a triterpene (C_{30})

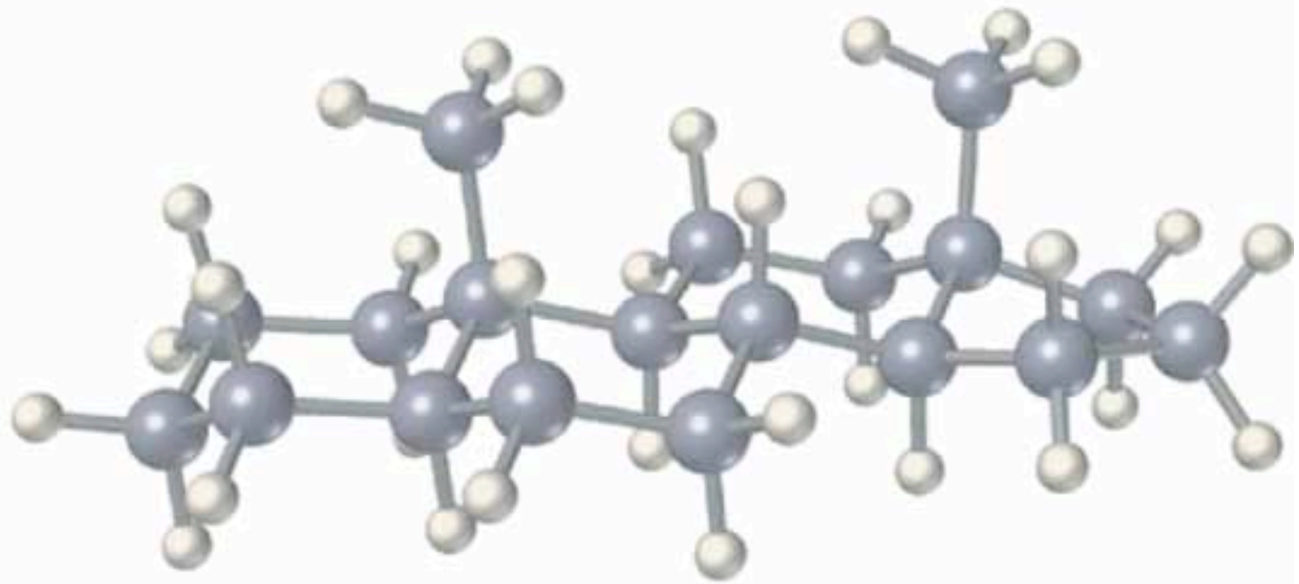
β-Carotene, a tetraterpene (C_{40})

Steroids

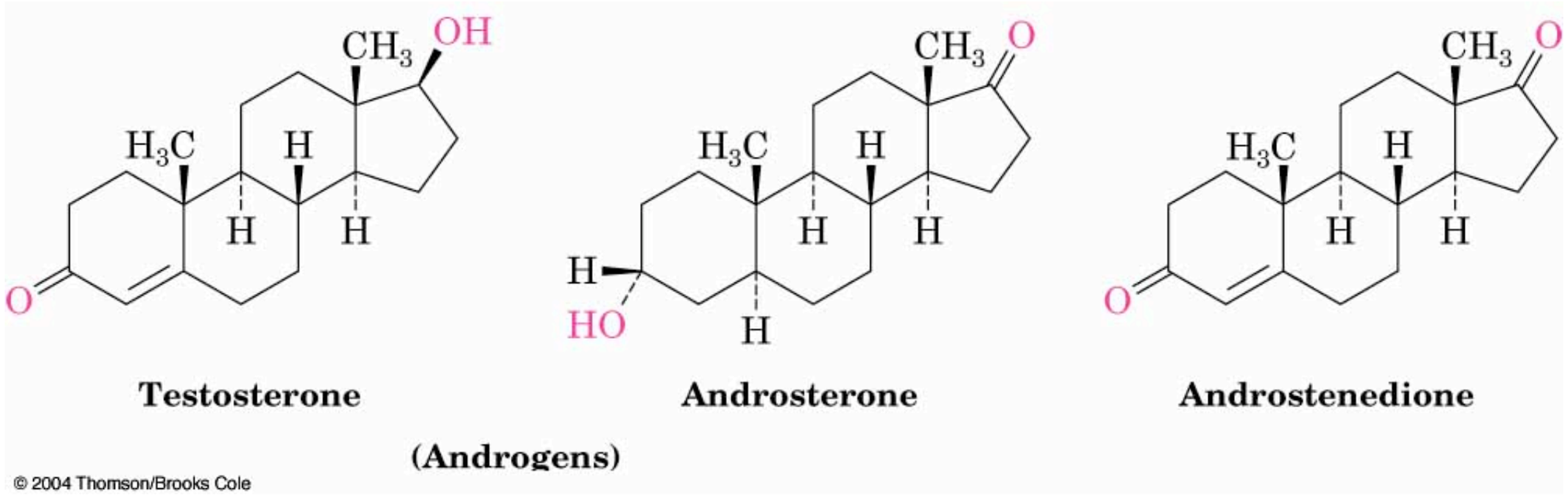
Hormones

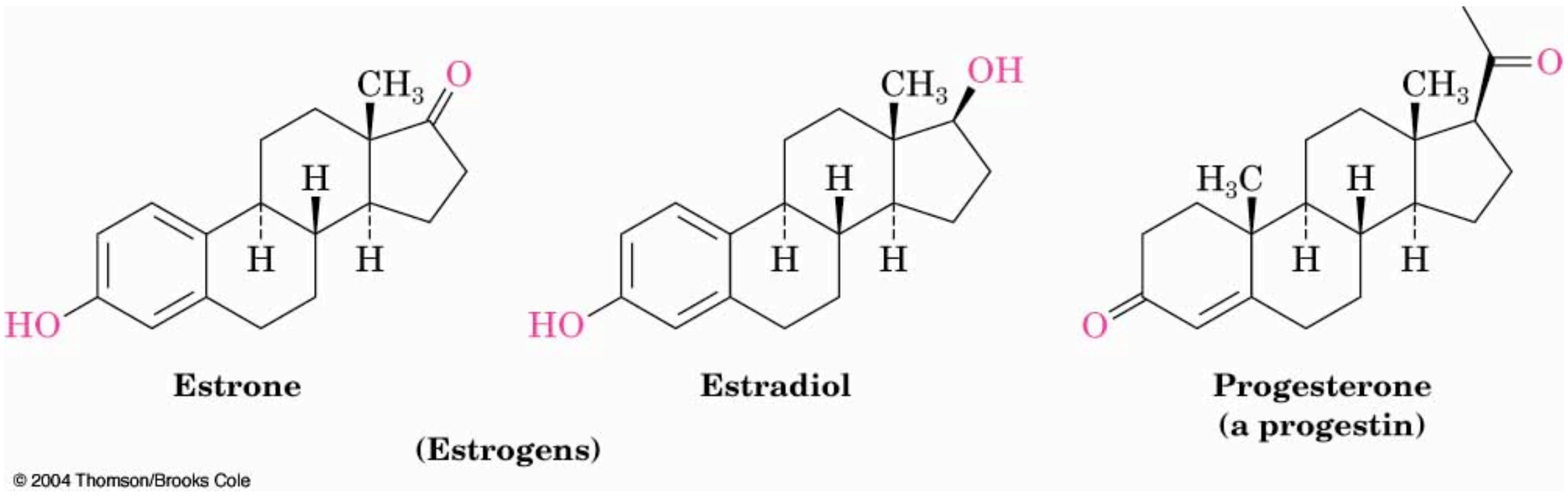


A steroid
(R = various side chains)

