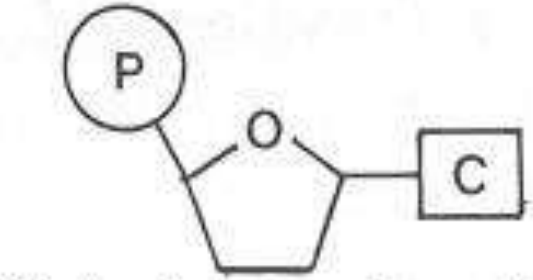
Biomolecules

Nucleic acids & Lipids

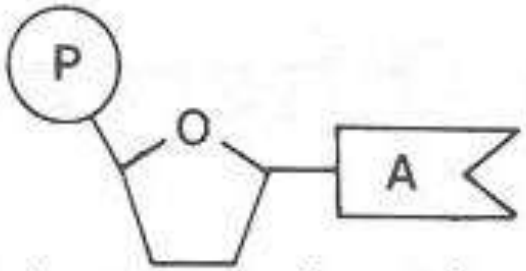
Nucleic Acids

- Composing elements: C, H , O, P, N
- Deoxyribonucleic Acid (DNA)
  - Encodes information used to assemble proteins.
- Ribonucleic Acid (RNA)
  - Reads DNA-encoded information to direct protein synthesis.

