BCHE2030 Tutorial 2 Group

Please change your name to the name on your student card.
If you are not attending your original group ocassionally, please indicate your original tutorial group next to your name. Thank you.
(If you change your group **permanently**, then no need to put down your group.)

Content

Lipids

Fatty acids identification

Different lipid-derived compounds

Nucleotides

Mutation

Midterm tips

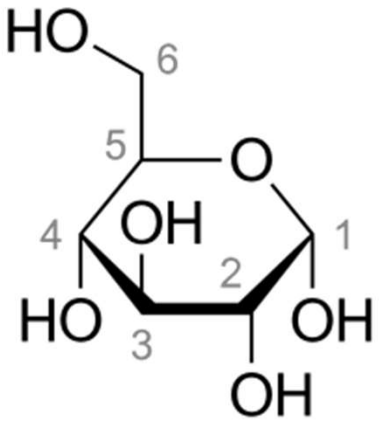
Try to write a summary for each lecture to test your understanding

After clear all concepts, try to memorize the characteristics of each type of biochemical compounds and related examples

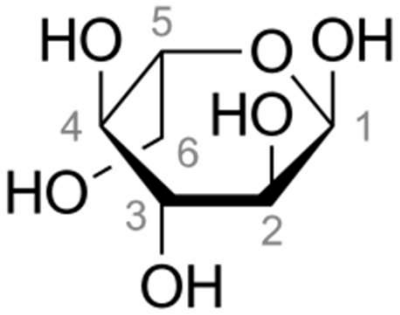
Finally, remember to sleep well before the test

Good quality of sleep and sufficient intake of nutrients will boost your memory :)

How to distinguish cyclic carbohydrates?

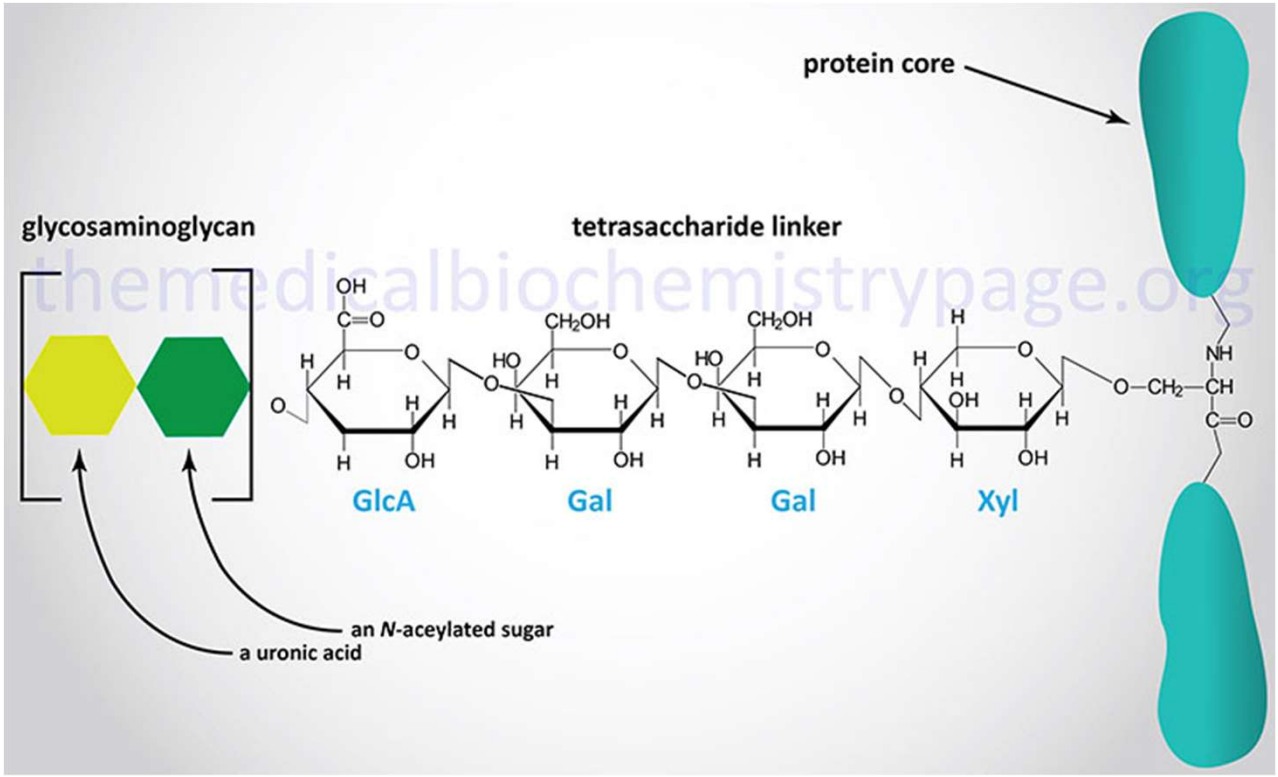


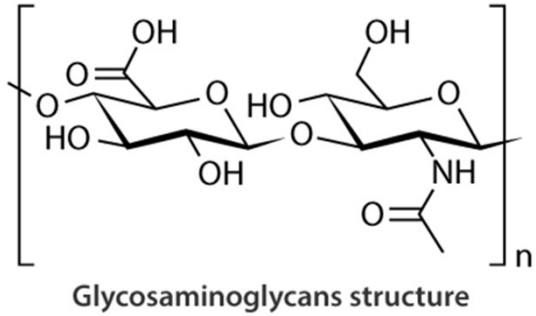
α-D-glucopyranose



α-L-glucopyranose

What factors allow hyaluronic acid to trap large amounts of water?





Lipids

3 major classes of lipids

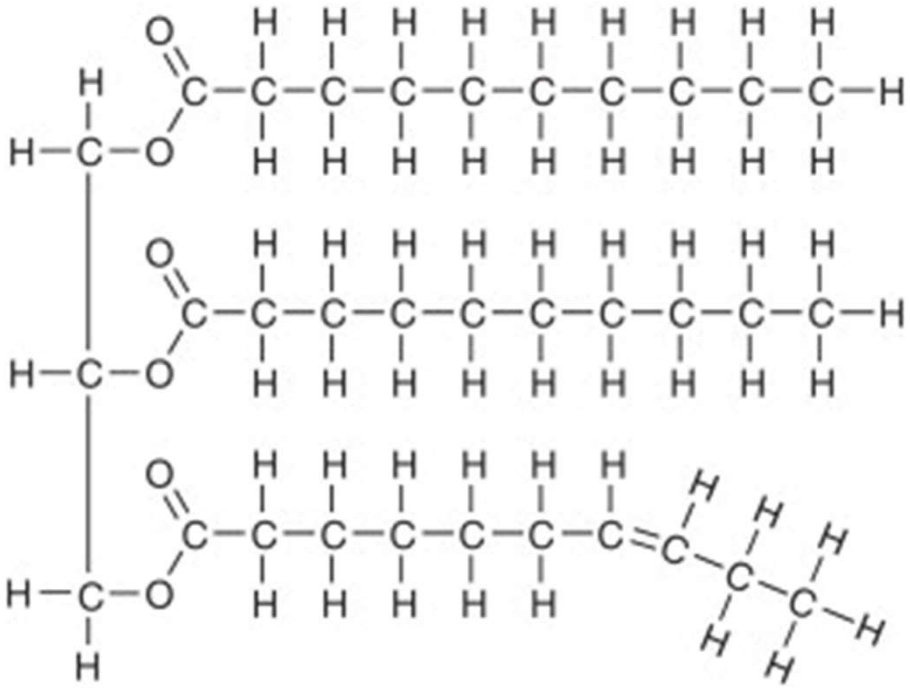
- Storage lipids
- Membrane lipids
- Signalling molecules

