

# Advanced Cell Biology. Lecture 7

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# Outline

Amino acids

Nucleic acids



## Outline

## Amino acids

## Nucleic acids



## Previous final question: the answer



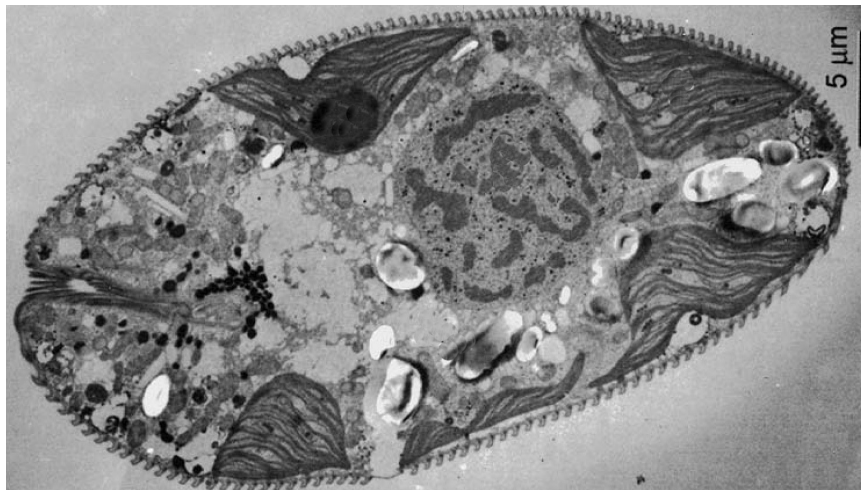
## Previous final question: the answer

Name one of essential amino acids

1. Isoleucine
2. Leucine
3. Lysine—probably, the most important
4. Methionine
5. Phenylalanine
6. Threonine
7. Tryptophan—the second most important
8. Valine



## 5. *Euglena*, unicellular protist: again

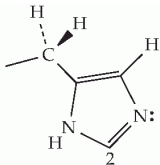




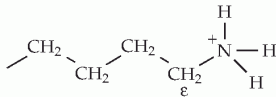
- ▶ Contain different nitrogen basic groups
- ▶ Could be strong bases and therefore binds other molecules to proteins



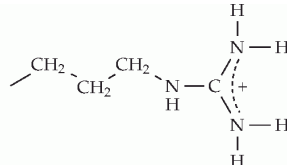
## Examples of basic amino acids



**Histidine (His, H)**



**Lysine (Lys, K)**



**Arginine (Arg, R)**

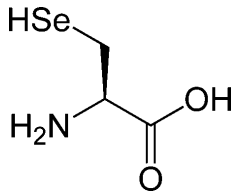


## Two extra amino acids

- ▶ **Selenocysteine** is similar to cysteine, but selenium instead of sulfur, forming a selenol group and selenoproteins
- ▶ **Pyrrolysine** is similar to lysine but with additional pyrroline ring, it presents in many proteins of archebacteria (archaea)
- ▶ They both depend on modified stop codons in RNA (normally, these codons break protein synthesis)

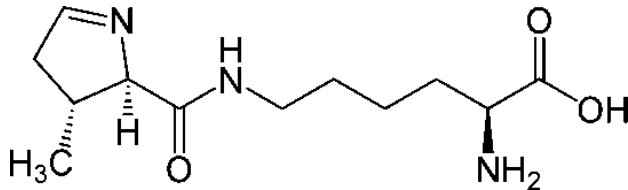


# Selenocysteine





## Pyrrolysine

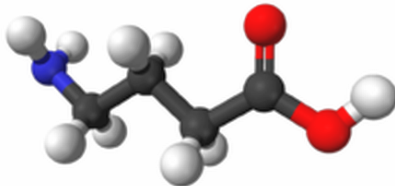
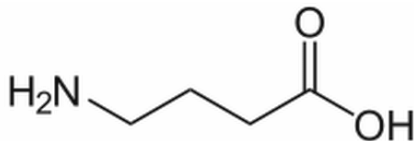