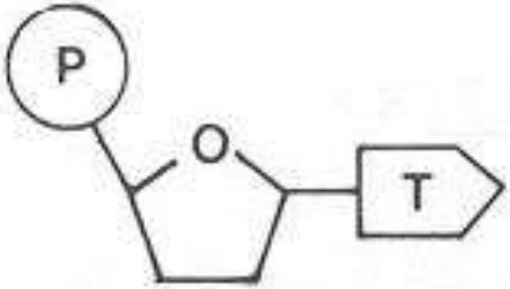
DNA nucleotides



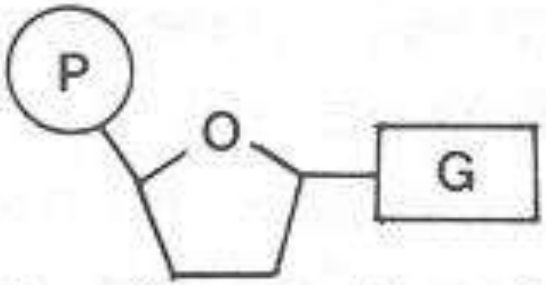
Cytosine nucleotide



Adenine nucleotide

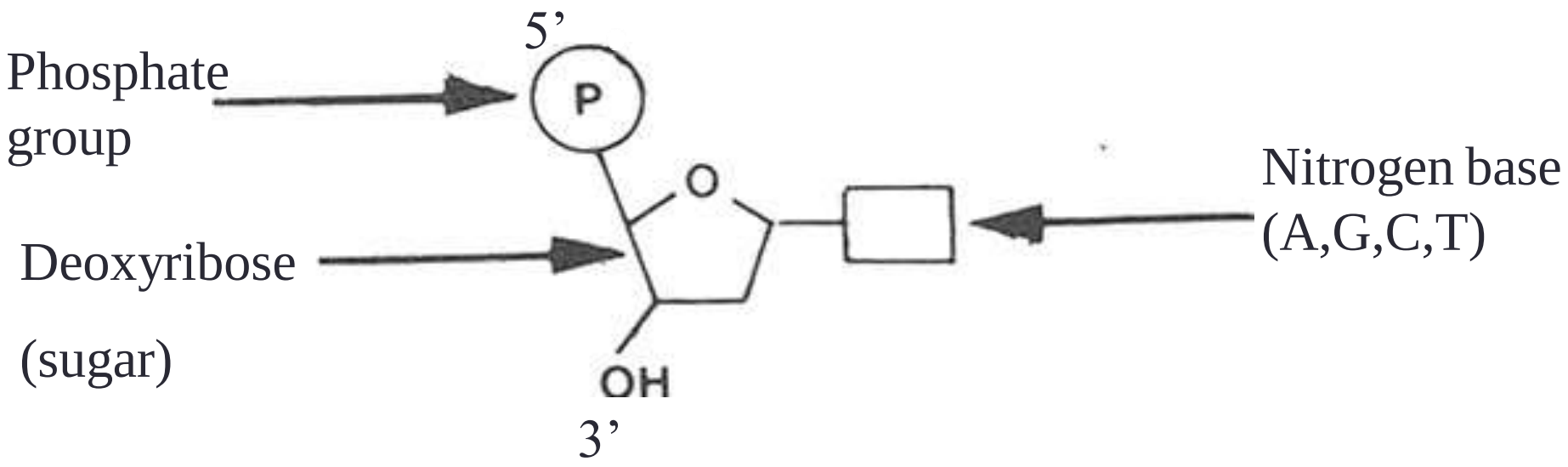


Thymine nucleotide



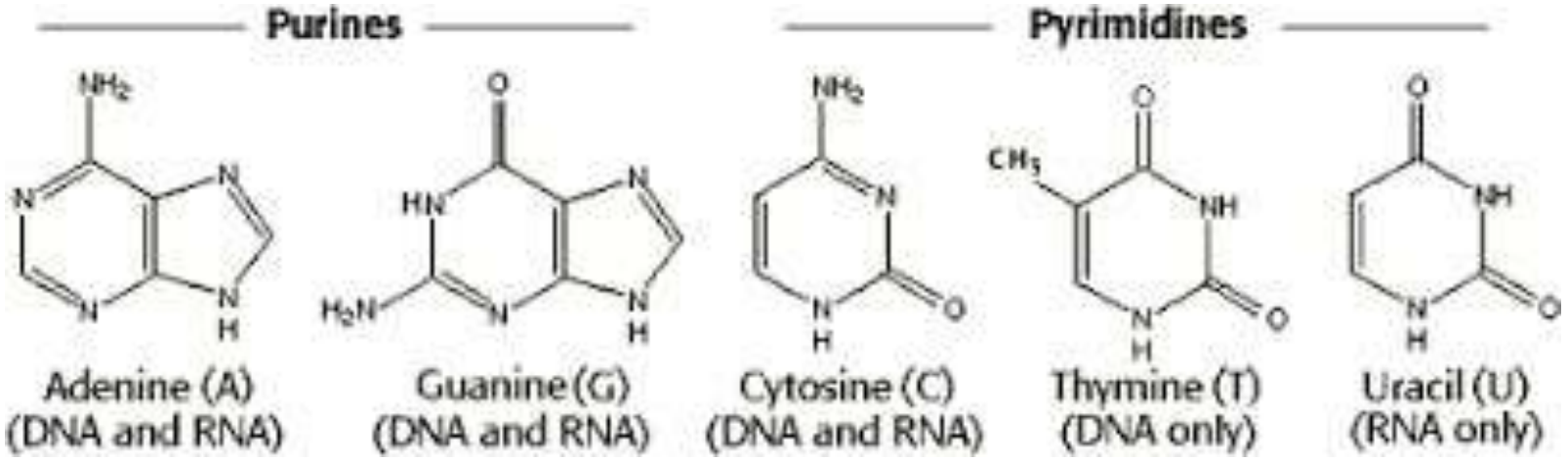
Guanine nucleotide

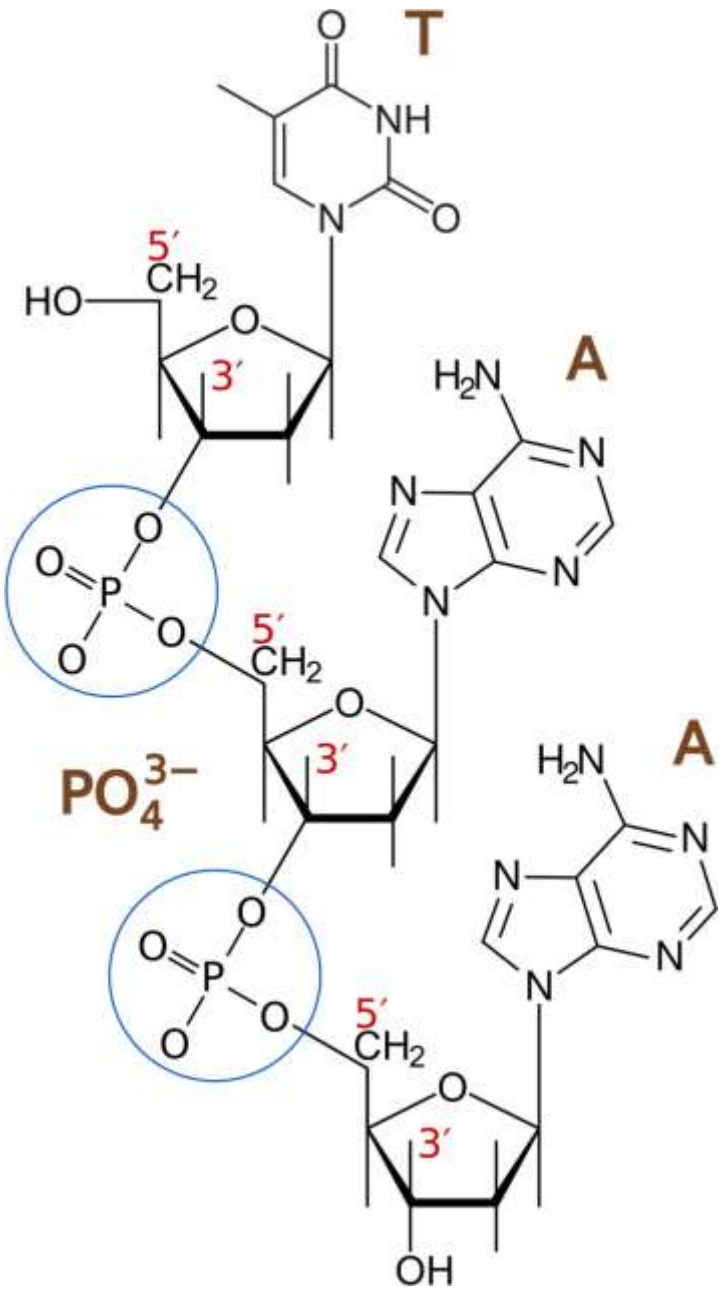
Nucleotide structure

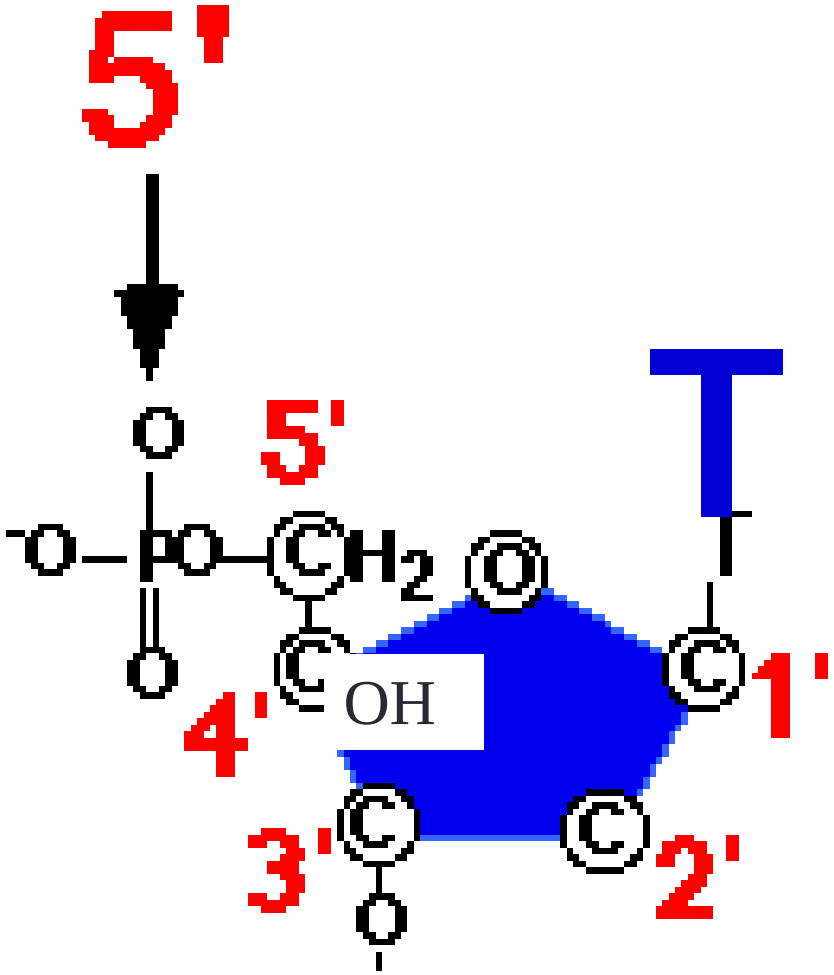


Nitrogen bases

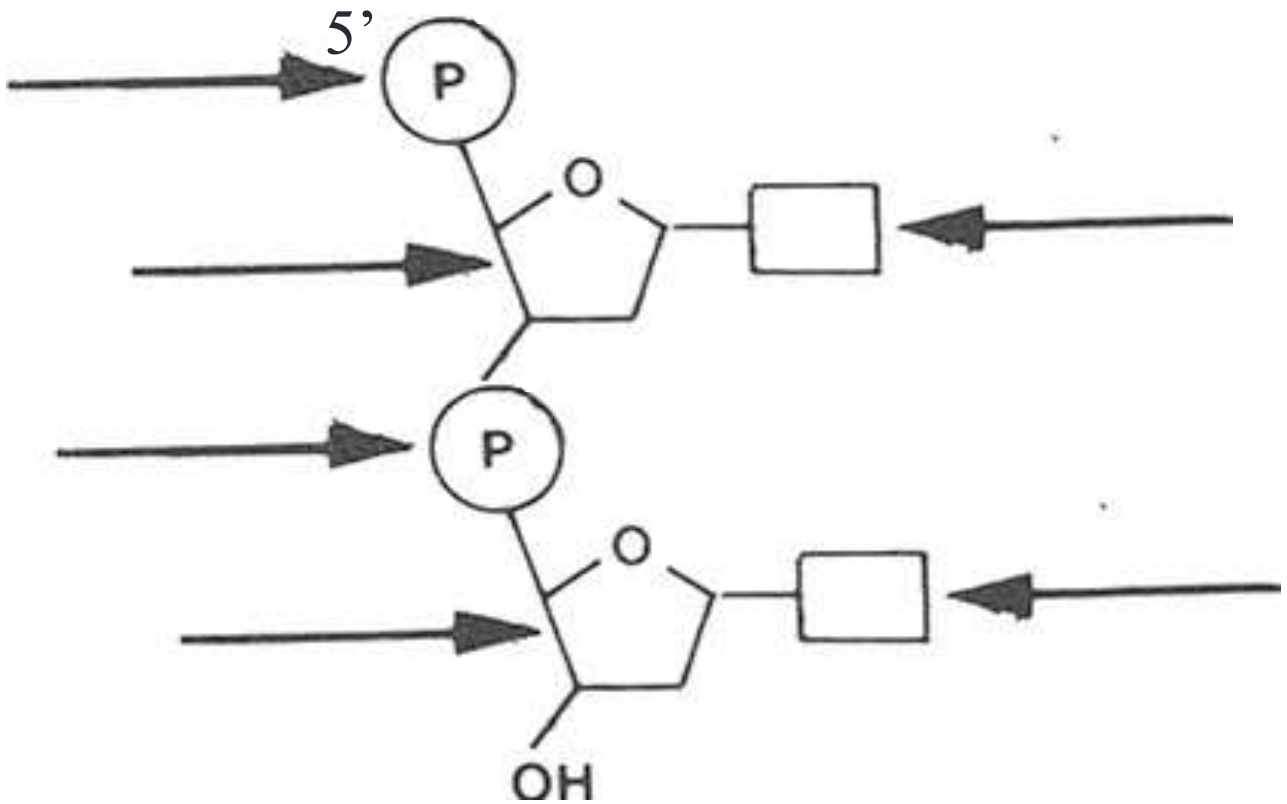
- Purines : Double-ringed
- Pyramidines : Single-ringed