Storage lipids

Example: Triacylglycerol

- Store excess fatty acids
- For different species, the acyl chain vary in

  degree of length and saturation

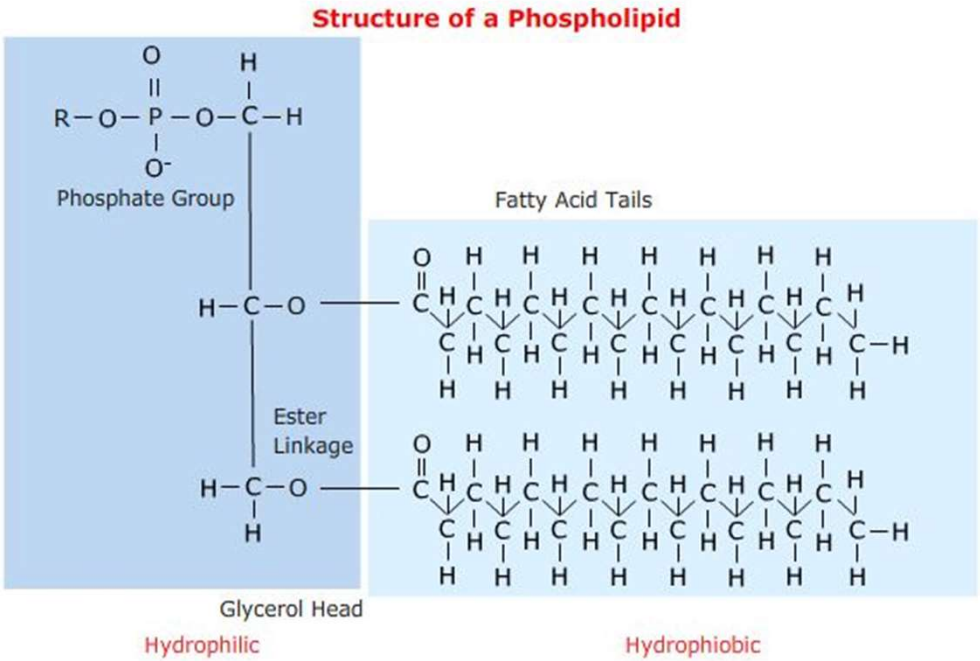


Membrane lipids

Example: Phospholipid

- Hydrophlic head and hydrophobic tail
- Regulates the permeability of the

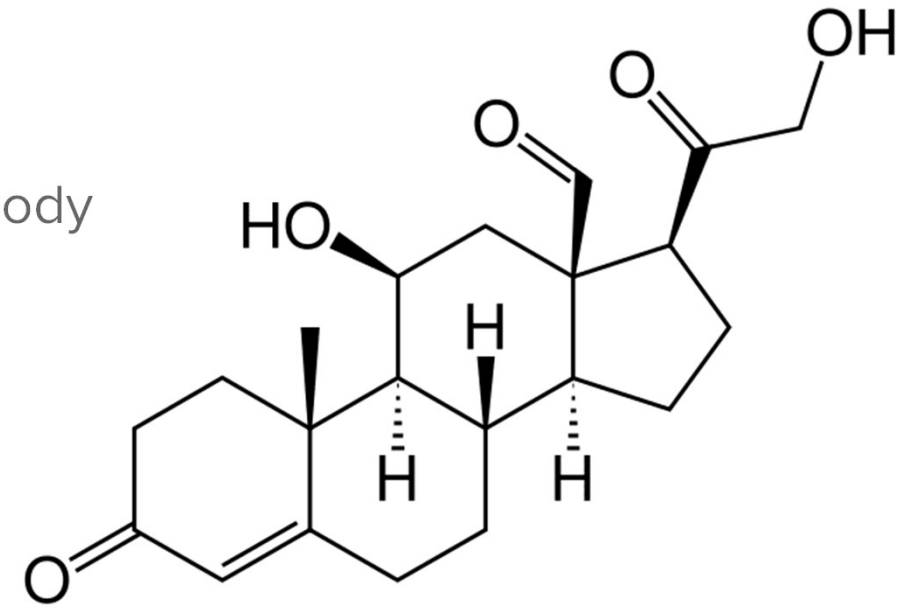
  cell membrane



Signalling molecules

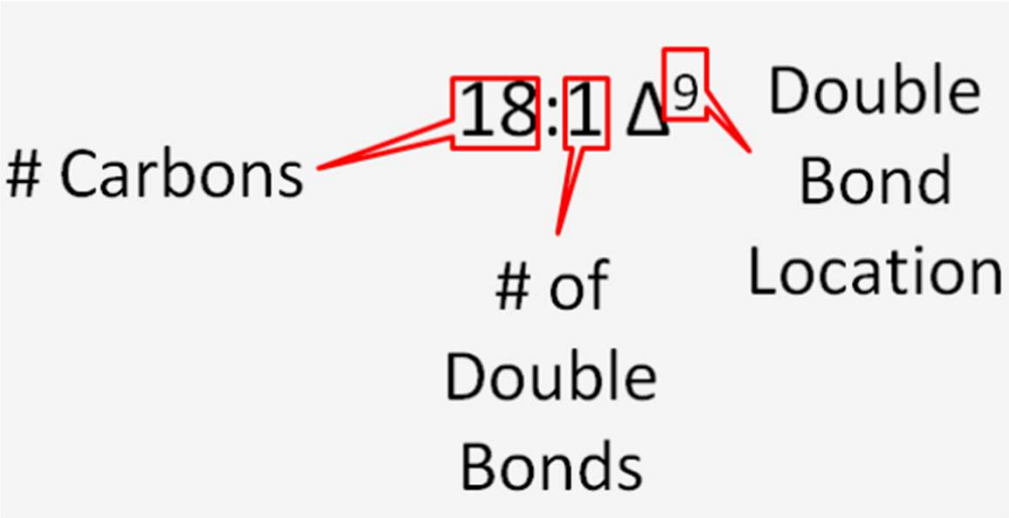
Example: Aldosterone

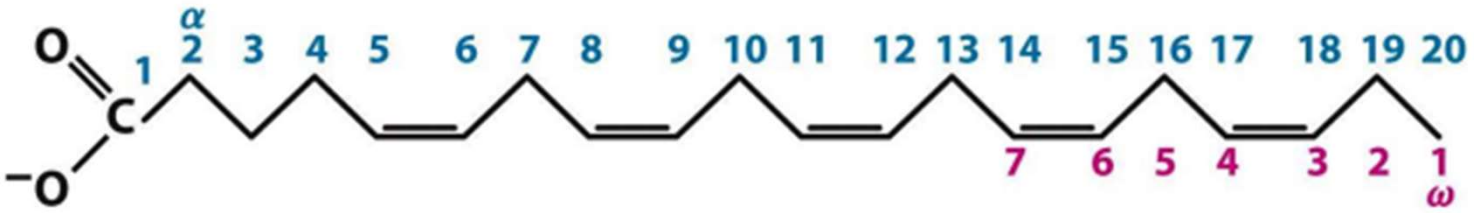
- Produced from cholesterol
- maintains salt and water balance in our body



Fatty acids identification

- number of carbon(usually 14<C<20)
- degree of unsatuation (C=C) varies
- Δ count from C start at carboxyl group

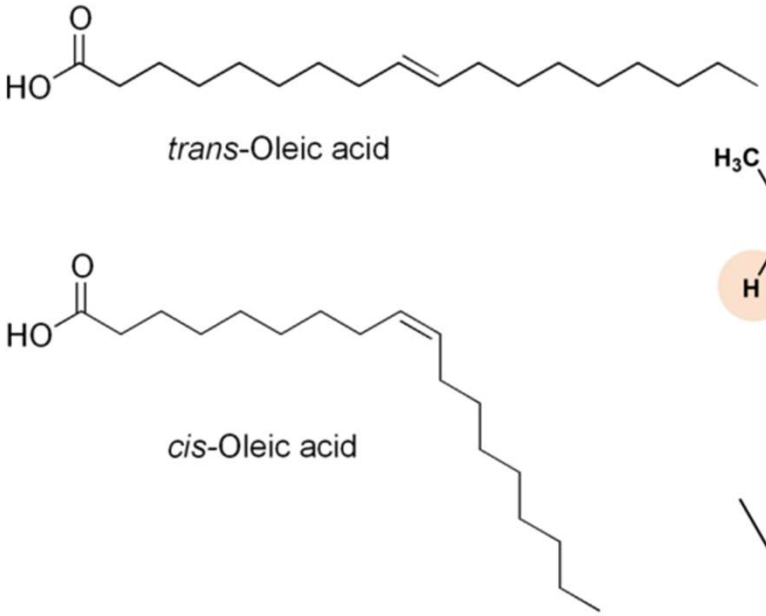


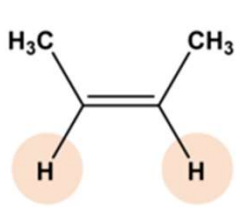


20:5($\Delta^{5,8,11,14,17}$) Eicosapentaenoic acid (EPA),

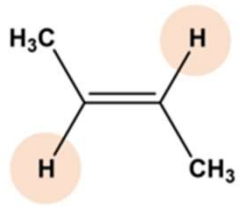
Cis/trans

- Degree of unsaturation affects the melting points of fatty acids
- natural foods mostly occurs in cis fatty acid
- the process of hydrogenation of vegetable oils formed trans fatty acid
- The absence of double bonds decreases fluidity