- ▶ **Taurine** abundant in muscular and brain tissues but its functions still not known
- ▶  **$\gamma$ -aminobutyric acid (GABA)** is non- $\alpha$  amino acid; it is one of main neurotransmitters in mammalian nervous system



# GABA





- ▶ **Nucleic bases**—heterocycles with nitrogen
- ▶ **Pentose** in cyclic form
- ▶ **Phosphoric acid**  $\text{H}_3\text{PO}_4$



- ▶ Simply  $\text{H}_3\text{PO}_4$
- ▶ Normally, fully dissociated (lost 2 hydrogen ions)



# Pentose

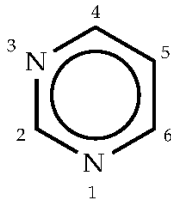
- ▶ **Deoxyribose** (in DNA)  
OR
- ▶ **Ribose** (in RNA)



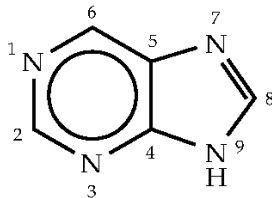
- ▶ **Pyrimidines** (1-cyclic): **uracil/thymine** or **cytosine**
- ▶ **Purines** (2-cyclic + amines): **adenine** or **guanine**
- ▶ *Nucleosides* are nucleic bases + pentoses



## Purines and pyrimidines



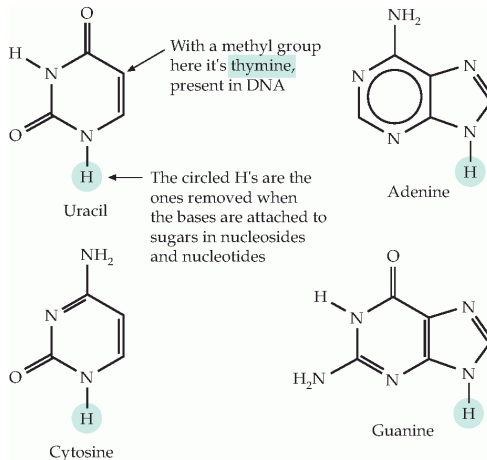
Pyrimidine



Purine



# Nucleic bases



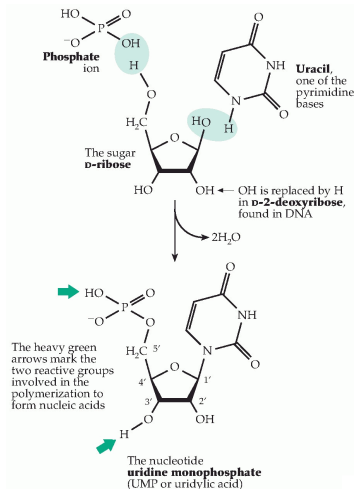
Note: all of these molecules are almost perfectly flat!



- ▶ Double condensation
- ▶ First  $\text{-OH}$  groups from sugar and phosphoric acid used



# Formation of nucleotide

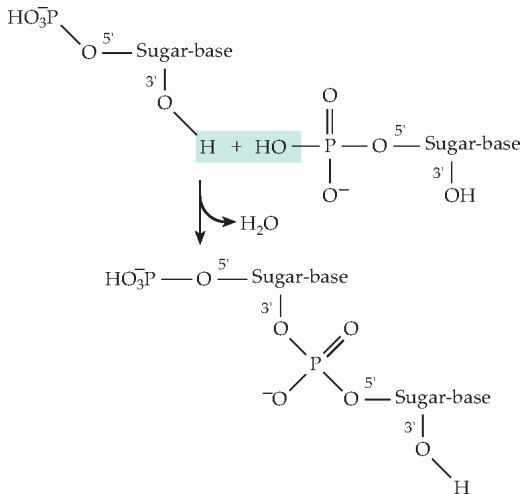




- ▶ Condensation between second free  $\text{-OH}$  groups of sugar and phosphoric acid
- ▶ Resulted polymer may have almost infinite length