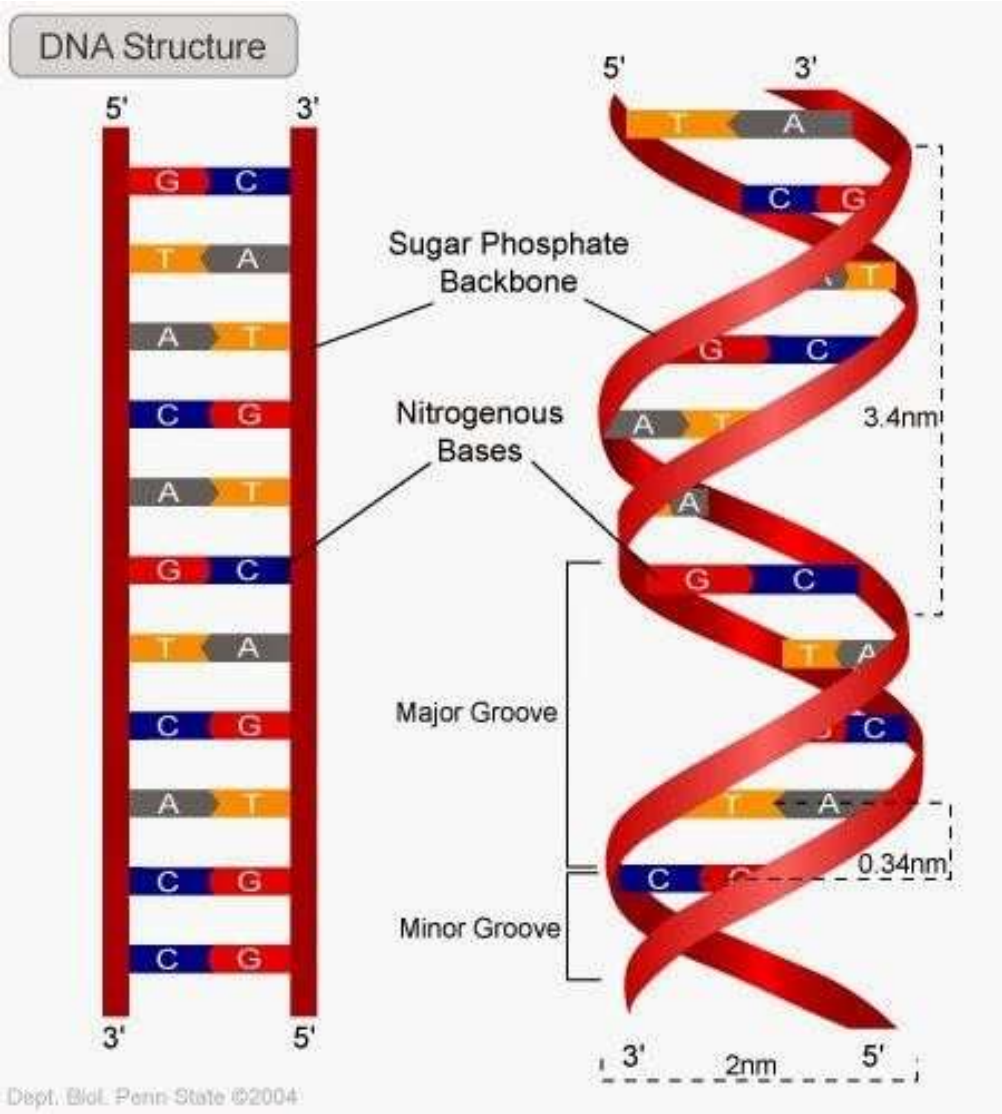

T
A
A
PO_4^{3-}
HO
OH
5′
3′
NH
N
O
P
H_2N
CH_2

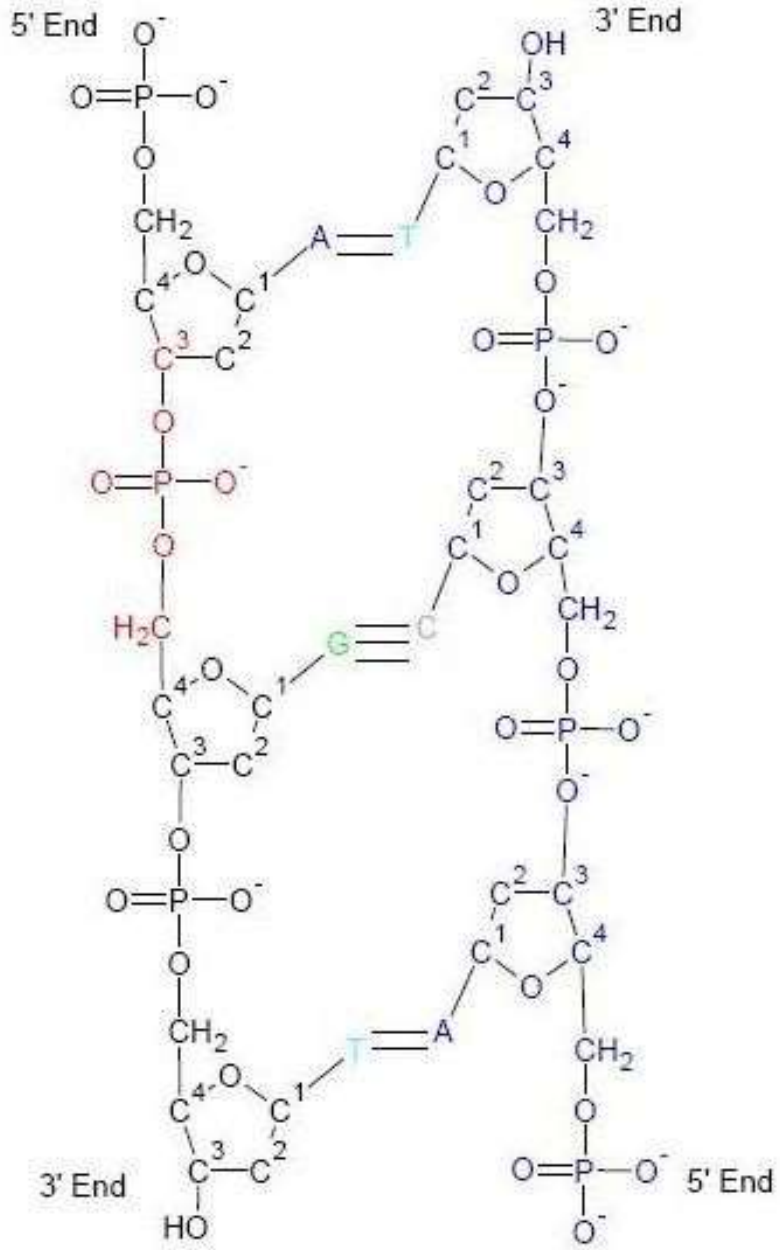

5'
5'
OH
4'
1'
3'
2'