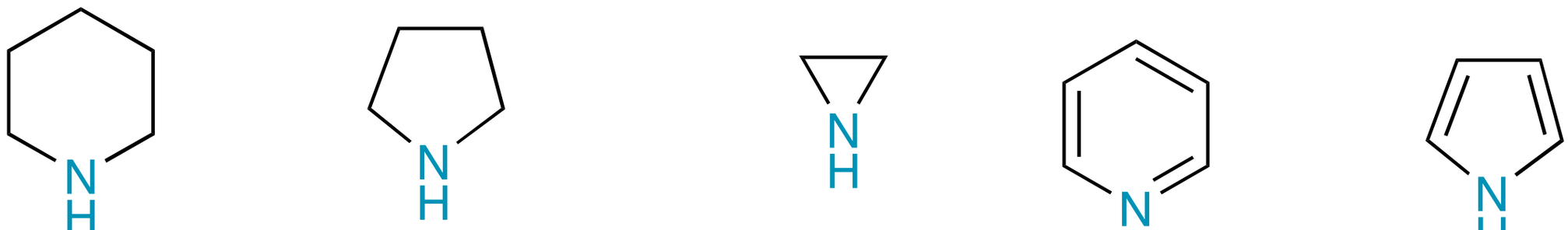


Sex Hormones

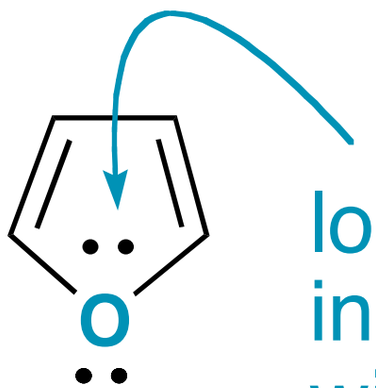




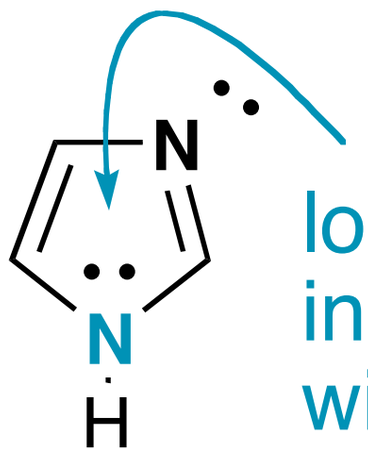
- Cyclic Molecules which contain a heteroatom - an atom other than C or H - are called Heterocycles



piperidine pyrrolidine aziridine pyridine pyrrole

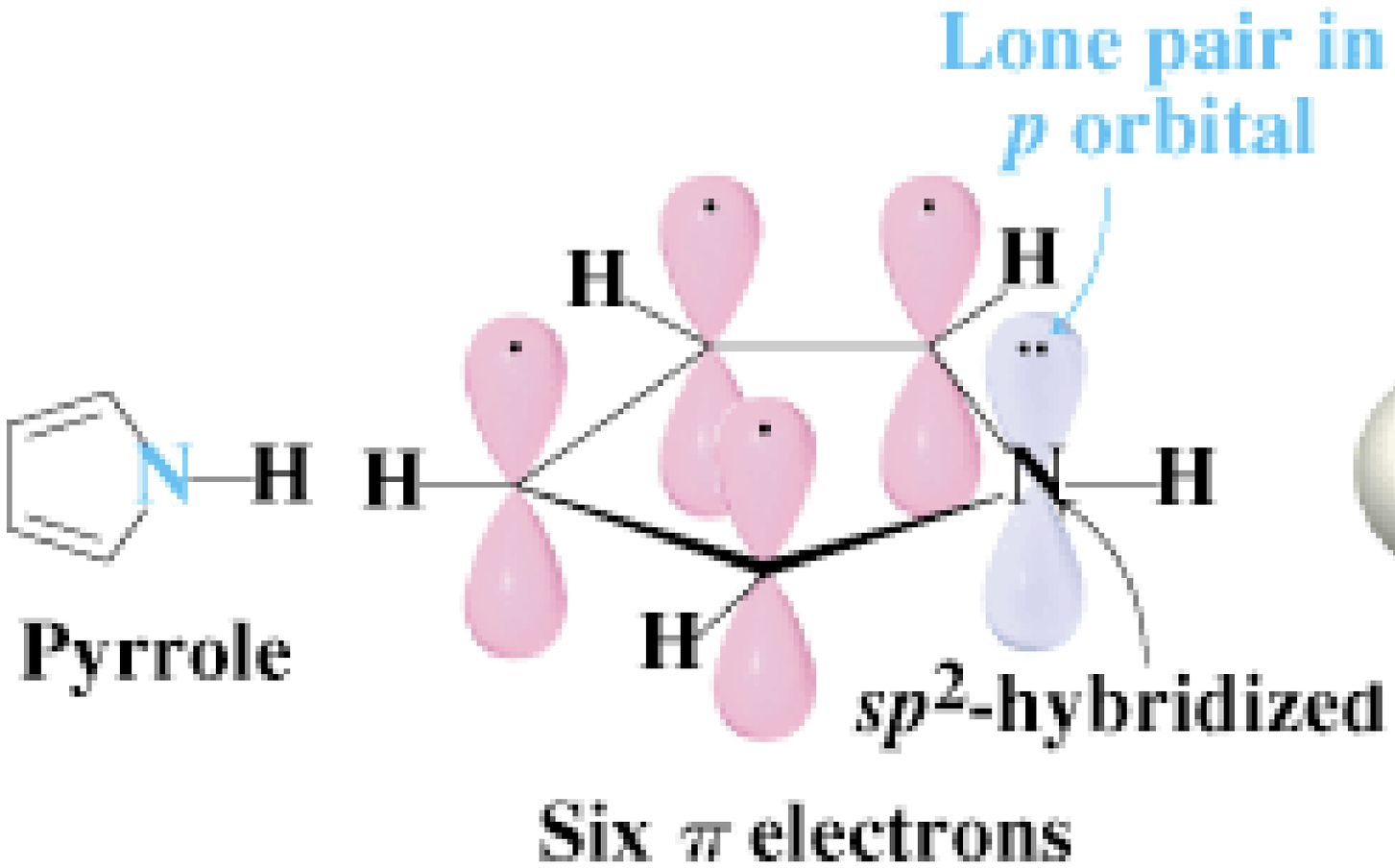


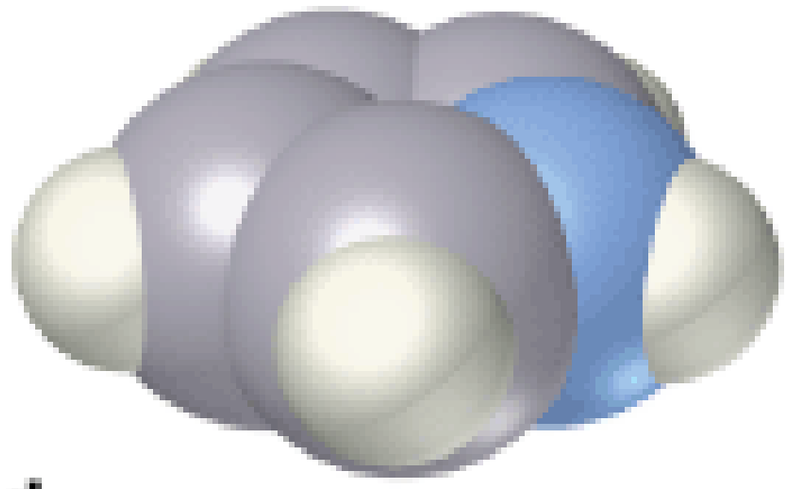
lone pair in resonance with aromatic pi system