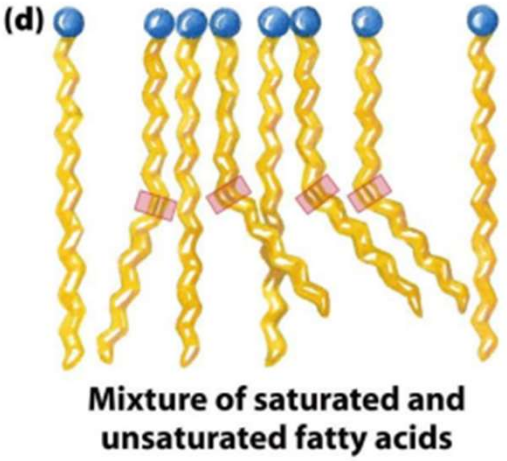




cis



trans



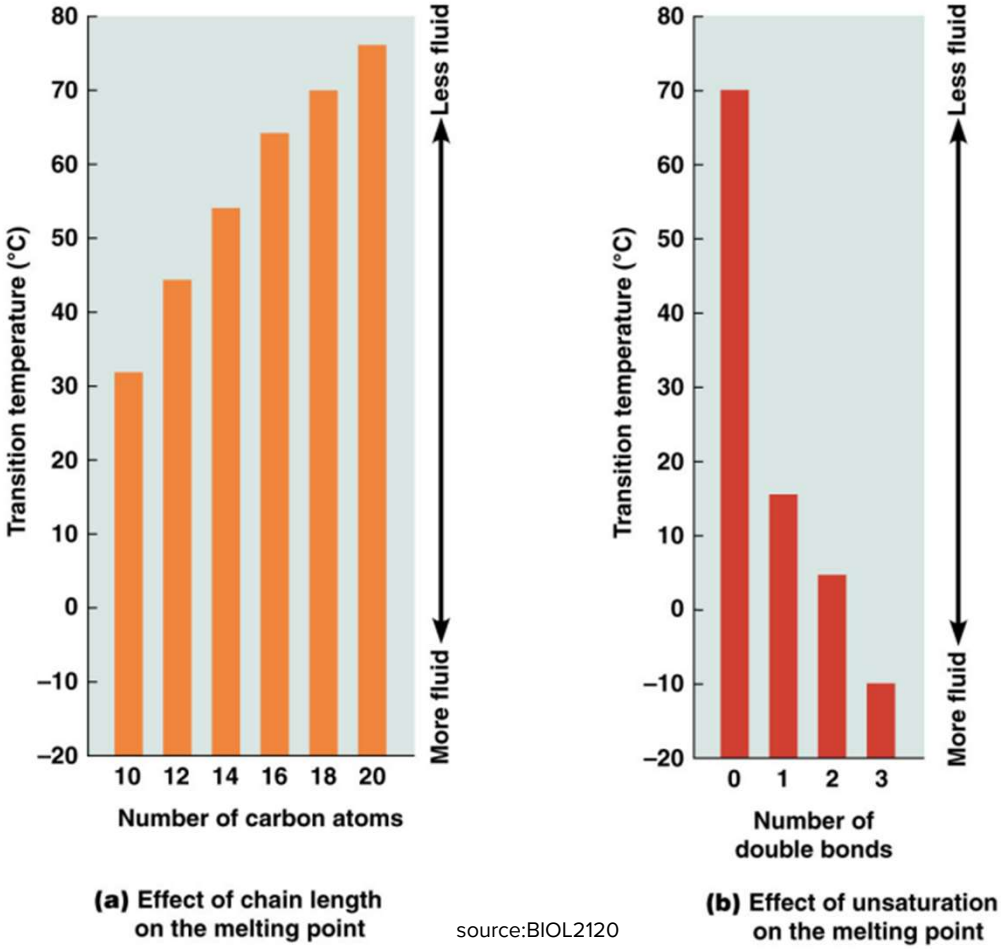
What is mean by α-Linolenic acid

- alpha is a common name
- does not refer to enantiomers

Omega Name	Common Name
4:0	Butyric Acid
12:0	Lauric Acid
14:0	Myristic Acid
16:0	Palmitic acid
18:0	Stearic Acid
20:0	Arachidic Acid
24:0	Lignoceric Acid
18:1 (n-9)	Oleic Acid
18:2 (n-6)	Linoleic Acid
18:3 (n-3)	Alpha-linolenic Acid
20:4 (n-6)	Arachidonic Acid
20:5 (n-3)	Eicosapentanoic Acid
22:6 (n-3)	Docosahexanoic Acid

Does all living organisms stores unsaturated fats?

- with steroid/cholesterol
- ensure that membranes are fluid at physiological temperatures

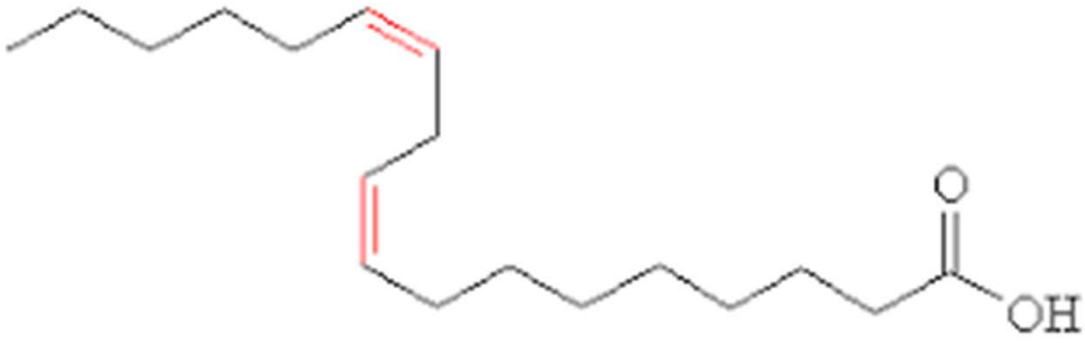


source:BIOL2120

Quiz 1

What is the Nomenclature of this fatty acid?

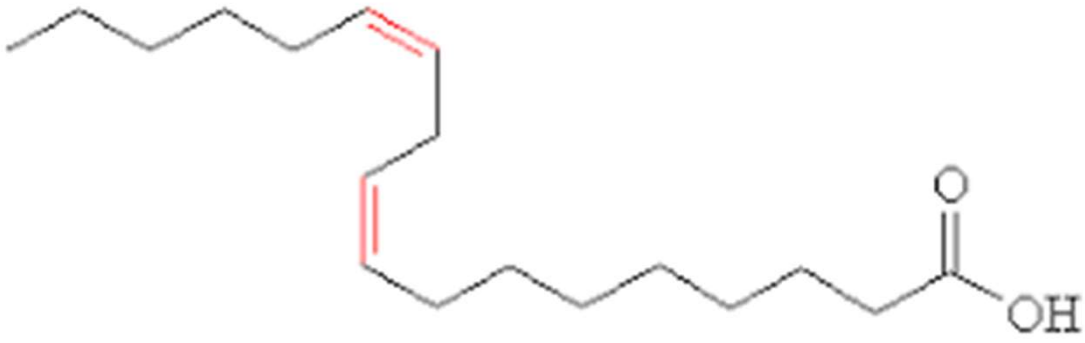
A. Cis, Cis, 18:2 $\Delta^{9,12}$
B. trans, trans, 18:2 $\Delta^{9,12}$
C. Cis, Cis, 18:2 $\Delta^{6,9}$
D. trans, trans, 18:2 $\Delta^{6,9}$



Quiz 1

What is the Nomenclature of this fatty acid?

A. Cis, Cis, 18:2 $\Delta^{9,12}$
B. trans, trans, 18:2 $\Delta^{9,12}$
C. Cis, Cis, 18:2 $\Delta^{6,9}$
D. trans, trans, 18:2 $\Delta^{6,9}$

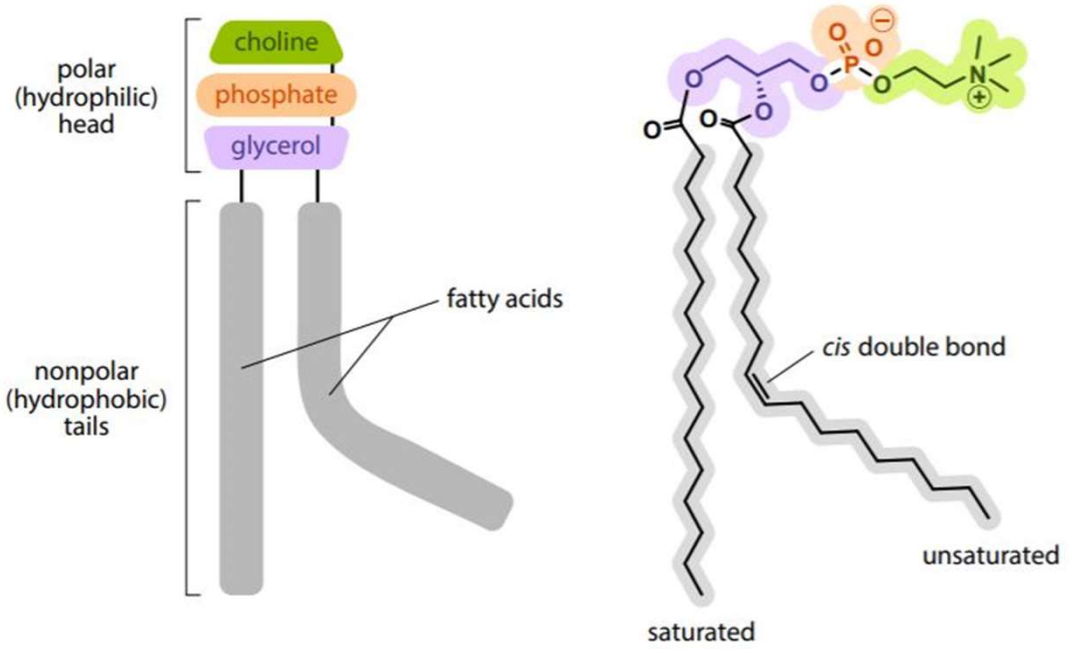


Phosphatidylcholine

- Most abundance class of phospholipid in membrane
- Phospholipid attached to choline particle
- Phosphorus part of phospholipid is made up

  of phosphatidylcholine

- charged groups facing different sides



Lipid-derived compounds

- Vitamins
- Hormones
- Cofactors

Biosynthesis of isoprenoid

Example: Vitamin A

- Cleavage of beta carotene to form retinol (Vitamin A)
- Further modifications of retinol forms all-trans-retinal (neuronal signalling molecule) and retinoic acid (hormonal signallingh molecule)

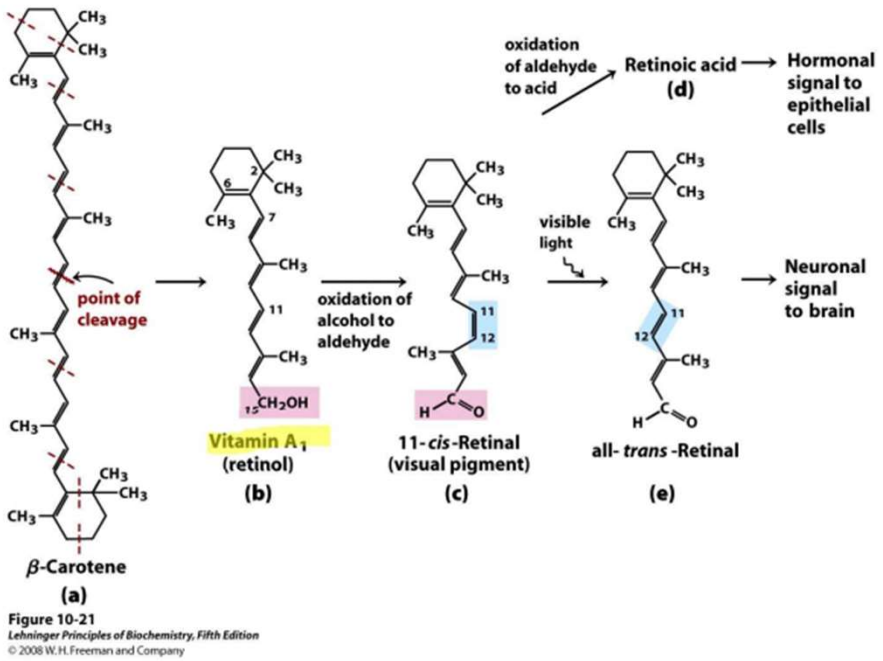
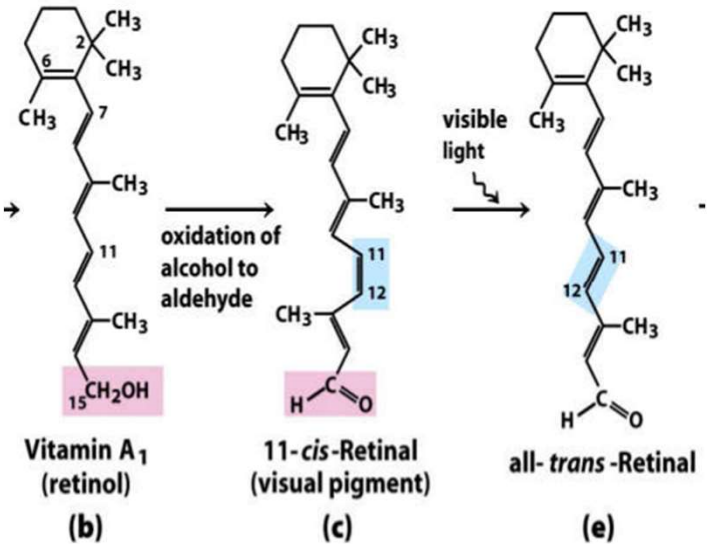


