

# Advanced Cell Biology. Lecture 6

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January 25, 2012

# Outline

## Questions and answers

### Amino acids

Structure and classification

### Nucleic acids

Structure and features

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Amino acids

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## Previous final question: the answer

Which role in the cell lipids do NOT play?

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Which role in the cell lipids do NOT play?

- ▶ Protein, DNA, RNA synthesis
- ▶ Transport
- ▶ Cellular respiration
- ▶ ~~Making energy~~
- ▶ ~~Exo- / endocytosis~~

# Amino acids

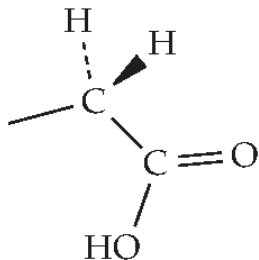
## Structure and classification

## Acidic amino acids

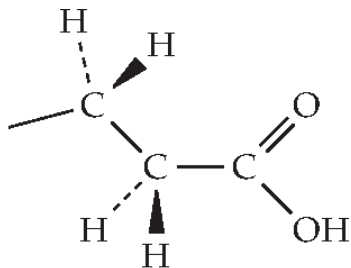
- ▶ Weak acids
- ▶ Provide anionic (–) groups on the surface of proteins



## Acidic amino acids



Aspartic acid (Asp, D)

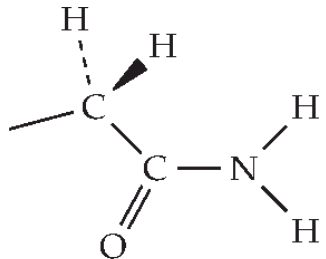


Glutamic acid (Glu, E)

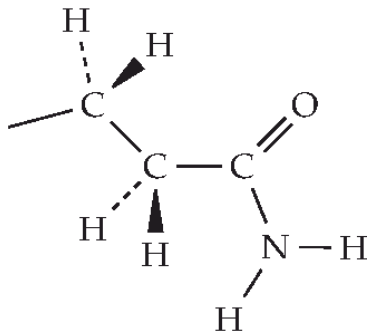
## Amidic

- ▶ Contain amide group  $\text{-CONH}$
- ▶ Not acidic, but polar and therefore participate in hydrogen bonding

## Amidic amino acids



Asparagine (Asn, N)



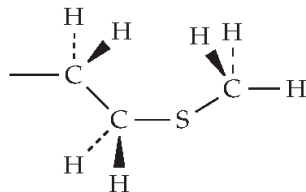
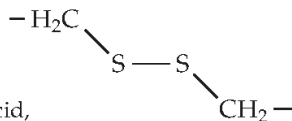
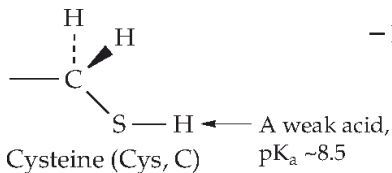
Glutamine (Gln, Q)

## Sulfur-containing

- ▶ Two  $-SH$  groups of cysteine may form **disulfide bridge** between different parts of protein molecule

Disulfide bonds movie

## Sulfur-containing amino acids

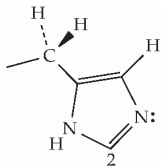


**Methionine (Met, M)**

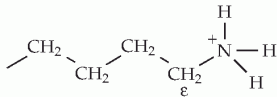
## Basic amino acids

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

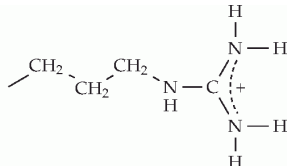
## Examples of basic amino acids



**Histidine (His, H)**



**Lysine (Lys, K)**



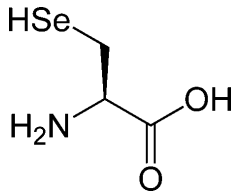
**Arginine (Arg, R)**

## Two extra amino acids

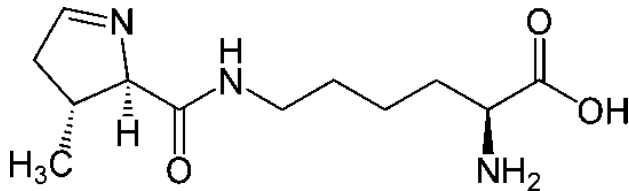
- ▶ **Selenocysteine** is similar to cysteine, but selenium instead of sulfur, forming a selenol group and selenoproteins
- ▶ **Pyrrolysine** is similar to lysine but with additional pyrroline ring, it presents in many proteins of archeobacteria (archaea)
- ▶ They both depend on modified stop codons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



# Selenocysteine



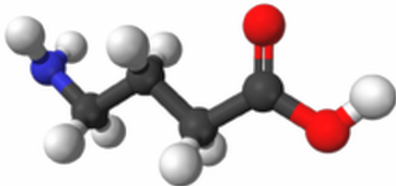
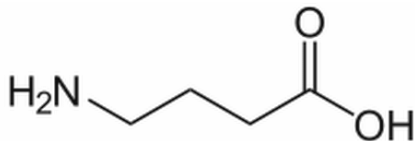
## Pyrrolysine



## Non-protein amino acids

- ▶ **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 acids

## Structure and features

## Composition of nucleic acids

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

# Phosphate

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

# Pentose

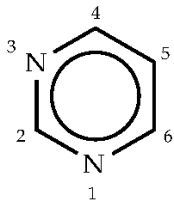
- ▶ **Deoxyribose** (in DNA)  
OR
- ▶ **Ribose** (in RNA)