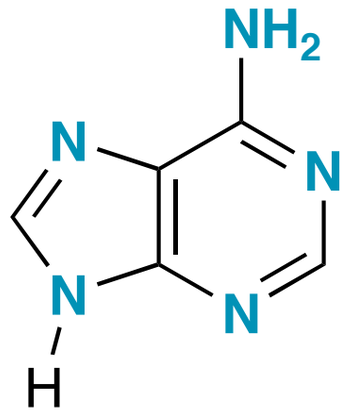
lone pair in resonance with aromatic pi system

Pyrrole

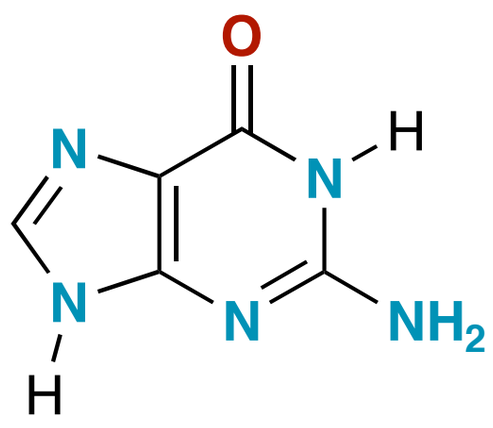

Lone pair in
p orbital
H
H
H
N
H
H
H
N
H
Pyrrole
sp2-hybridized
Six π electrons



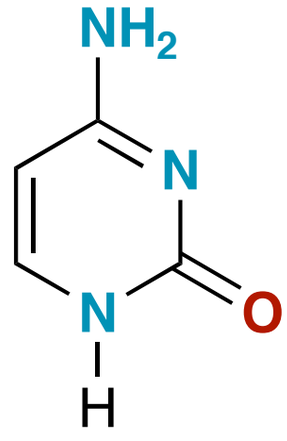
Heterocycles in DNA and RNA



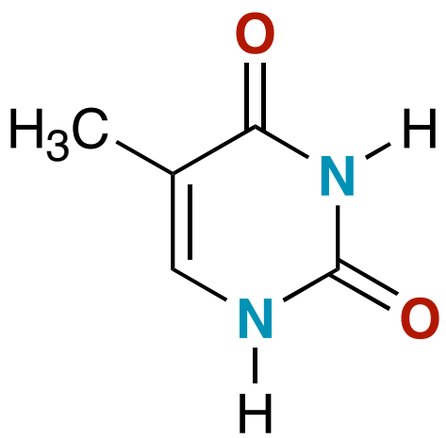
Adenine



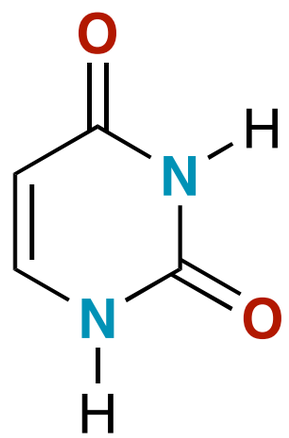
Guanine



Cytosine

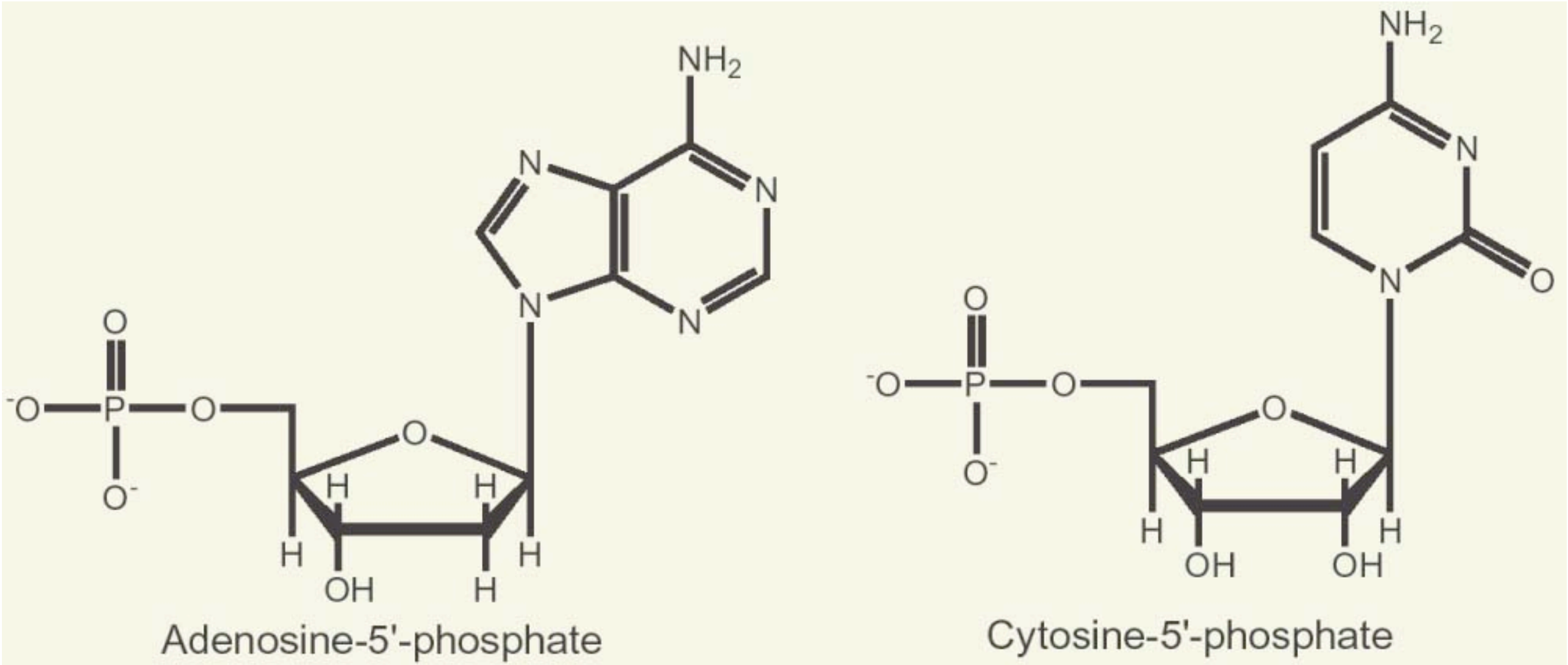


Thymine

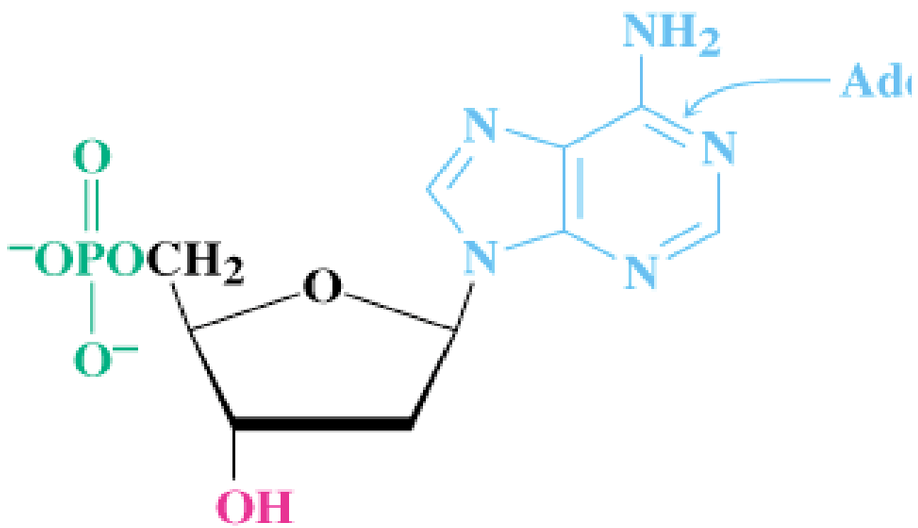


Uracil

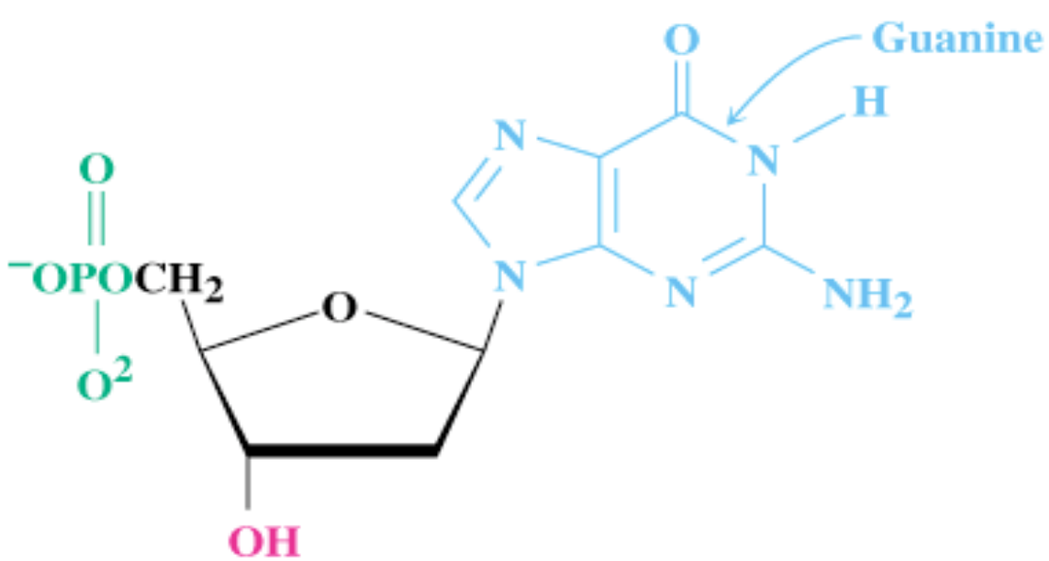
- The DNA/RNA bases are attached to phosphosugars