# Formation of nucleic acid polymers





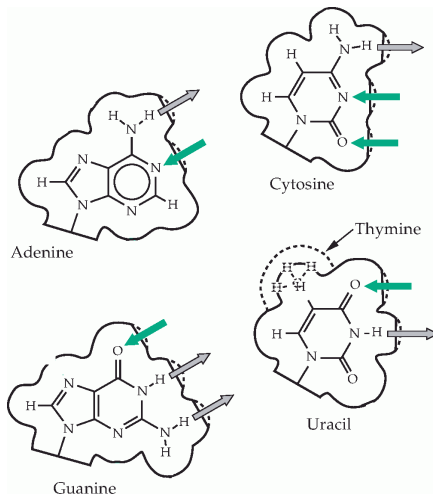
- ▶ Deoxyribose vs. ribose
- ▶ Thymine vs. uracil





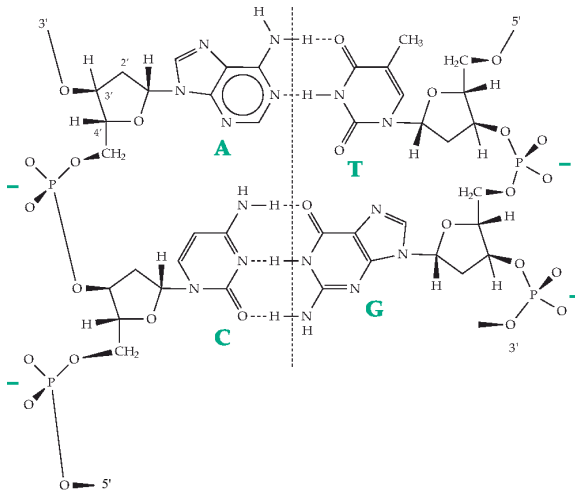


## Hydrogen bonds between nucleotides





# Hydrogen bonds in complementary strands

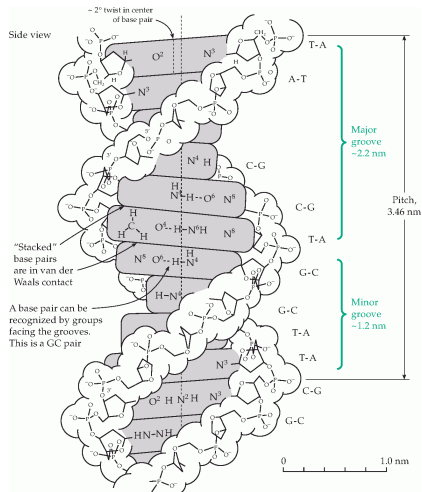




- ▶ DNA form helical structure where phosphate and sugar form “envelope” and bases form a “core”
- ▶ Two grooves: major and minor

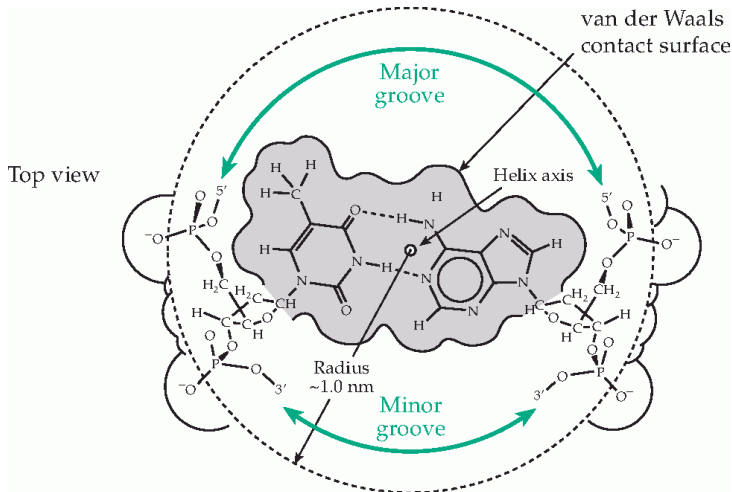


# DNA double helix





## DNA double helix from top

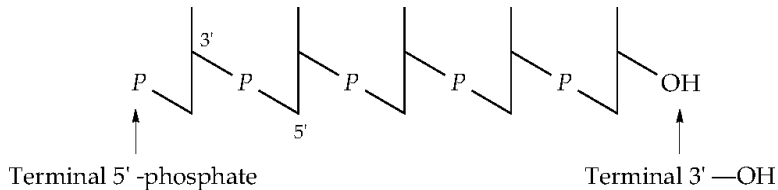




- ▶ Since nucleotides are complementary, it is usually only one strand listed
- ▶ Each strand has 3' (–OH) and 5' ends (phosphate)