Figure 10-21
Lehninger Principles of Biochemistry, Fifth Edition

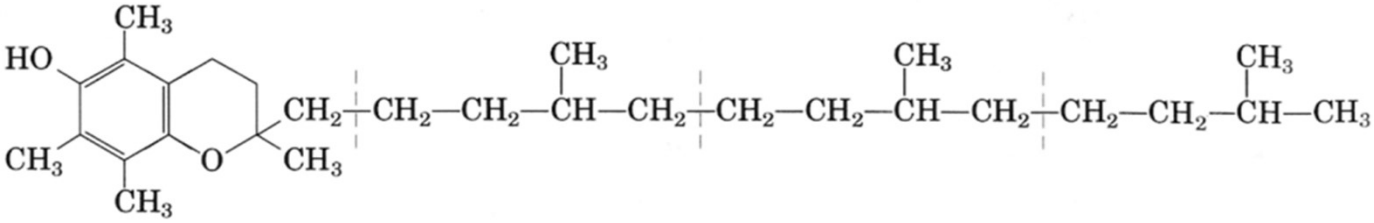
Vitamins A

- Containing isoprene unit (4 straight chain carbons + 1 branched carbon)
- Vitamin A: precursor for retinal (pigment in rod cells)
- vision in dark
- Deficiency:
  - night blindness
  - skin dryness
  - retarded growth and development



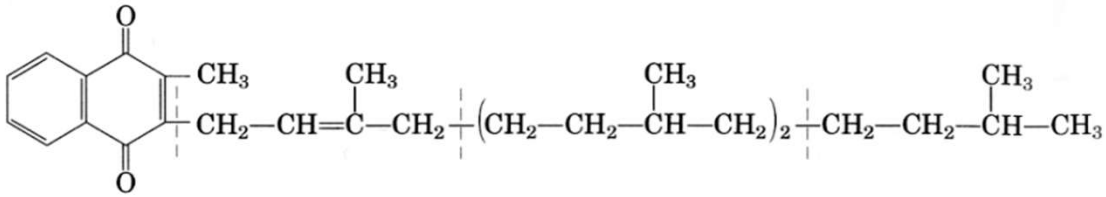
Vitamin E

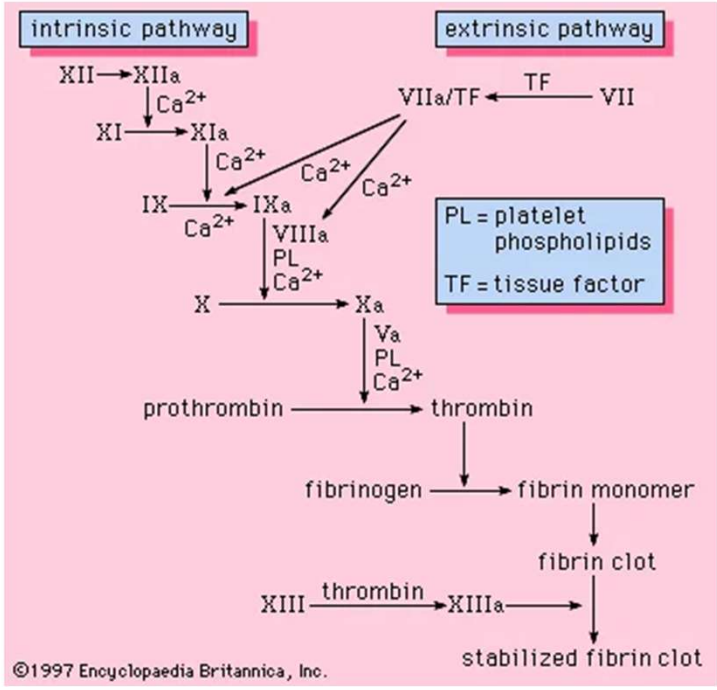
- contain isoprene unit
- antioxidants (aromatic ring donates e- to radicals)
- Deficiency:
  - Fragile RBC (due to oxidative stress)



Vitamin K

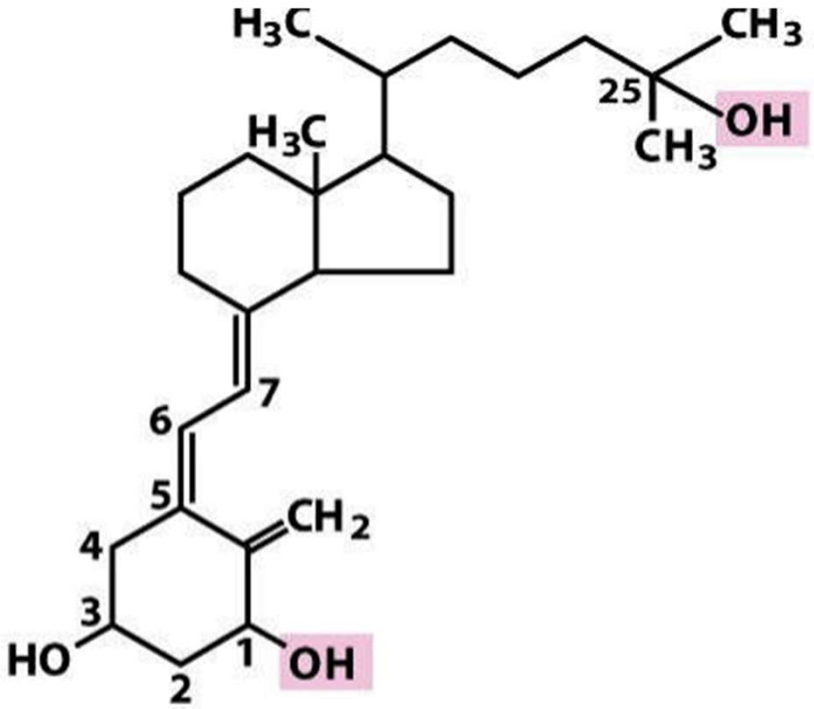
- contain isoprene unit
- acts as blood clotting factor
- involve in formation of prothrombin (precursor of protease thrombin)





Vitamin D3 (calcitriol)

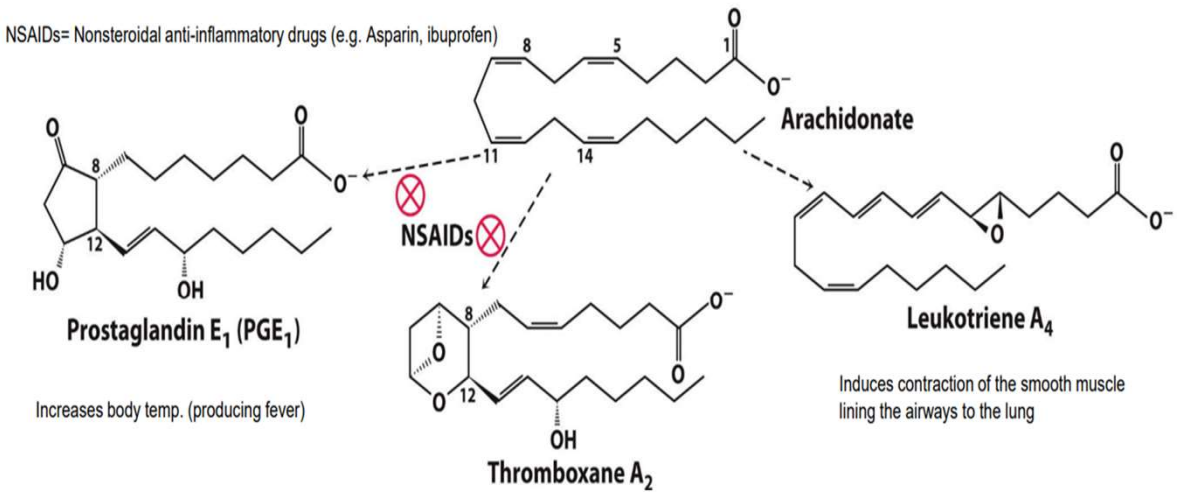
- regulates Calcium uptake and plasma calcium concentration
- Deficiency:
  - Rickets

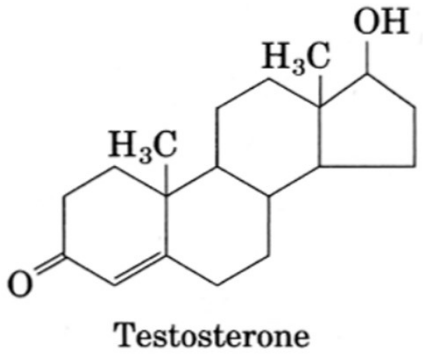


1,25-Dihydroxycholecalciferol (1,25-dihydroxyvitamin D_3)