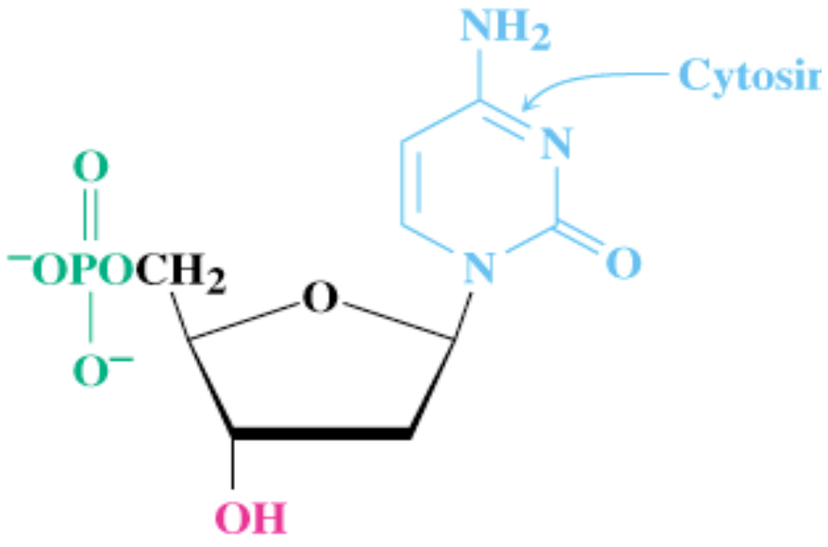
Deoxyribonucleotides



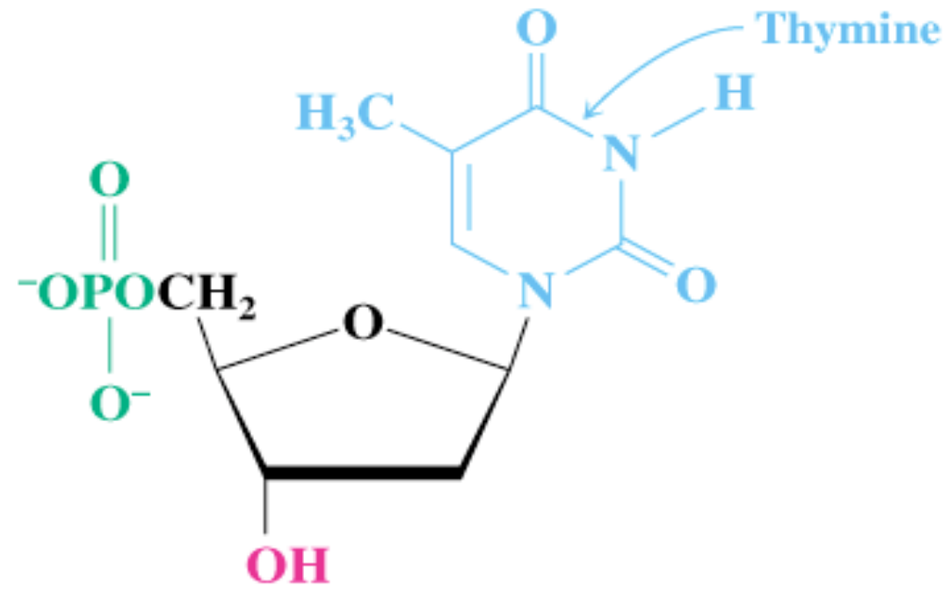
2′-Deoxyadenosine 5′-phosphate



2'-Deoxyguanosine 5'-phosphate

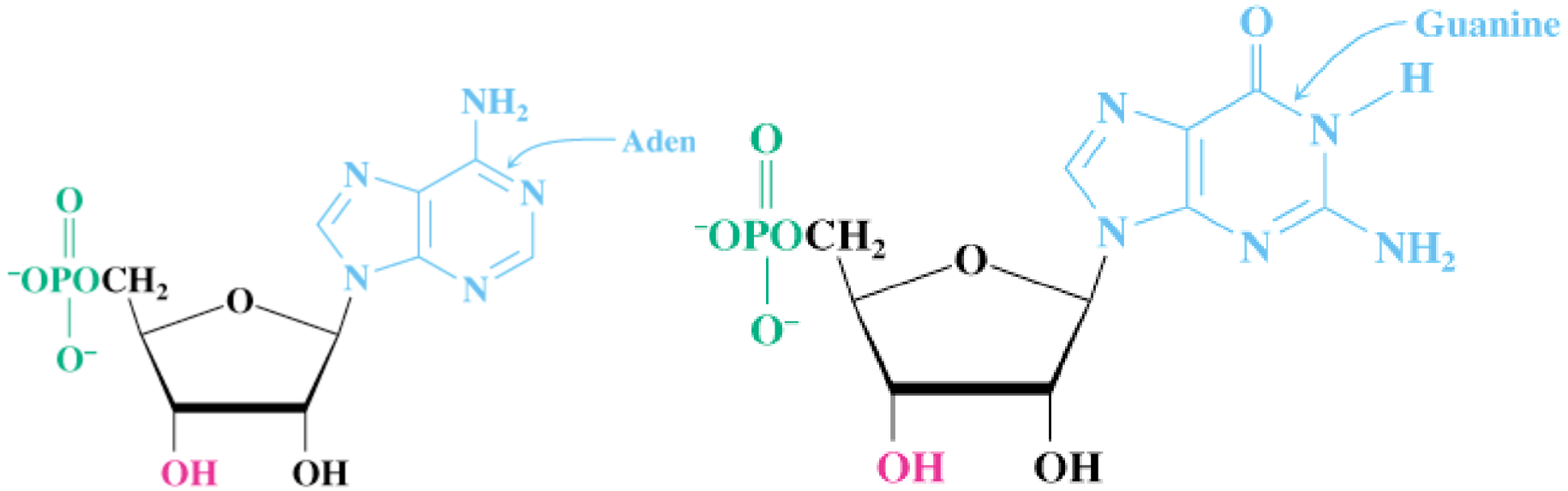


2'-Deoxycytidine 5'-phosphate

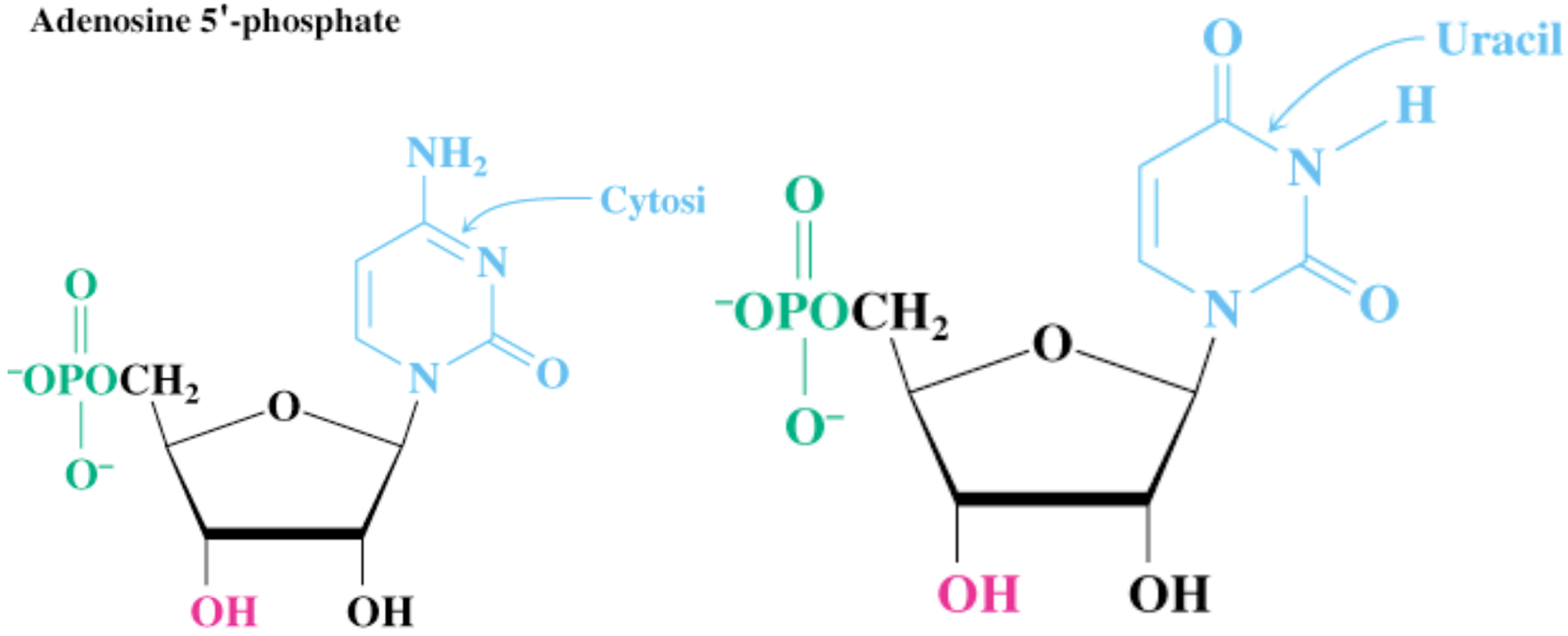


2'-Deoxythymidine 5'-phosphate