Nucleotide structure



Structure of DNA




5' End
3' End
3' End
5' End

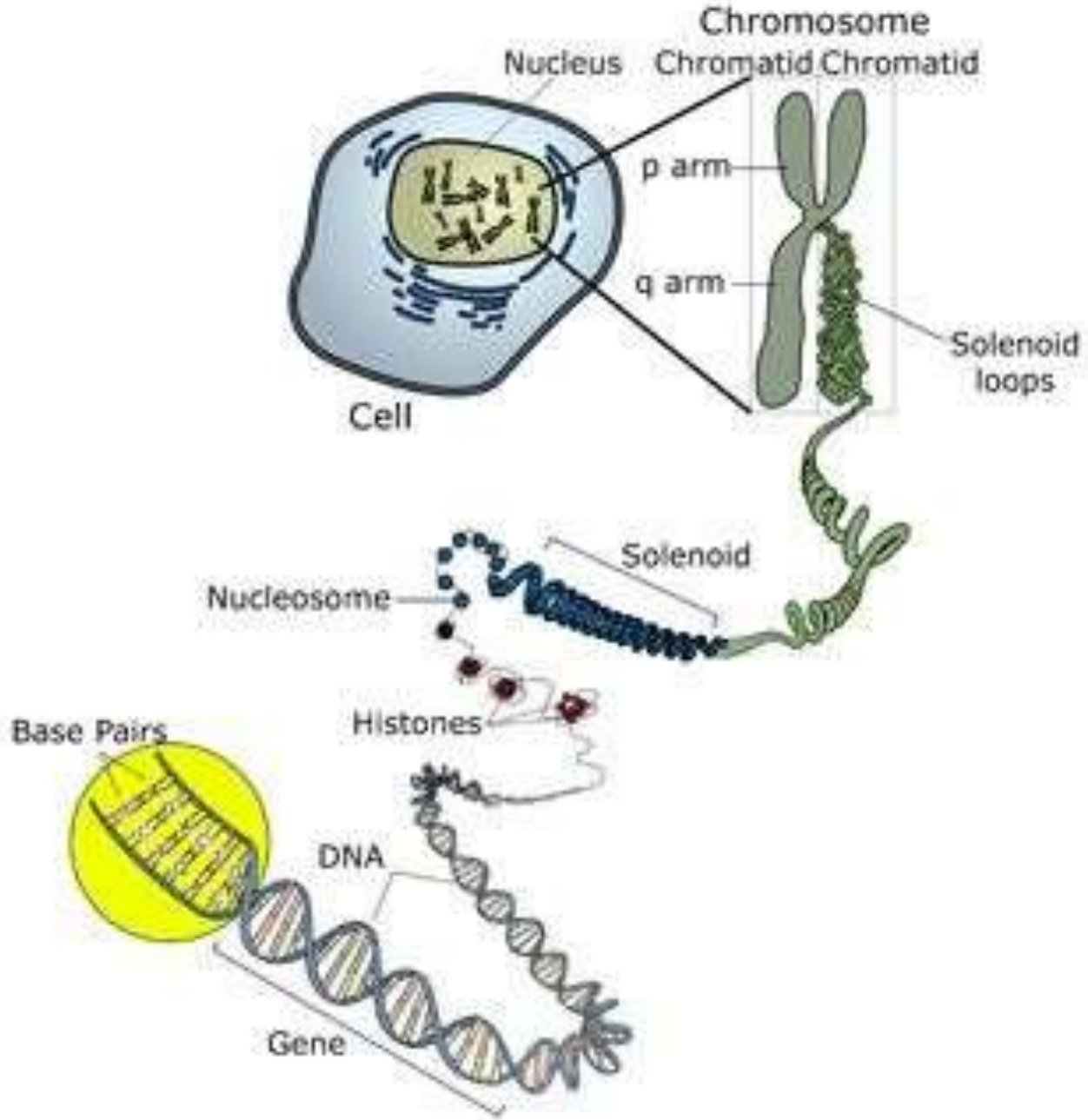


Image adapted from: National Human Genome Research Institute.

DNA Molecule: Two Views

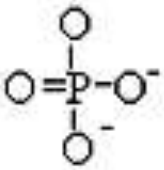
Sugar —

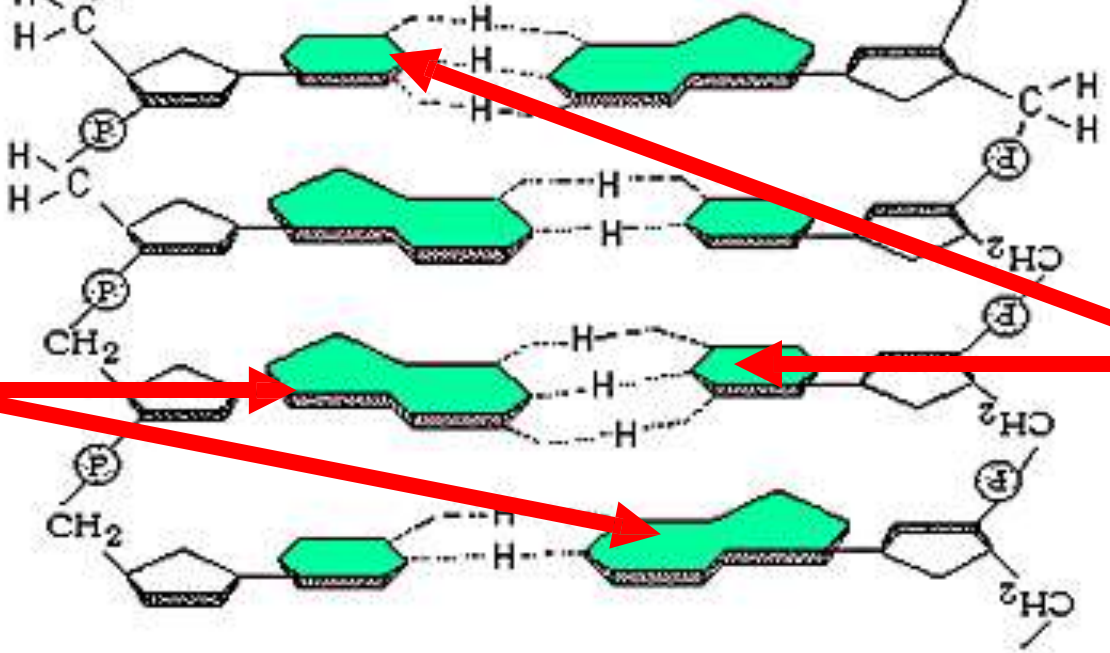
Cytosine and Thymine

Bases

Adenine and Guanine

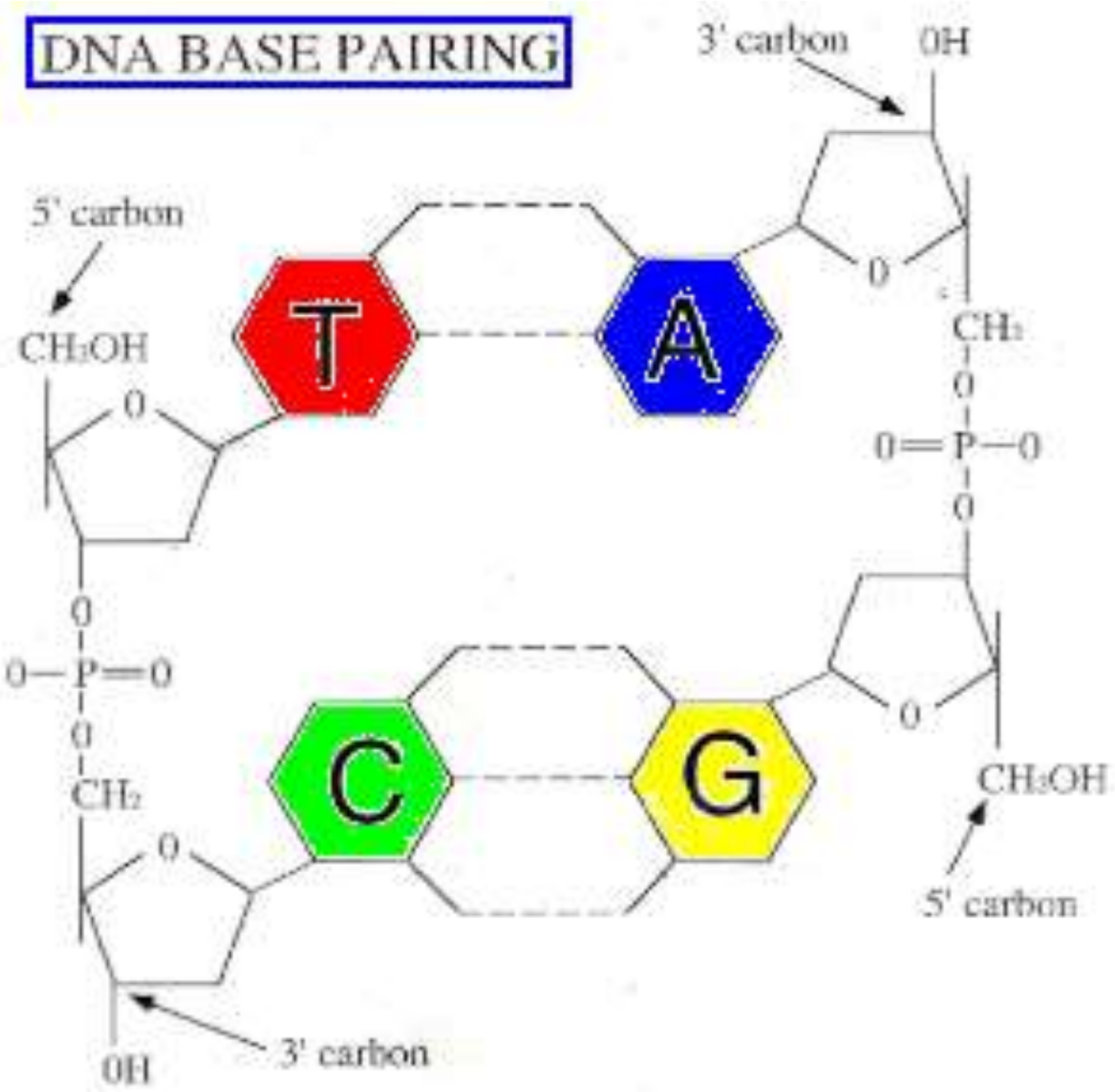
Phosphate group (P)