## 3' and 5' ends





# Abbreviations for nucleic acids components

Base:	Uracil (Ura)	Cytosine (Cyt)	Adenine (Ade)	Guanine (Gua)
Nucleoside:	Uridine (Urd or U)	Cytidine (Cyd or C)	Adenosine (Ado or A)	Guanosine (Guo or G)
5'-Nucleotide:	Uridine 5'-phosphate or 5'-uridylic acid (Urd-5'-P or UMP)	Cytidine 5'-phosphate or 5'-cytidylic acid (Cyd-5'-P or CMP)	Adenosine 5'-phosphate or 5'-adenylic acid (Ado-5'-P or AMP)	Guanosine 5'-phosphate or 5'-guanylic acid (Guo-5'-P or GMP)

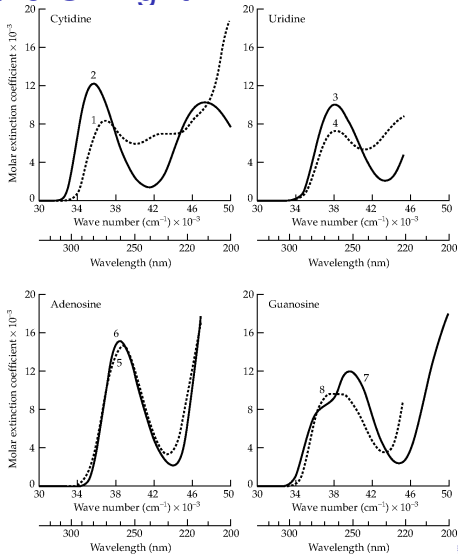


## Abbreviations for nucleotide sequences

U,T,C,A,G	Uracil, thymine, cytosine, adenine, guanine
Y or Pyr	Pyrimidine (T or C)
R or Pur	Purine (A or G)
M	Amino base (A or C)
K	Keto base (G or T)
S	Strongly pairing (G or C)
W	Weakly pairing (A or T)
H	Not G (any other base)
B	Not A
V	Not T or U
D	Not C
N	Any base



# Nucleotides and UV light

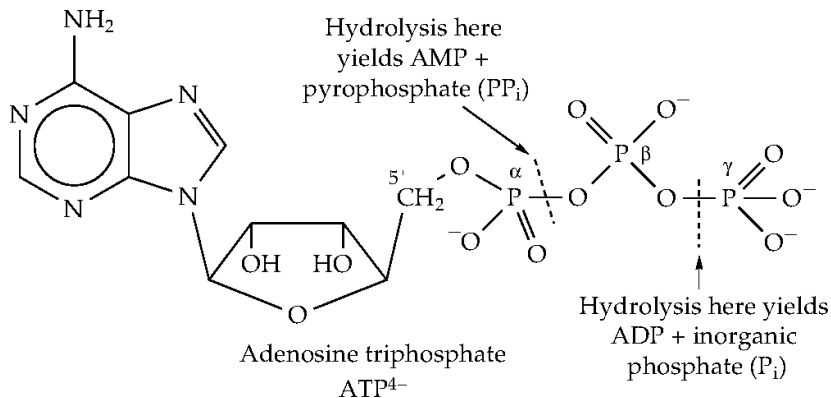




- ▶ ATP (**adenosine-triphosphate**) is **coenzyme** (ferment helper), derivative of ribose, adenine and three phosphoric acids
- ▶ Contain two highly energetic bonds