Hormones

- paracrine (close)/endocrine (far)
- Paracrine: eicosanoids
  - derivatives of arachnoid acid (omega 6 lipid)
- Endocrine: steroids (cholesterol)
  - four fused rings

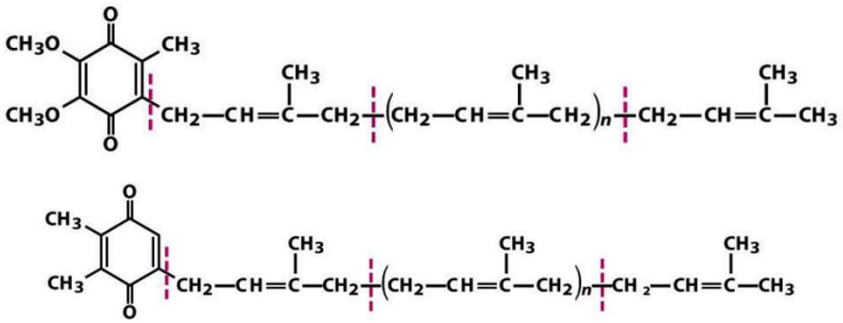




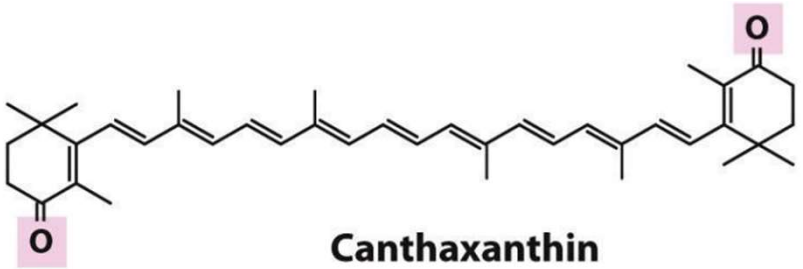
Testosterone

Cofactor/Pigments

- Q (ubiquinone)/PQ(plastoquinone)
  - lipid-soluble, move freely in membrane lipids
- ATP synthesis

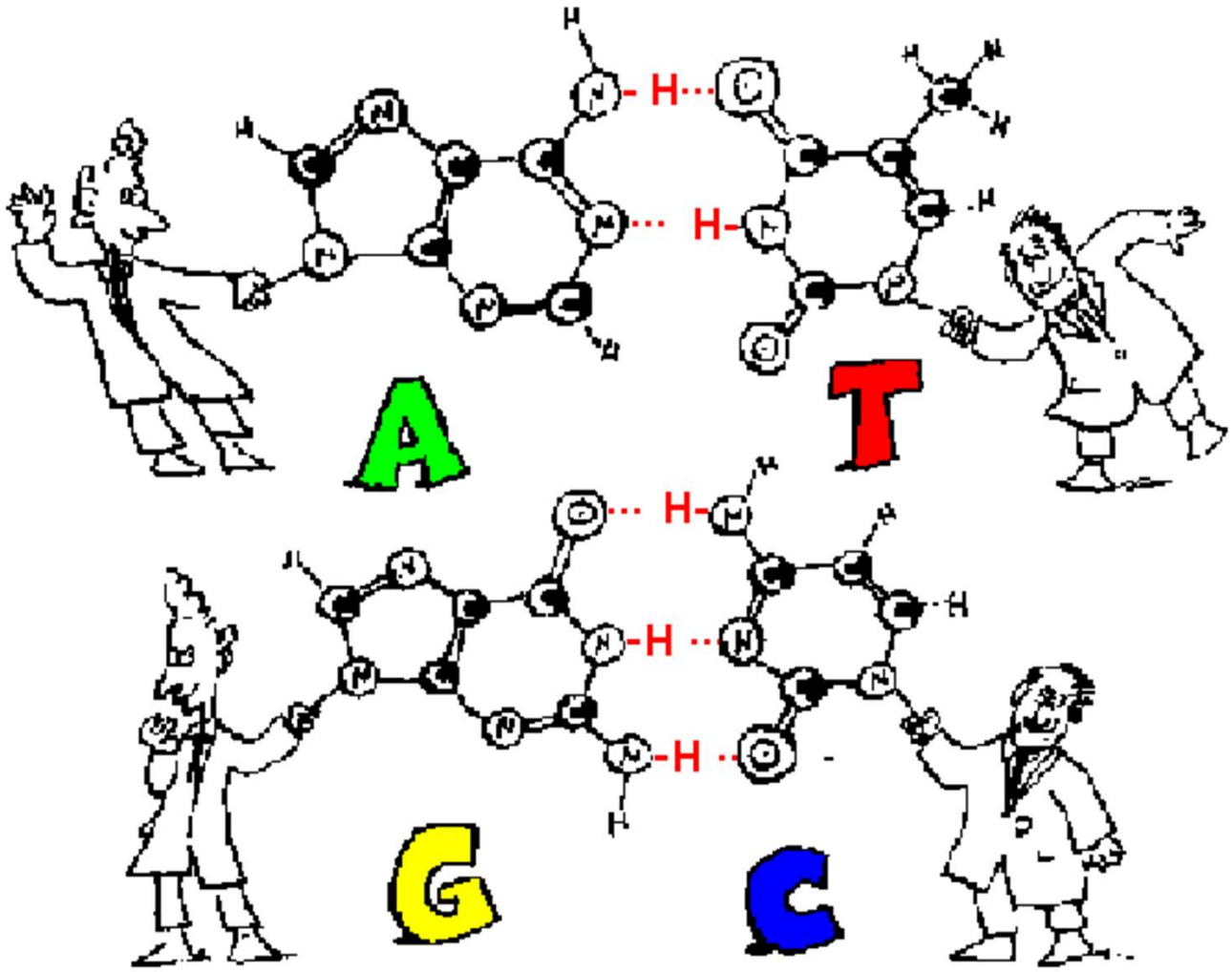


- Pigments
  - conjuagted C=C bonds/
  - allow delocalization of electrons



Canthaxanthin
(bright red)

Base Pairing in DNA

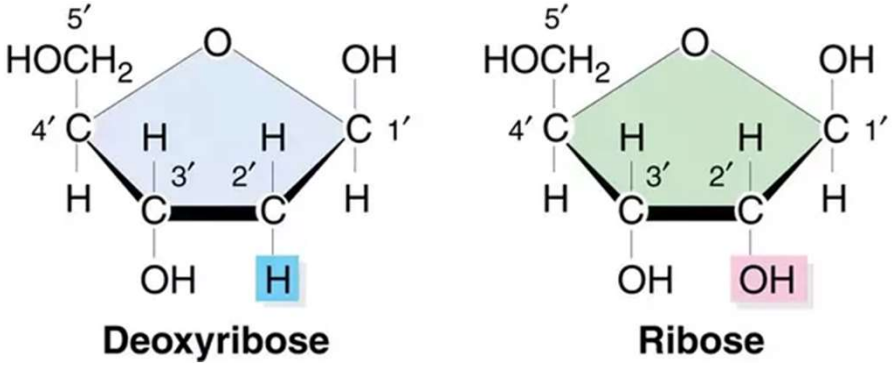


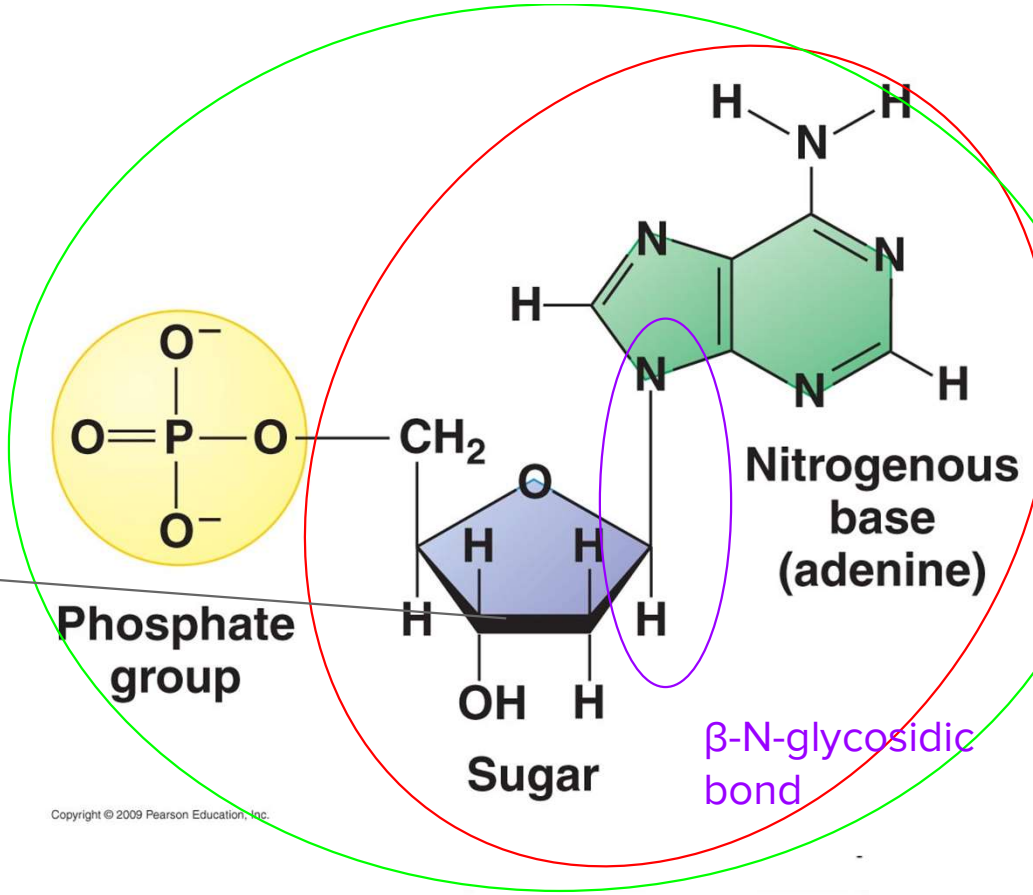
A-T: 2 H bonds

G-C: 3 H bonds

- strength of GC pair and AT pair is different (GC > AT)
  - In PCR, the GC-content of primers is often used to predict their annealing temperature to the template DNA