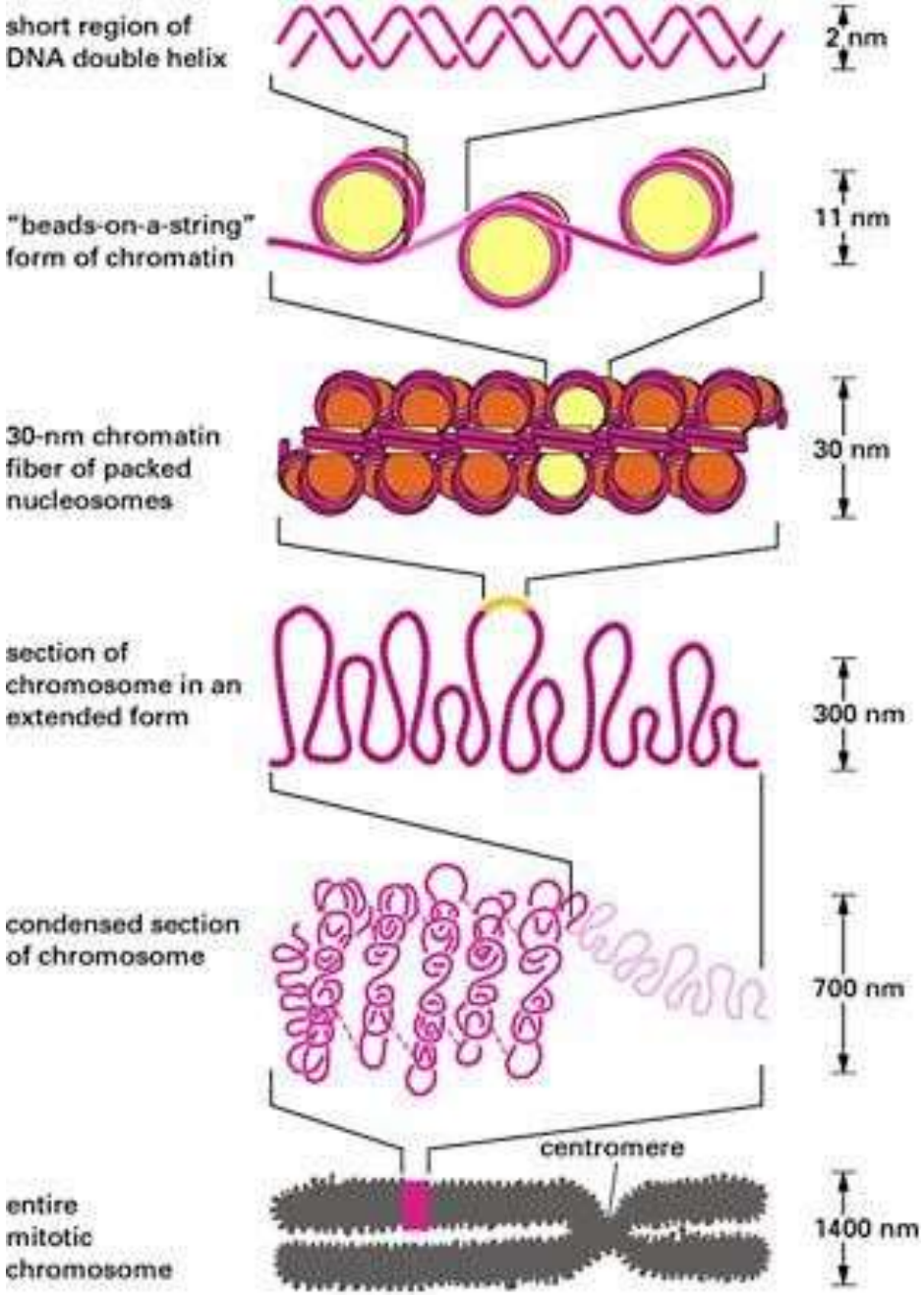




purines

pyrimidines


DNA BASE PAIRING
3' carbon
OH
5' carbon
CH₂OH
T
A
C
G
CH₂
O
O=P—O
O—P=O
CH₂OH
5' carbon
3' carbon
OH



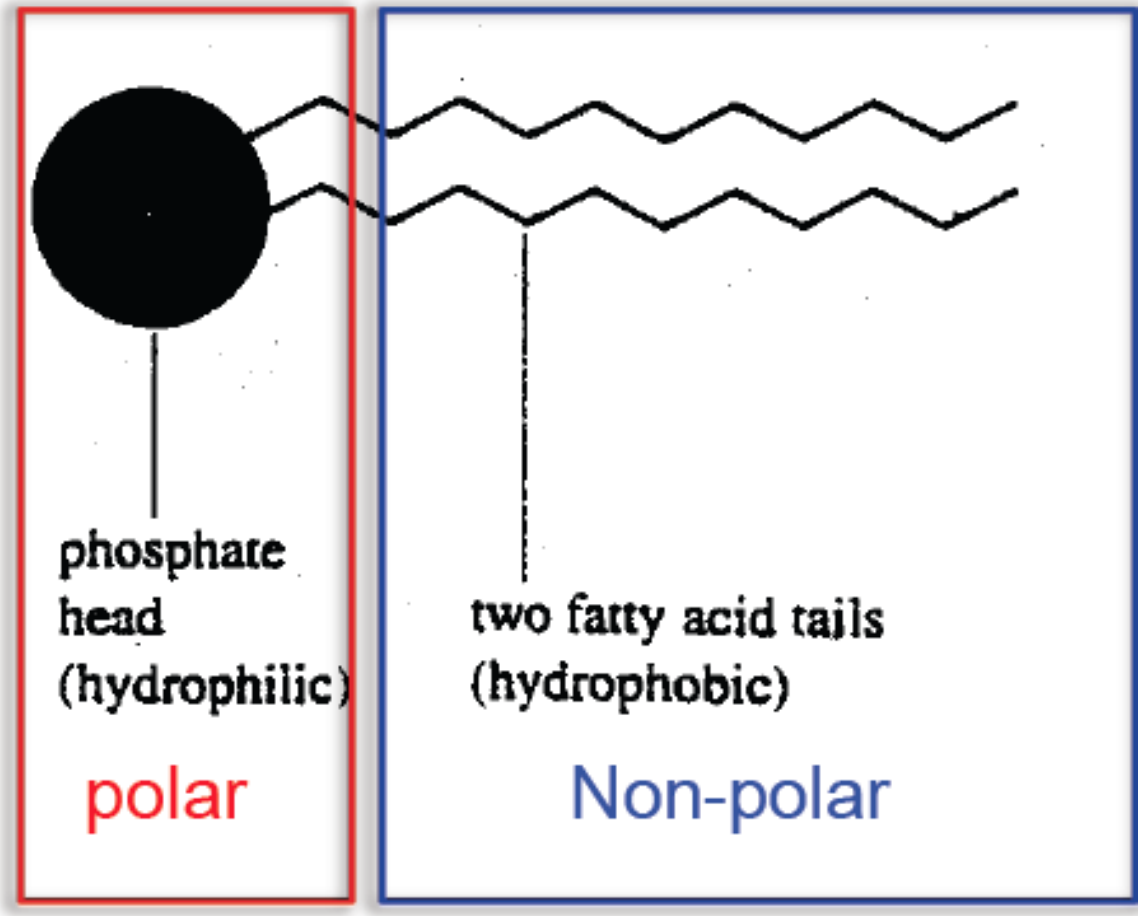
NET RESULT: EACH DNA MOLECULE HAS BEEN PACKAGED INTO A MITOTIC CHROMOSOME THAT IS 50,000x SHORTER THAN ITS EXTENDED LENGTH