Ribonucleotides



Adenosine 5'-phosphate

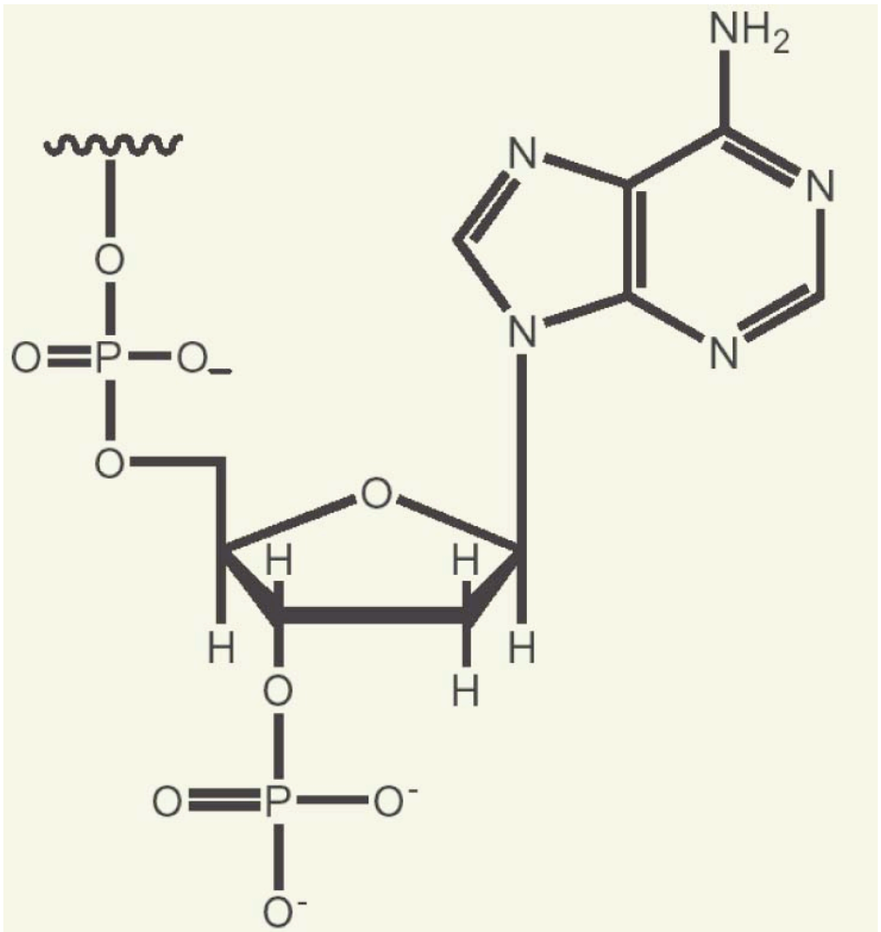


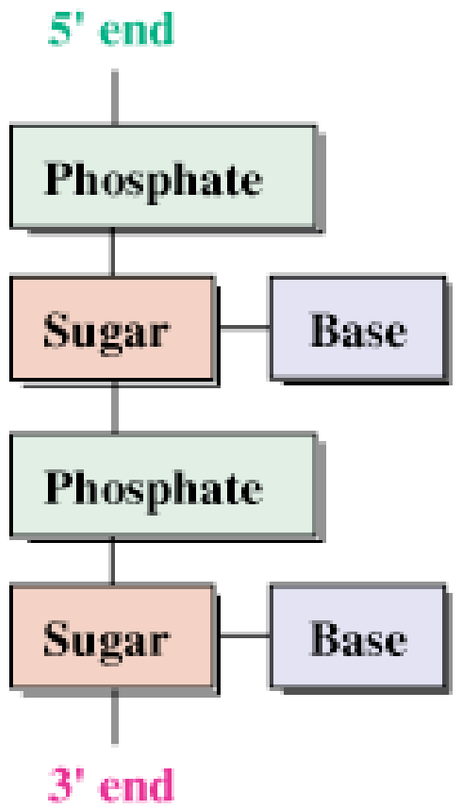
Cytidine 5'-phosphate

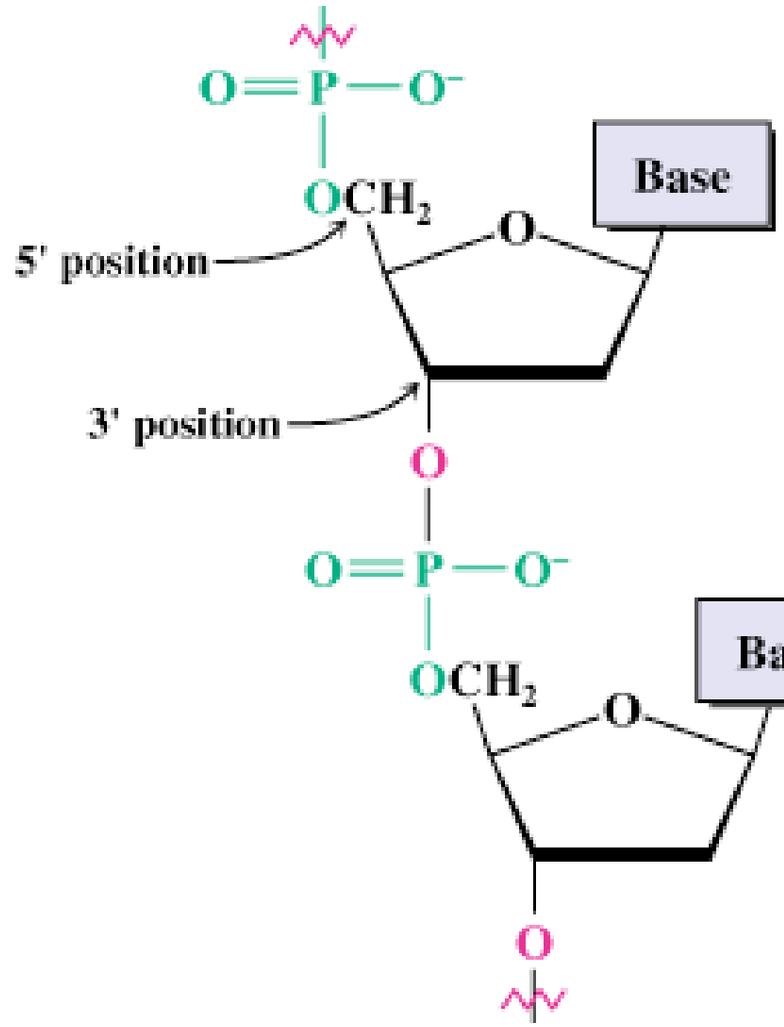
Uridine 5'-phosphate

Nucleic Acid Structure

- The nucleotides are connected together by the phosphates on the sugars