## ATP





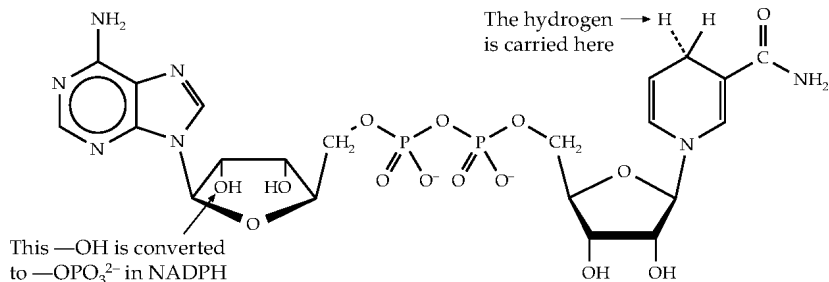
## ATP movie



- ▶ NADP, **nicotinamide adenine dinucleotide phosphate** is a coenzyme, derivative of adenine
- ▶ Typically, used as hydrogen carrier
- ▶ Has a medical name “vitamin B<sub>3</sub>”



# NADPH



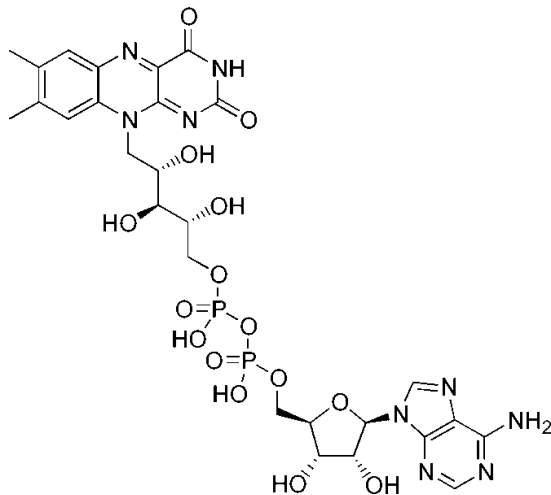
The reduced coenzyme NADH



- ▶ FAD, **flavin adenine dinucleotide**, vitamin B<sub>2</sub>
- ▶ CoA, **coenzyme A**, vitamin B<sub>5</sub>
- ▶ Both are extremely important for cell respiration

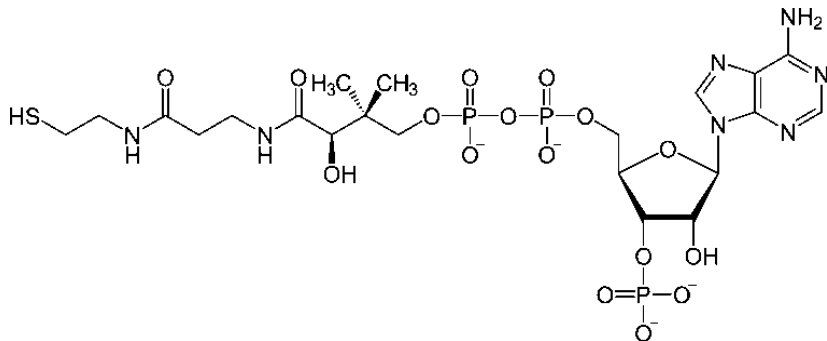


# FAD





# CoA









## Final question (3 points)

Write a sequence complementary to **ATTGGAAGC**  
Is it from DNA or RNA?



- ▶ There are 20 (+2) standard amino acids classifying in 9 groups
- ▶ Nucleic acids are composition of purin/pyrimidin base, ribose/deoxyribose and phosphoric acid



## For Further Reading



A. Shipunov.

*Advanced Cell Biology* [Electronic resource].

2011—onwards.

Mode of access: [http:](http://)

[//ashipunov.info/shipunov/school/biol\\_250](http://ashipunov.info/shipunov/school/biol_250)



B. Alberts et al.

*Essential Cell Biology*. 3rd edition.

Garland Science, 2009.

*Chapter 2: Molecules in cells* (pp. 56–58), Panel 2-6.