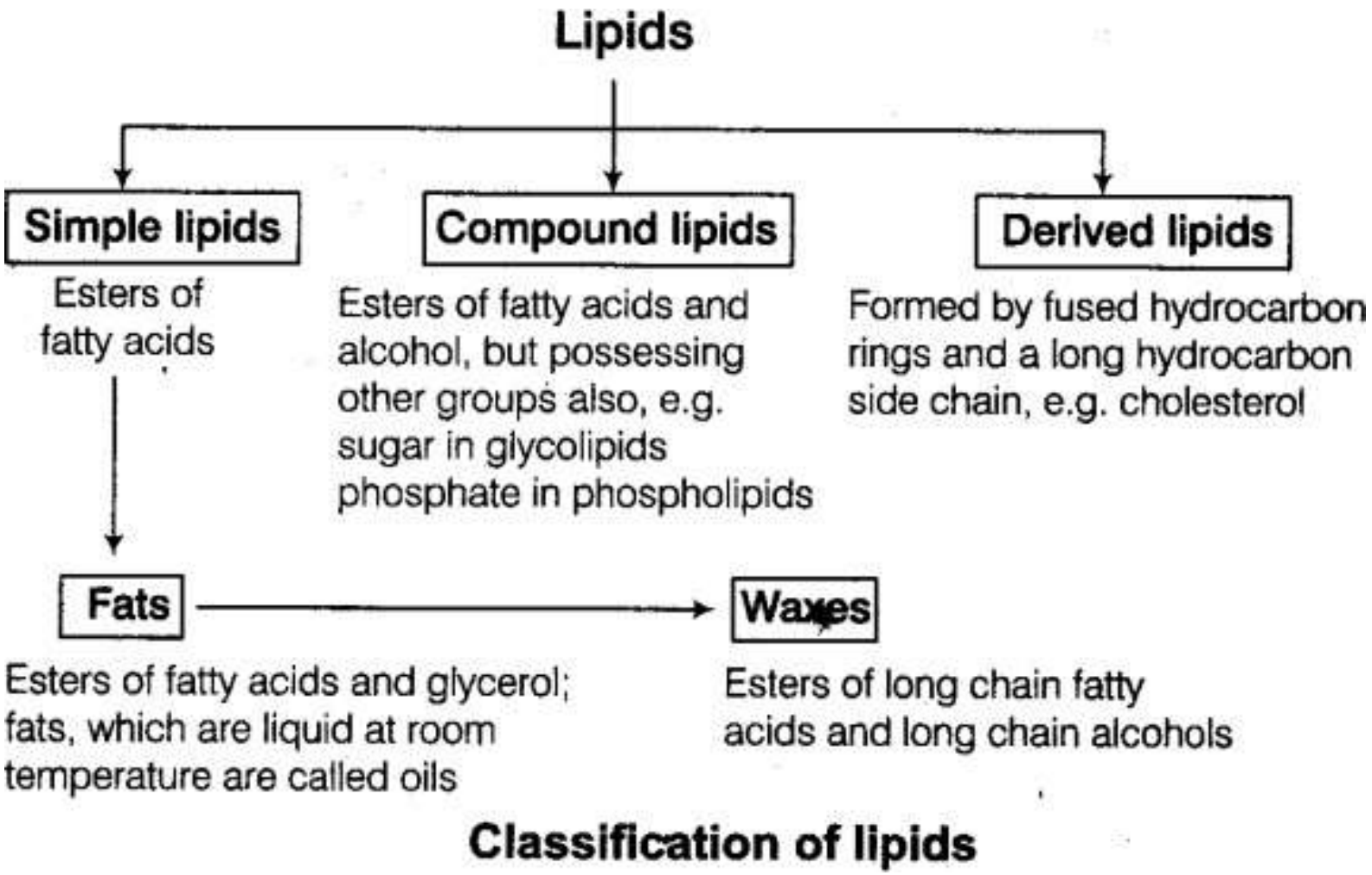
RNA

- Adenine, Guanine, Cytosine, Uracil
- Types:
  - mRNA
  - tRNA
  - rRNA

Lipids

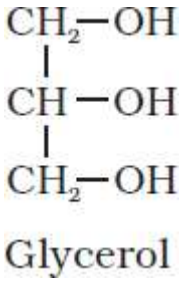
- Composing elements C, H, O
- Lipids are loosely defined as groups of organic molecules that are insoluble in water. Their chemical formula vary considerably.
- Include:
  - fats
  - oils
  - Waxes
  - Phospholipids
  - steroids: sex hormones and cholesterol
  - some vitamins
  - glycolipids (lipids with carbohydrates attached)


phosphate
head
(hydrophilic)
two fatty acid tails
(hydrophobic)
polar
Non-polar

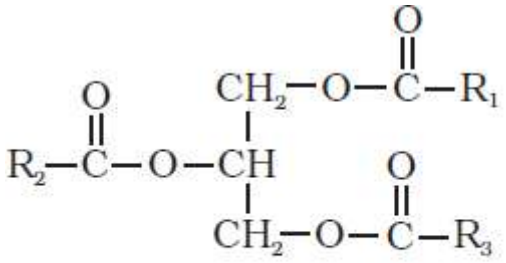


Classification of lipids

- Many lipids have both glycerol and fatty acids.
- The fatty acids are found esterified with glycerol.
- They can be then monoglycerides, diglycerides and triglycerides.
- These are also called fats and oils based on melting point.



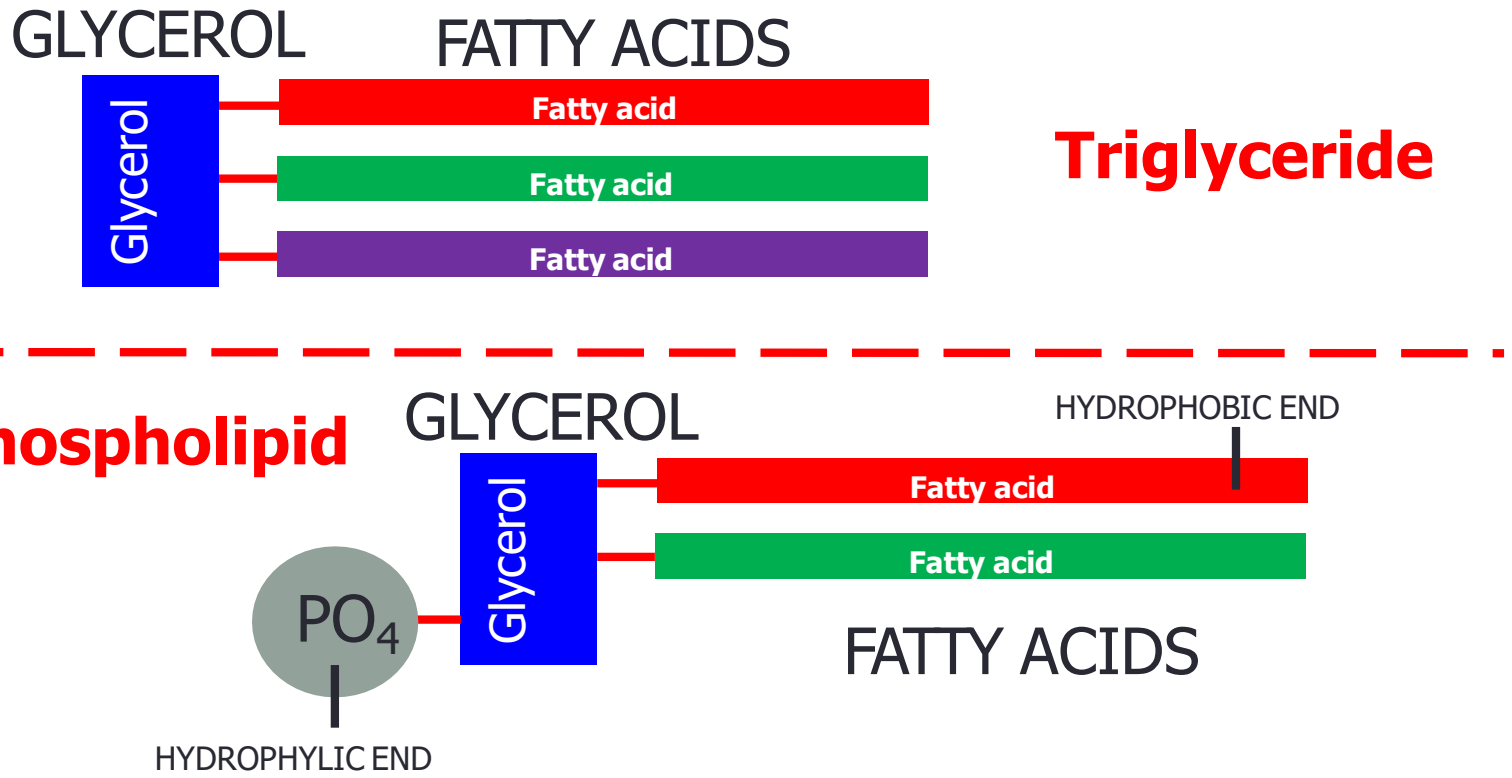
Glycerol



Triglyceride (R_1, R_2 and R_3 are fatty acids)