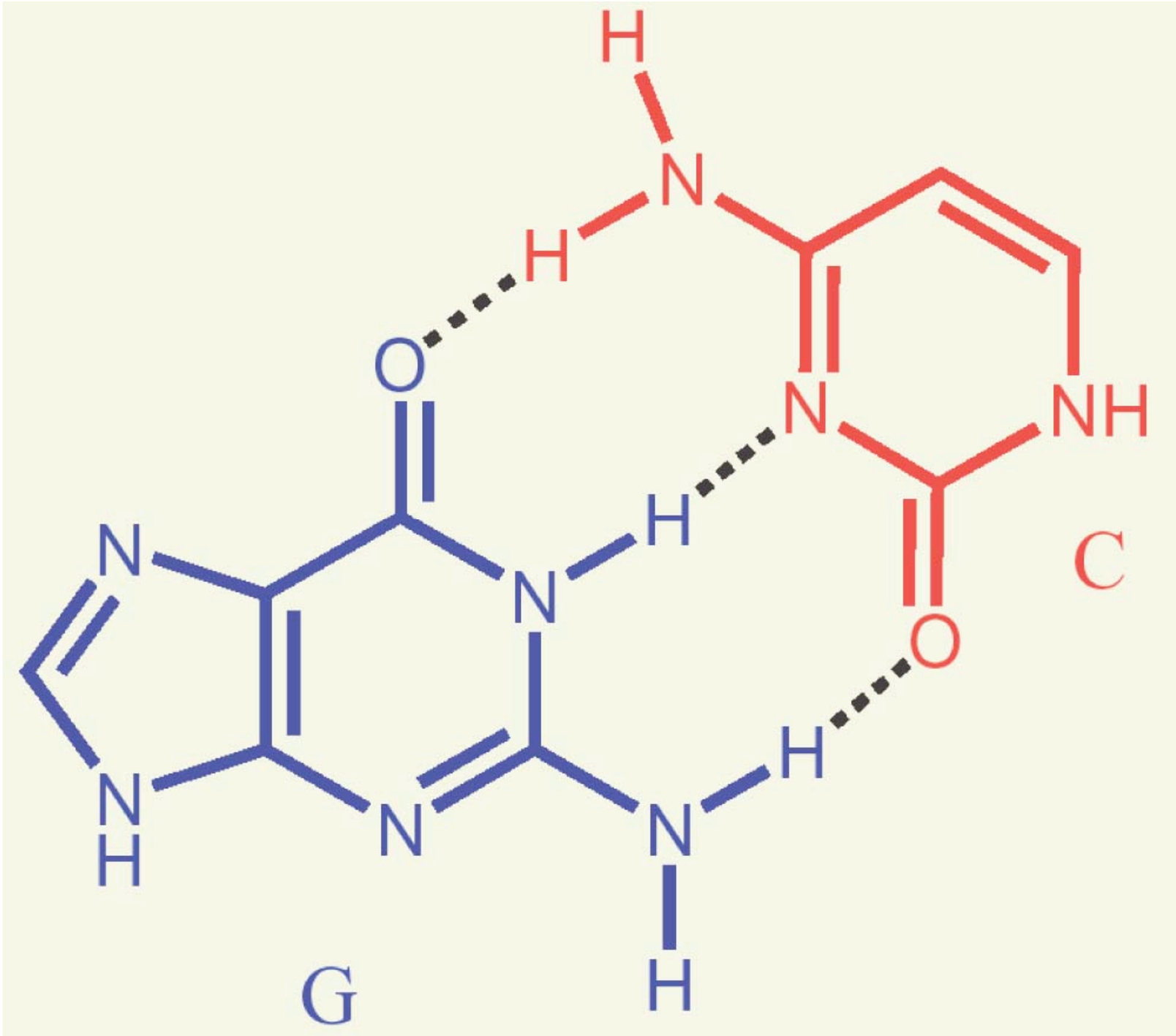


DNA Structure

- 1953 - Watson and Crick discovered DNA was made up of two strands running in opposite directions
- The strands are held together by hydrogen bonding from the bases
- Specific bases bind to each other like lock and key
- The strands are Complementary