Structure of Nucleotides





nitrogen containing base

pentose

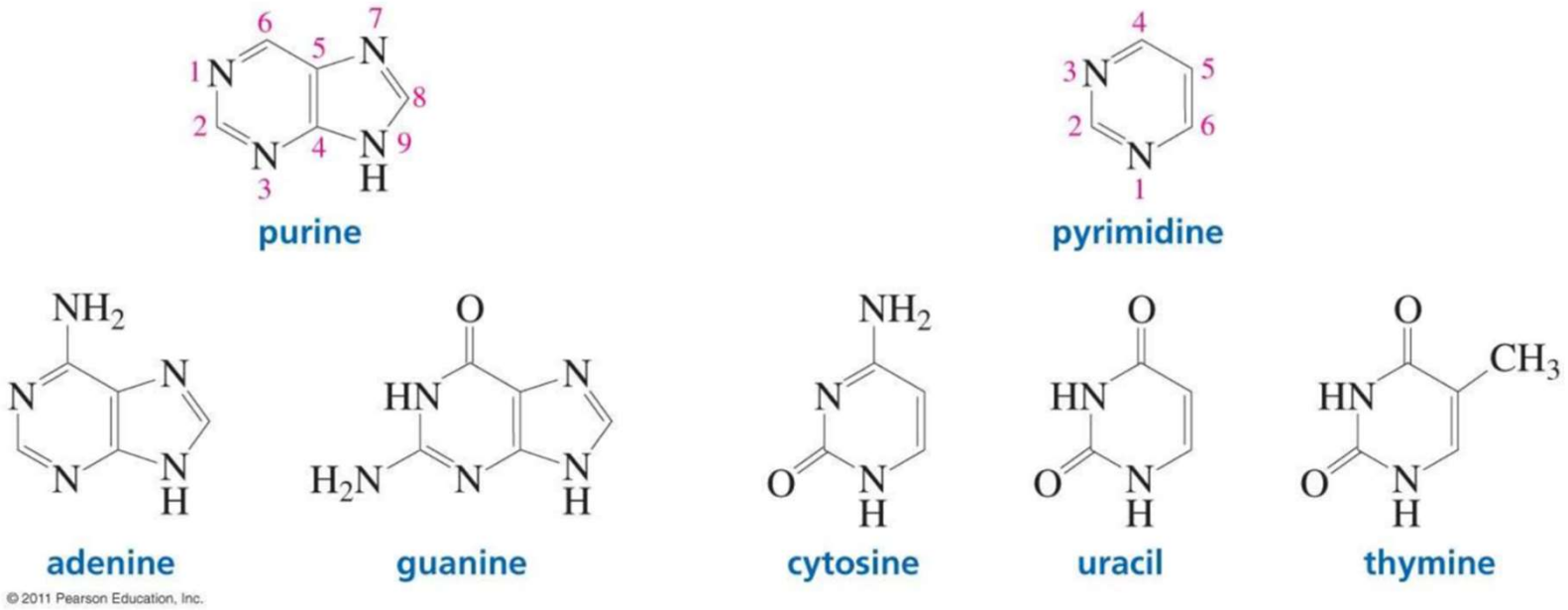
Nucleoside

phosphate

Nucleotide

Bases in Nucleic Acids

The heterocyclic amines are commonly referred to as **bases** (**nucleobases**).



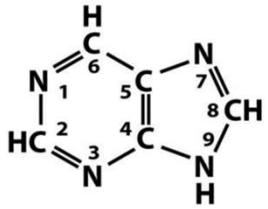
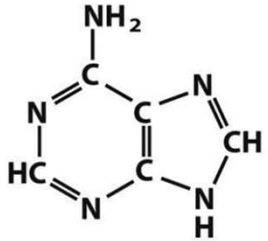
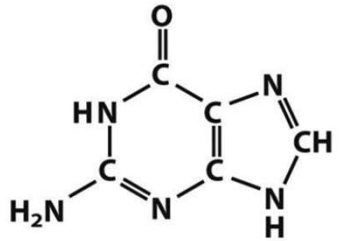
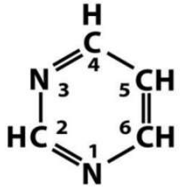
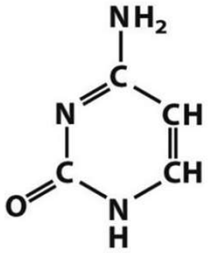
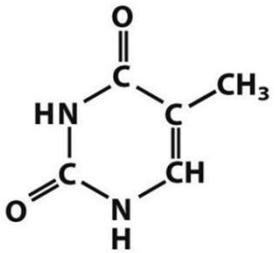
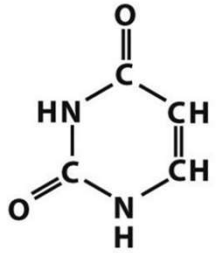
- Adenine (**A**), guanine (**G**), cytosine (**C**) and thymine (**T**) are found in DNA.
- Adenine (**A**), guanine (**G**), cytosine (**C**) and uracil (**U**) are found in RNA.

Why are the numbering ways of purine and pyrimidine different?

Two simple rules for numbering a heterocyclic ring:

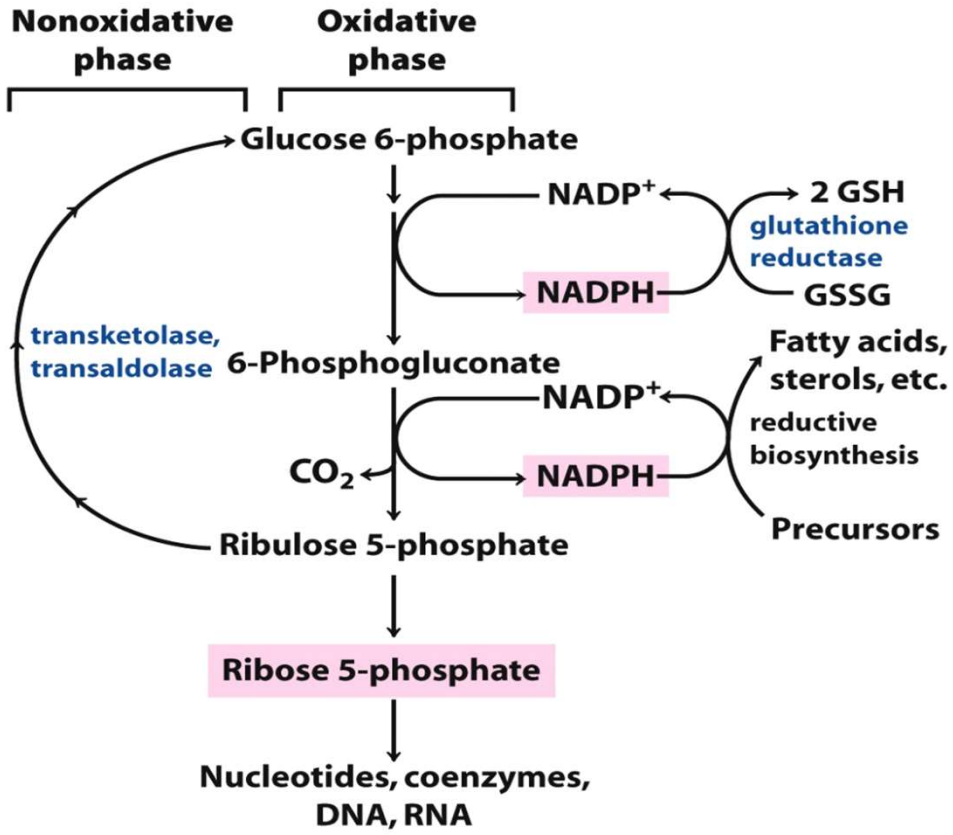
- Hetero atoms (aka. N) should have the lowest possible numbers.
- Carbon atoms which are shared by two rings should follow the lowest possible numbers.

The numbering way is artificially set by scientists. (So... just by their preference!)

General Structure	Common base	
 Purine	 Adenine	 Guanine
 Pyrimidine	 Cytosine	 Thymine (DNA)
		 Uracil (RNA)

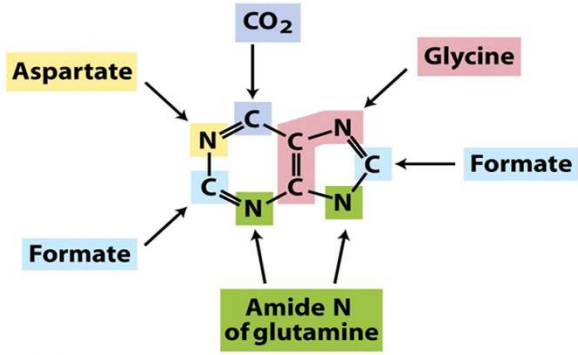
Synthesis of Nucleotides (nucleotide = pentose + base + Pi)

- **ribose 5-phosphate: from pentose phosphate pathway (i.e. G6P -> ribose 5-phosphate)**
- base synthesis & attachment of base to pentose-Pi: VERY complicated (don't need to know details)
- ribonucleotide->deoxyribonucleotide: the reaction is catalyzed by ribonucleotide reductase