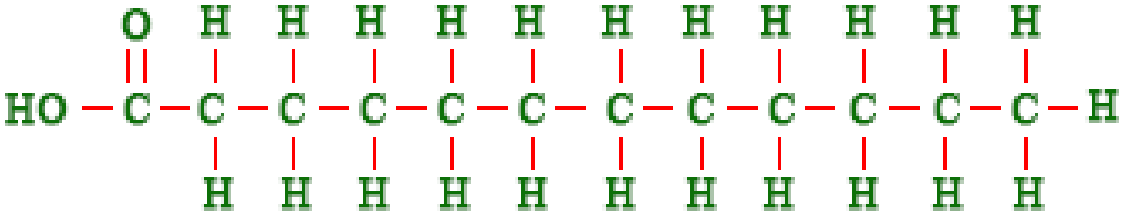
Lipid structure

- Most lipids are composed of a of glycerol molecule with attached fatty acids

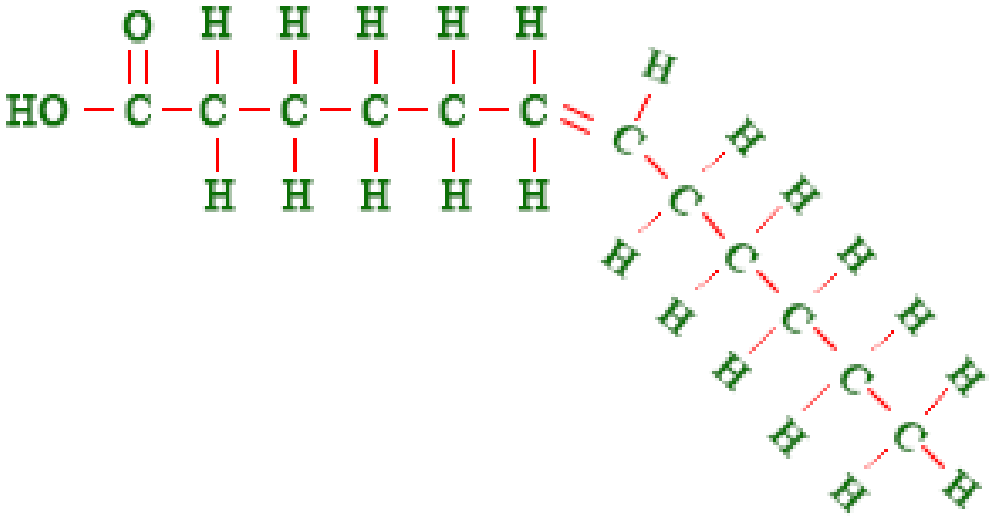


Structure of Fatty Acids

Saturated Fatty Acid

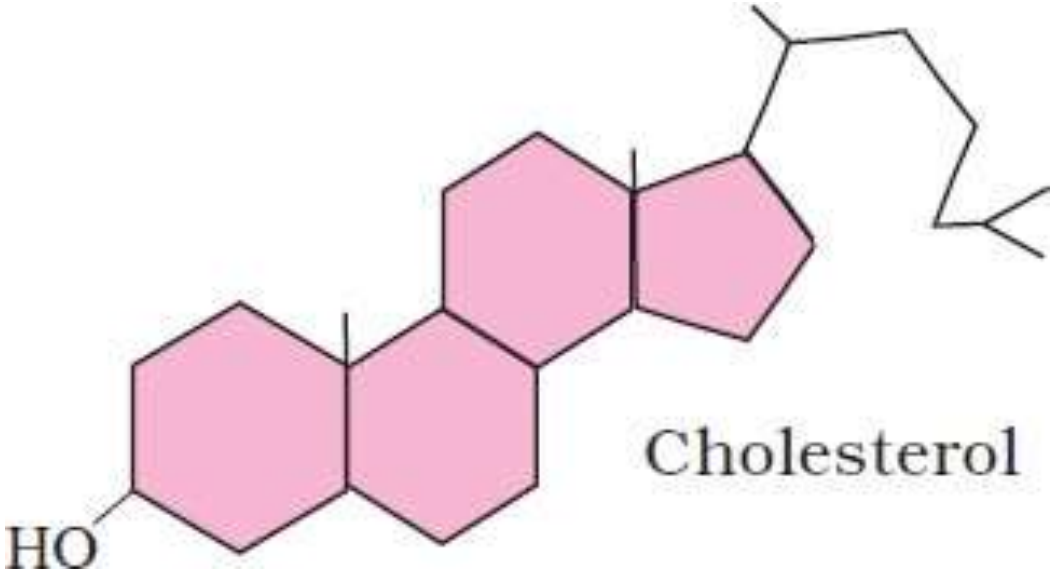


Unsaturated Fatty Acid

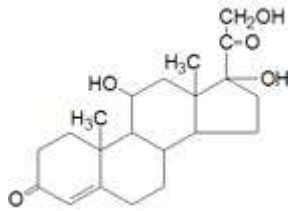
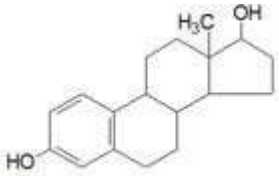
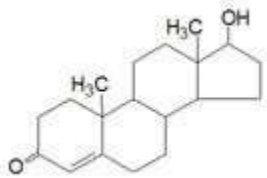
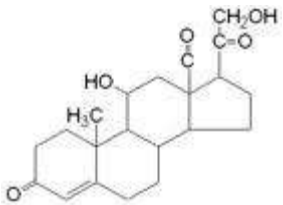
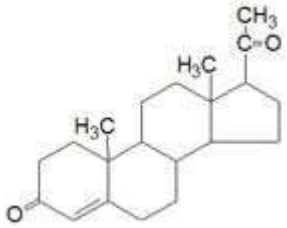


Lipid structure

- Some lipids have a four ringed structure
- Ex: Cholesterol and other lipids that are derived from cholesterol

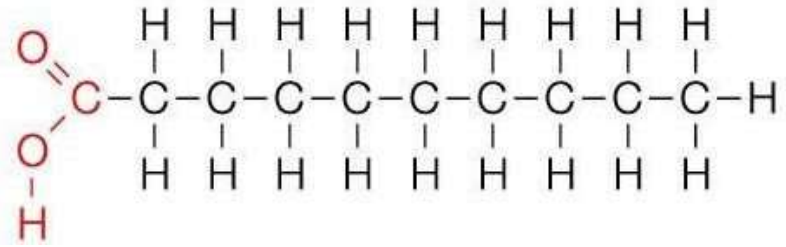


Steroid Hormones

	**Progesterone**: responsible for changes associated with the menstrual cycle and with differentiation factor for mammary glands
	**Aldosterone**: raises blood pressure and fluid volume, increases Na^+ uptake
	**Testosterone**: male sex hormone synthesized in the testes, responsible for secondary male sex characteristics
	**Estradiol**: an estrogen, principal female sex hormone, produced in the ovary, responsible for secondary female sex characteristics
	**Cortisol**: involved in stress adaptation, elevates blood pressure and Na^+ uptake, numerous effects on the immune system