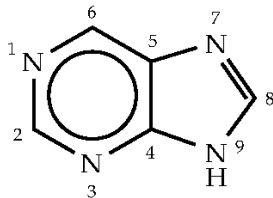
## Nucleic bases and nucleosides

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

## Purines and pyrimidines

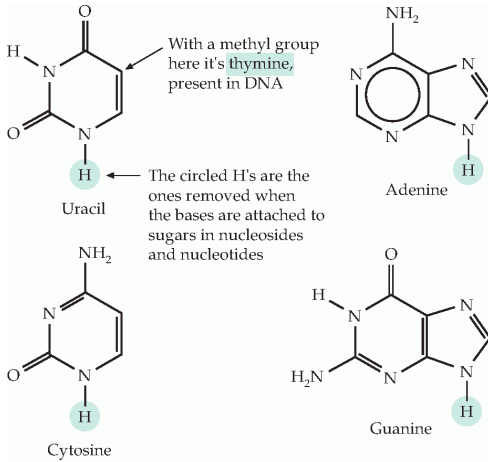


Pyrimidine



Purine

## Nucleic bases

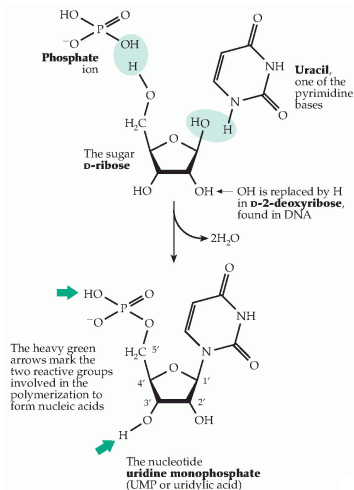


Note: all of these molecules are almost perfectly flat!

## Nucleotide synthesis

- ▶ Double condensation
- ▶ First –OH groups from sugar and phosphoric acid used

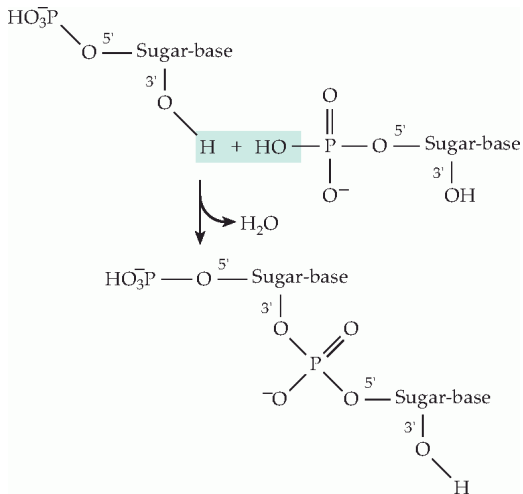
## Formation of nucleotide



## Nucleic acid synthesis

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

## Formation of nucleic acid polymers



## DNA and RNA chemistry

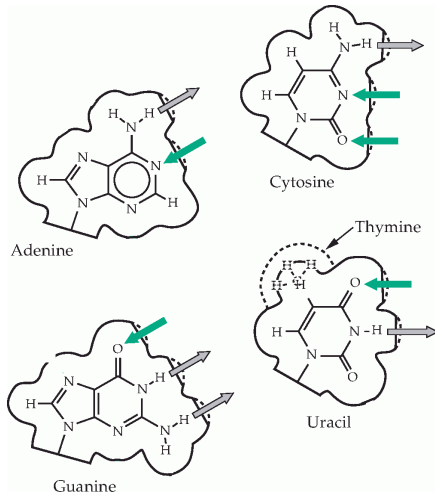
- ▶ Deoxyribose vs. ribose
- ▶ Thymine vs. uracil



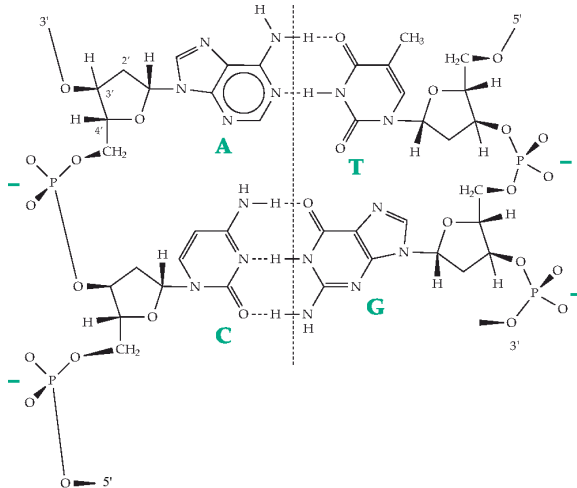
## Hydrogen bonds, complementarity and base pairs

- ▶ 2 hydrogen bonds (one “in”, one “out”): adenine and thymine/uracil
- ▶ 3 hydrogen bonds (one “in”, two “out” in guanine): guanine and cytosine
- ▶ A–T and G–C are base pairs consist of *complementary nucleotides*

## Hydrogen bonds between nucleotides



# Hydrogen bonds in complementary strands



## Final question (3 points)

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

## Summary

- ▶ 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:`

`//ashipunov.info/shipunov/school/biol_250`



B. Alberts et al.

*Essential Cell Biology*. 3rd edition.

Garland Science, 2009.

*Chapter 2: : Molecules in cells, Panels 2–6.*