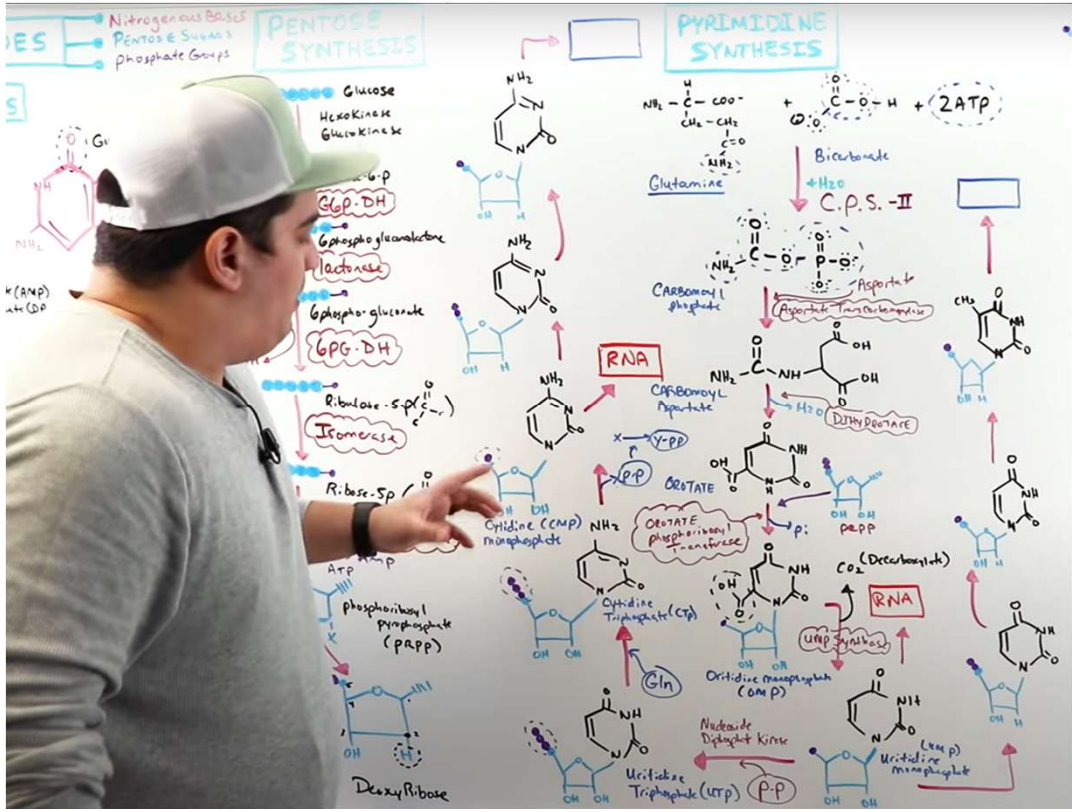


https://www.youtube.com/watch?v=4GFKdLy2fOE

Synthesis of Nucleotides (nucleotide = pentose + base + Pi)

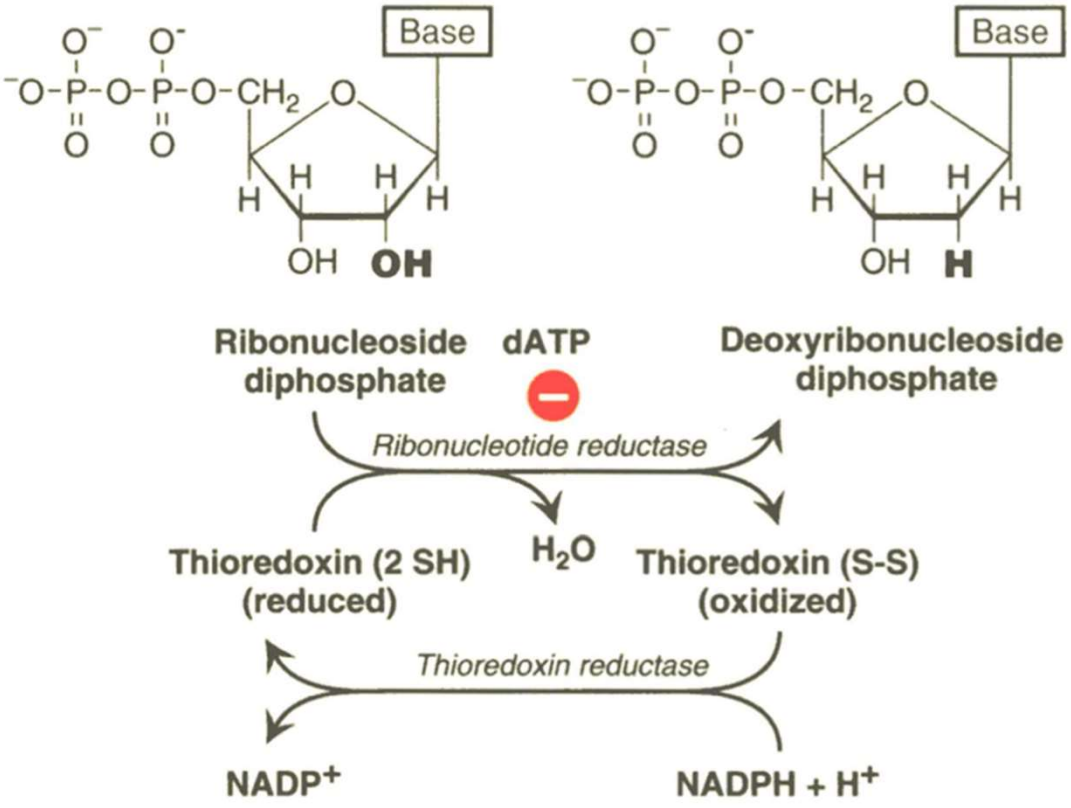


- ribose 5-phosphate: from pentose phosphate pathway (i.e. G6P -> ribose 5-phosphate)
- **base synthesis & attachment of base to pentose-Pi: VERY complicated (don't need to know details)**
- ribonucleotide->deoxyribonucleotide: the reaction is catalyzed by ribonucleotide reductase



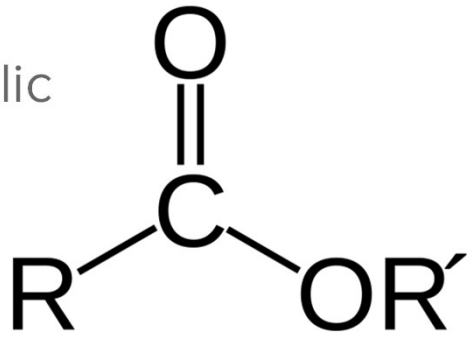
Synthesis of Nucleotides (nucleotide = pentose + base + Pi)

- ribose 5-phosphate: from pentose phosphate pathway (i.e. G6P -> ribose 5-phosphate)
- base synthesis & attachment of base to pentose-Pi: VERY complicated (don't need to know details)
- **ribonucleotide->deoxyribonucleotide: the reaction is catalyzed by ribonucleotide reductase**

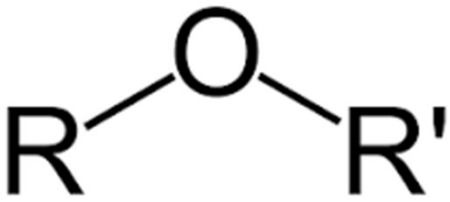


How are archaea resistant to hydrolysis with its ether linkage?

- Esters are more polar than ethers due to the presence of highly electrophilic carbonyl group
- Weak polarity of ethers cause them to be more stable and resistant to hydrolysis



ester



ether

Quiz 2

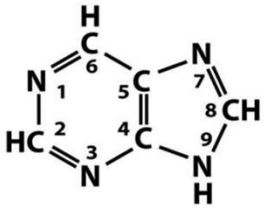
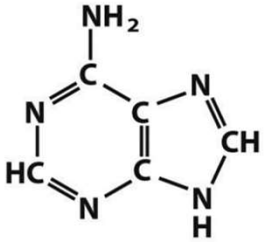
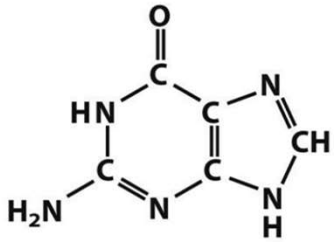
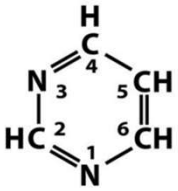
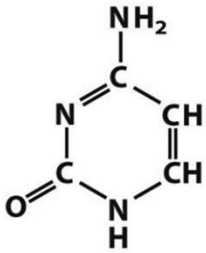
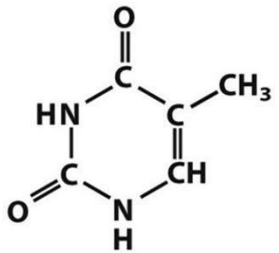
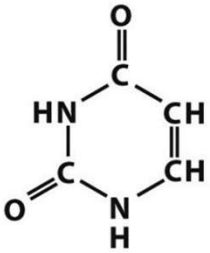
Which of the following is correct?

A. cytosine is purine
B. adenosine is pyrimidine
C. guanine is pyrimidine
D. none of the above

Quiz 2

Which of the following is correct?

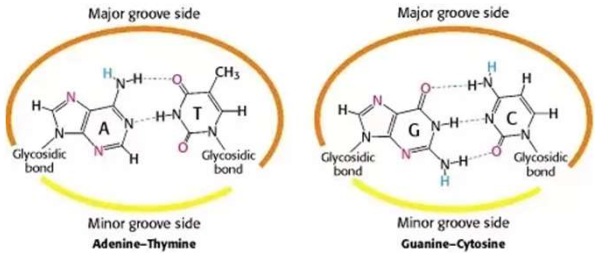
A. cytosine is purine
B. adenosine is pyrimidine
C. guanine is pyrimidine
D. none of the above

General Structure	Common base
 Purine	 Adenine  Guanine
 Pyrimidine	 Cytosine  Thymine (DNA)  Uracil (RNA)

Major and minor grooves in DNA

Q:What are the grooves of the double helix? What is the importance of having two grooves of unequal width?