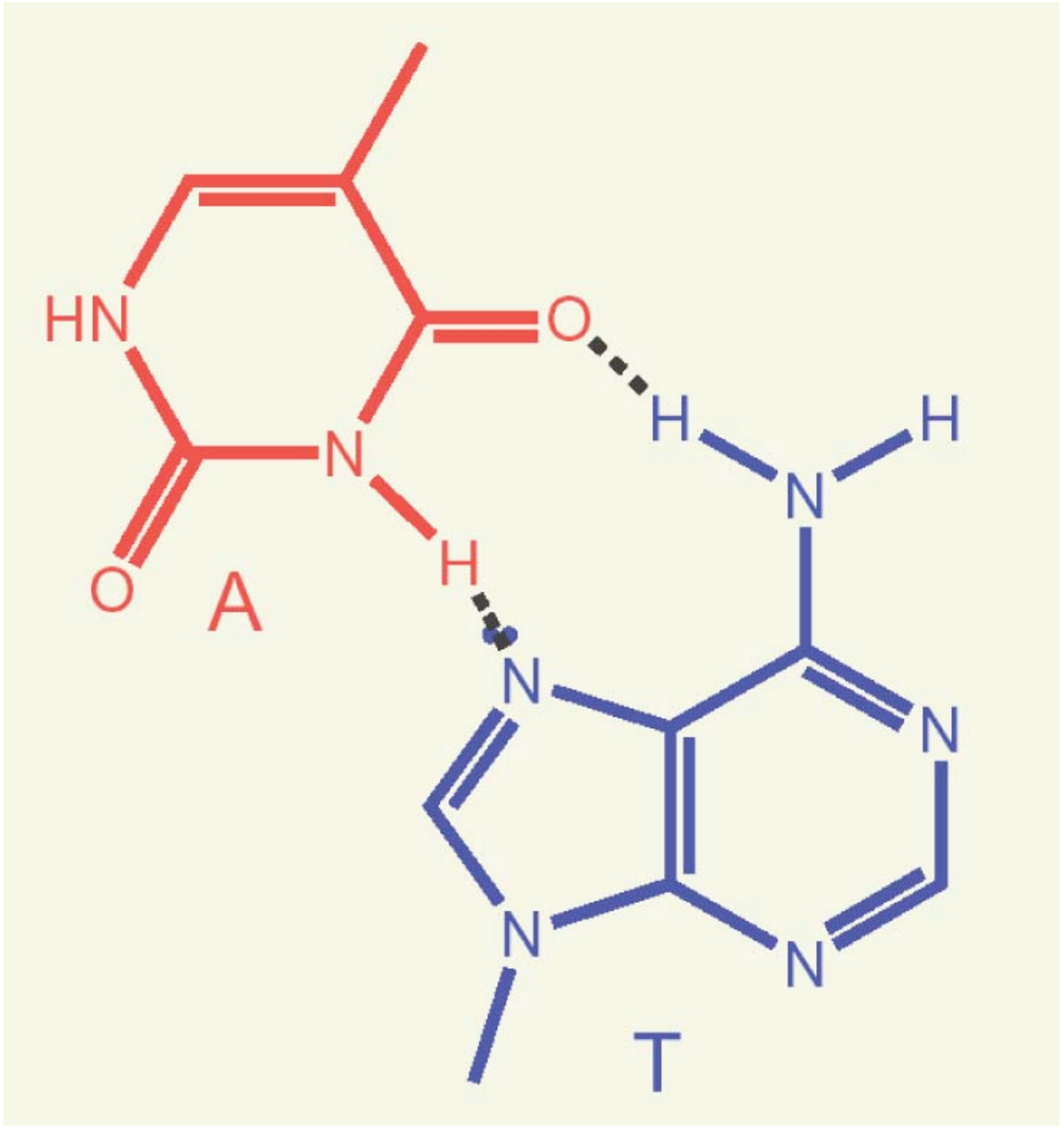
Bases Pair up with Hydrogen Bonds

- Guanosine matches with Cytosine



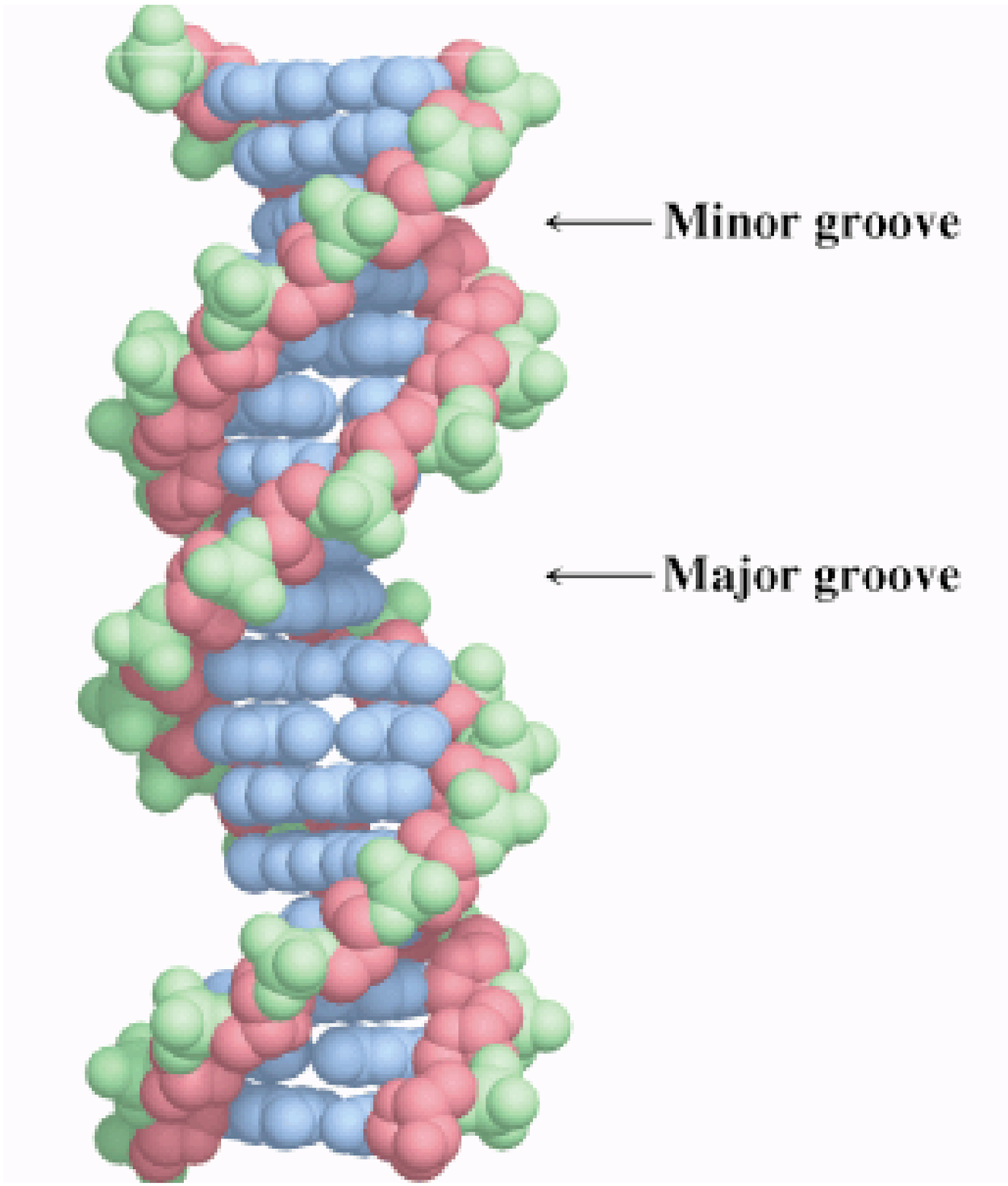
Bases Pair up with Hydrogen Bonds

- Adenine matches with Thymine



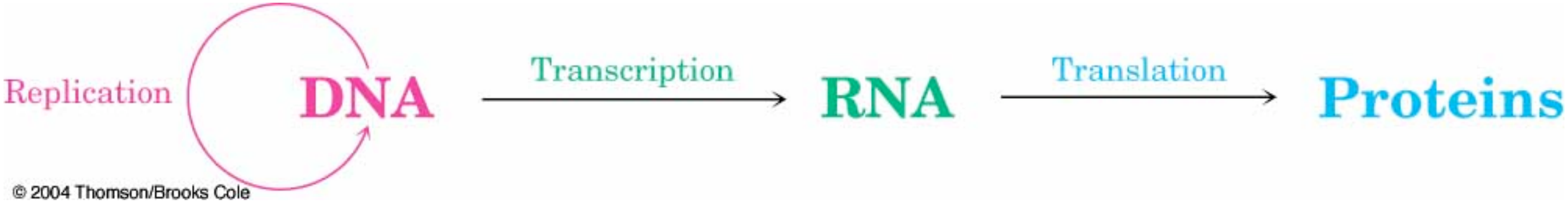
DNA Double Helix

- Two grooves are formed
- Sugar phosphate runs along the outside