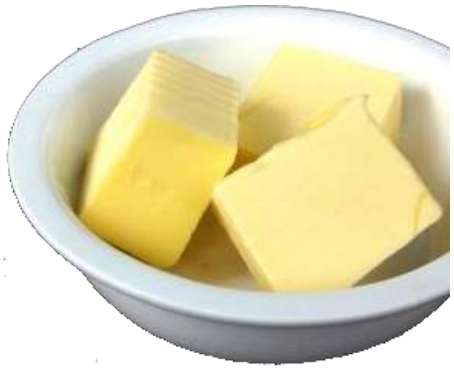
Saturated fatty acid

Saturated fats:



Their fatty acids

- have no double bonds between carbon atoms(have maximum number of hydrogen atoms)
- Straight structure
- fats usually from animal sources
- Solid at room temperature(20°C)

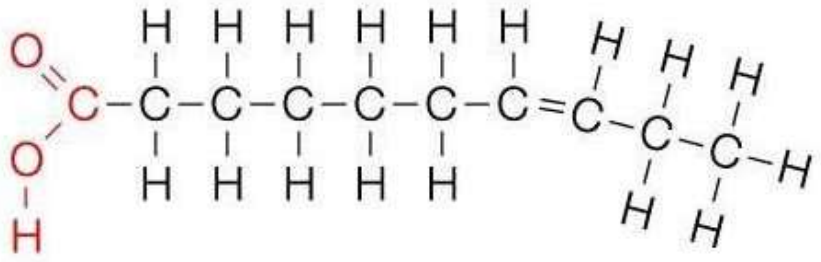


Unsaturated fats

Their Fatty acids have:

- Have some carbon atoms that are double bonded(not fully hydrogenated)
- Kinked in shape
- Healthy
- From plant sources
- Liquid at room temperature (20°C)

Unsaturated fatty acid



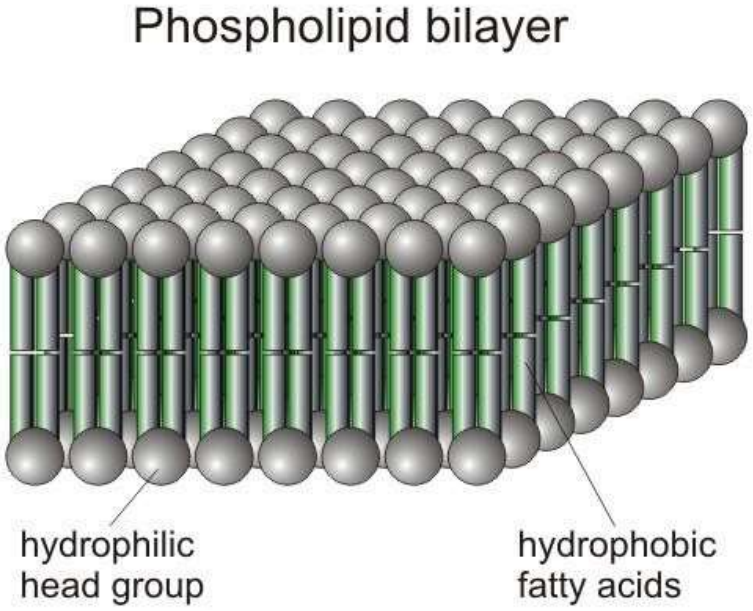
Importance; Biological Role

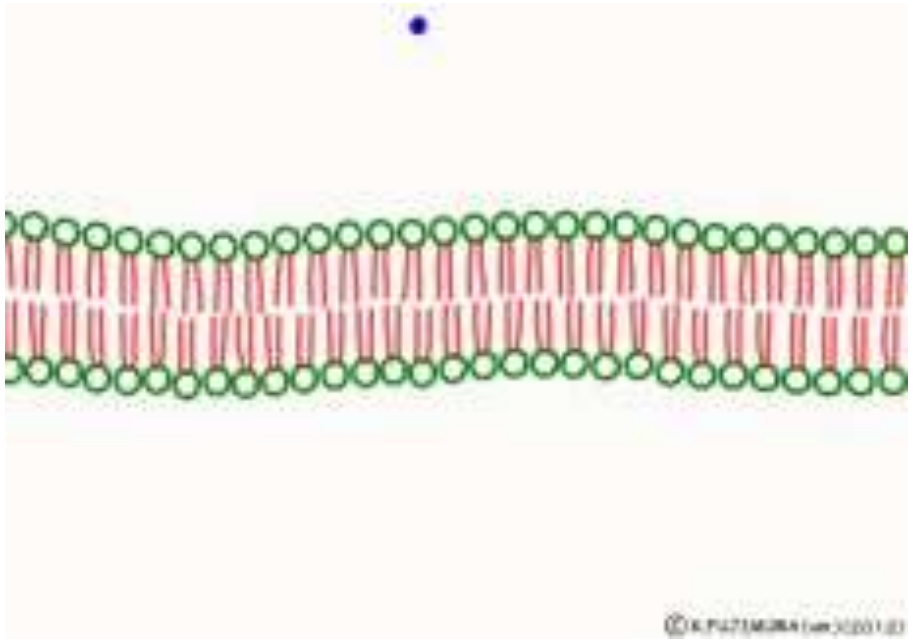
- Lipids are often stored in special **adipose tissue**, within large fat cells

- Lipids are concentrated sources of **energy** and can be broken down (through fatty acid oxidation in the mitochondria) to provide fuel for aerobic respiration

Importance; Biological Role

- An important structural component of membranes





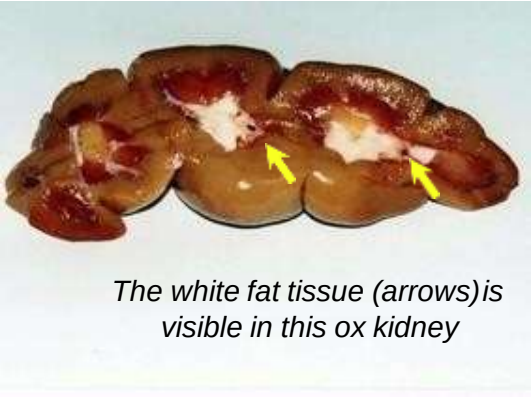
Phospholipids are the primary structural component of all cellular membranes, such as the plasma membrane

Importance; Biological Role

- Acts as a shock absorber and good insulator
- Fat absorbs shocks. Organs that are prone to bumps and shocks (e.g. kidneys) are cushioned with a relatively thick layer of fat.
- Stored lipids provide insulation in extreme environments. Increased body fat levels in winter reduce heat losses to the environment.
-

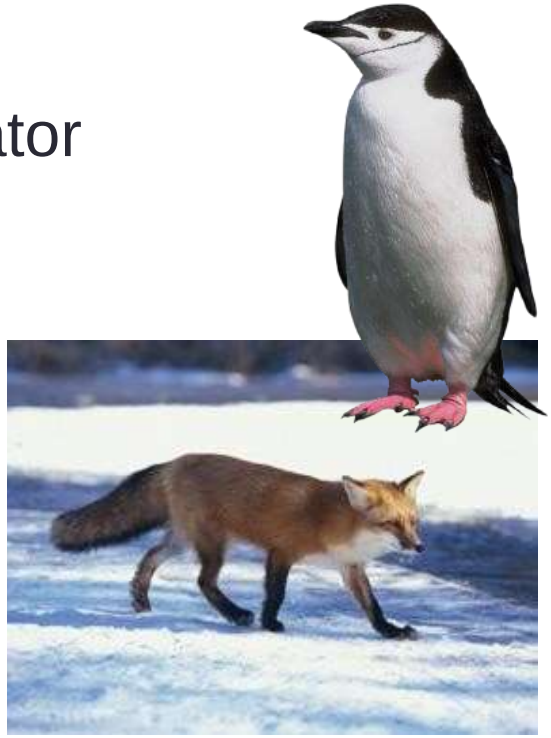
Importance; Biological Role

- acts as a shock absorber and good insulator



The white fat tissue (arrows) is visible in this ox kidney

Fat absorbs shocks. Organs that are prone to bumps and shocks (e.g. kidneys) are cushioned with a relatively thick layer of fat.



Stored lipids provide insulation in extreme environments. Increased body fat levels in winter reduce heat losses to the environment.

Importance; Biological Role

- Water proofing of some surfaces
- Transmission of chemical messages via hormones

Waxes and oils, when secreted on to surfaces provide waterproofing in plants and animals.

Forming a triglyceride

- NOT a Polymer