- Major grooves larger than minor grooves
- different angles in glycosidic bond (120/240)
- major grooves: unique pattern for specific protein recognition and binding
- e.g. Transcription factors (DNA binding protein)
- Minor grooves: non-specific DNA binding protein or AT specific DNA binding protein



from BCHE3040

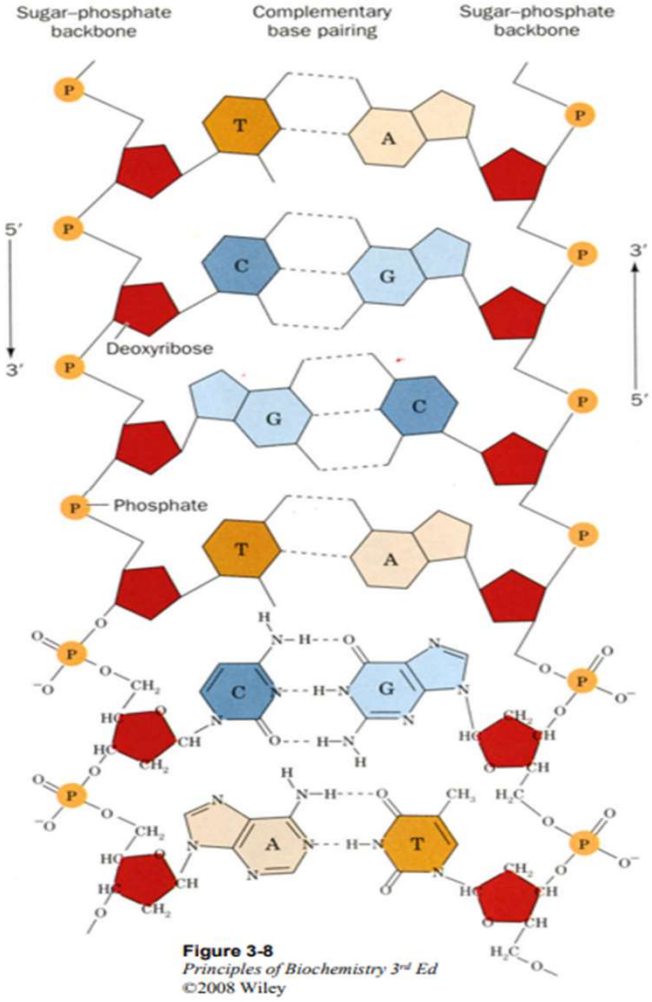
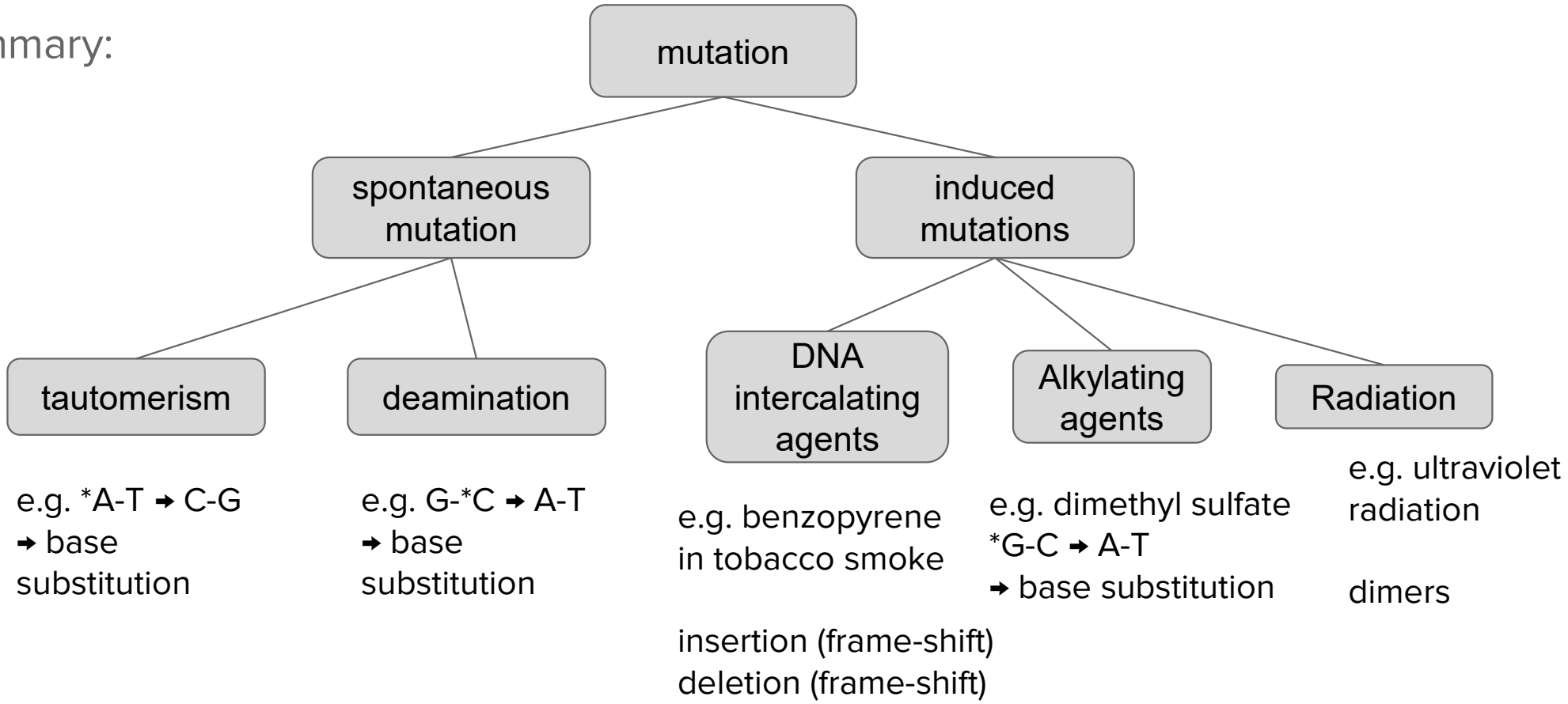


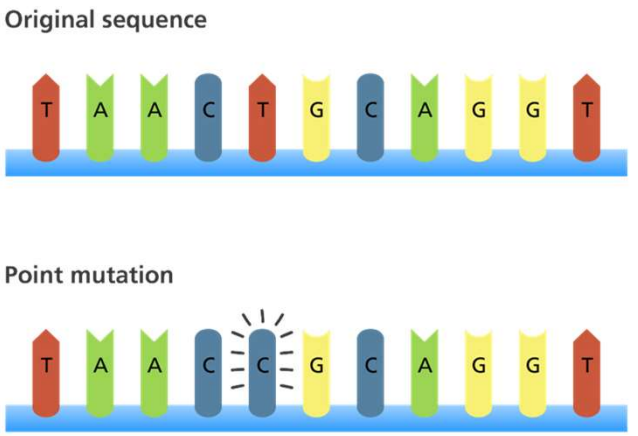
Figure 3-8
Principles of Biochemistry 3rd Ed
©2008 Wiley

DNA Mutation

Summary:



DNA Mutation



Concept check:

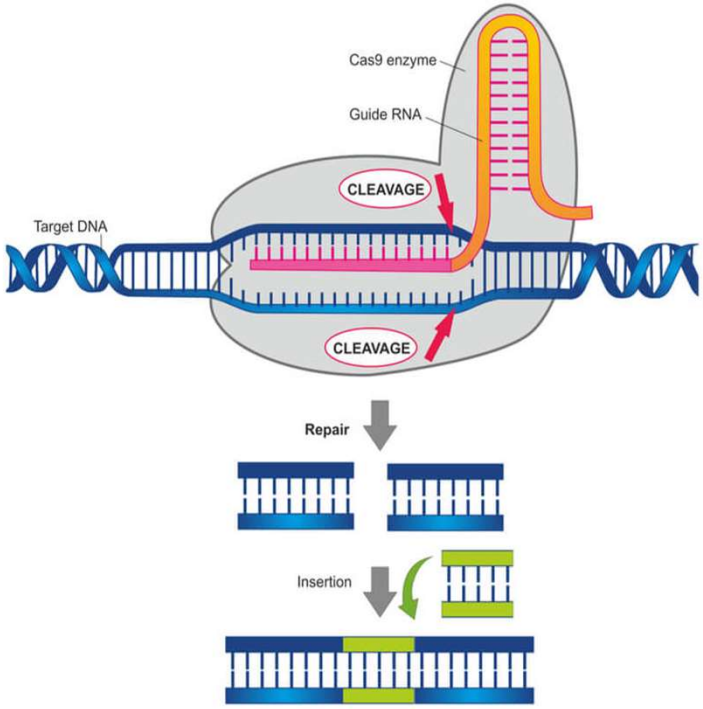
Does mutation only happen on DNA?

Mutation can also happen in RNA (e.g. during transcription), which results in protein defects later. But because only DNA is the genetic material for cell division, mutation in DNA will cause permenant change to the cell and its subsequent daughter cells, while protein defect only has transient effect on the cell.

Is mutation always bad?

Cancer cells are often associated with a number of mutations, especially around genes controlling cell regulation and proliferation, thus altering the normal function of the cell. However, a single mutation can also be “neutral” if it is a silent mutation, while cells also have mechanism to “fix” mutation. Studying the mutation and related mechanism can also help in the development of gene therapy.

CRISPR-Cas9



Clustered regularly interspaced short palindromic repeats

and CRISPR associated protein

(Nobel Prize in 2020)

- Originally an immune system in bacteria and arachae
- Scientists utilized it to edit gene from different organisms
- normally inactivates a gene in gene editing, requires template and DNA repair system if one wants to replace with a new sequence

Can upload past paper or exercises for revision?

Usually past paper is taken right away after mid-term and final exam (so students cannot keep a copy).

However, you may check past final exam questions in CUHK library website.

(Remember to select “exam papers” before searching)