- The major groove is slighty bigger and deeper than the minor groove

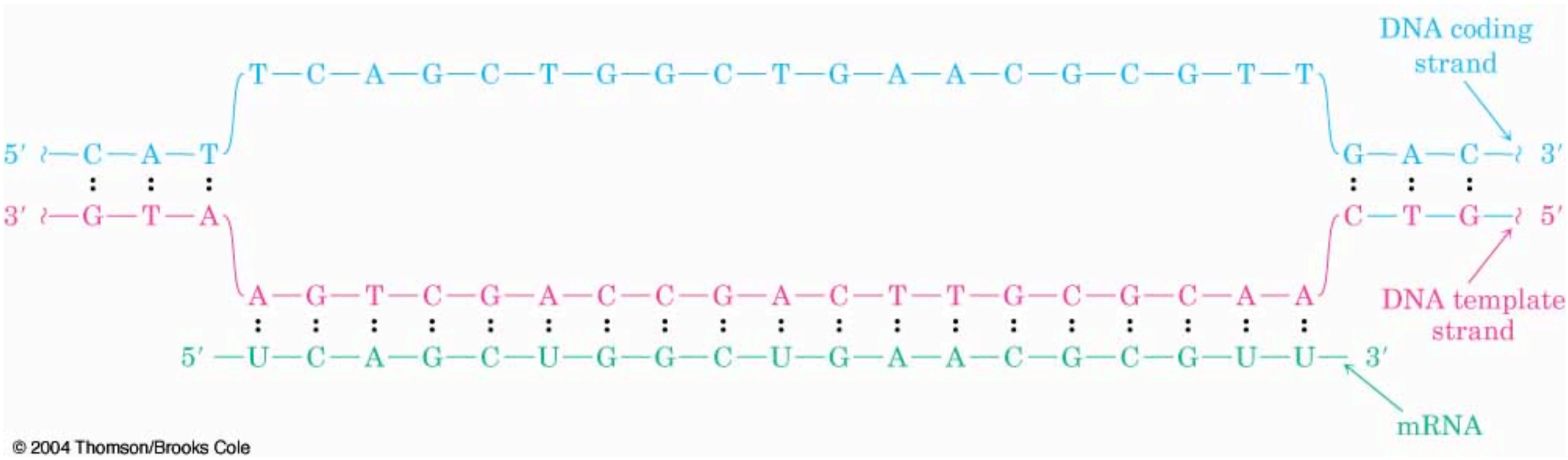


The Genes

- DNA is a code for the synthesis of proteins. Every 3 base pair sequence is directly correlated with a specific amino acid.



- DNA unwinds and codes an RNA strand



- RNA encodes the amino acid sequence for protein synthesis