From DNA to Protein

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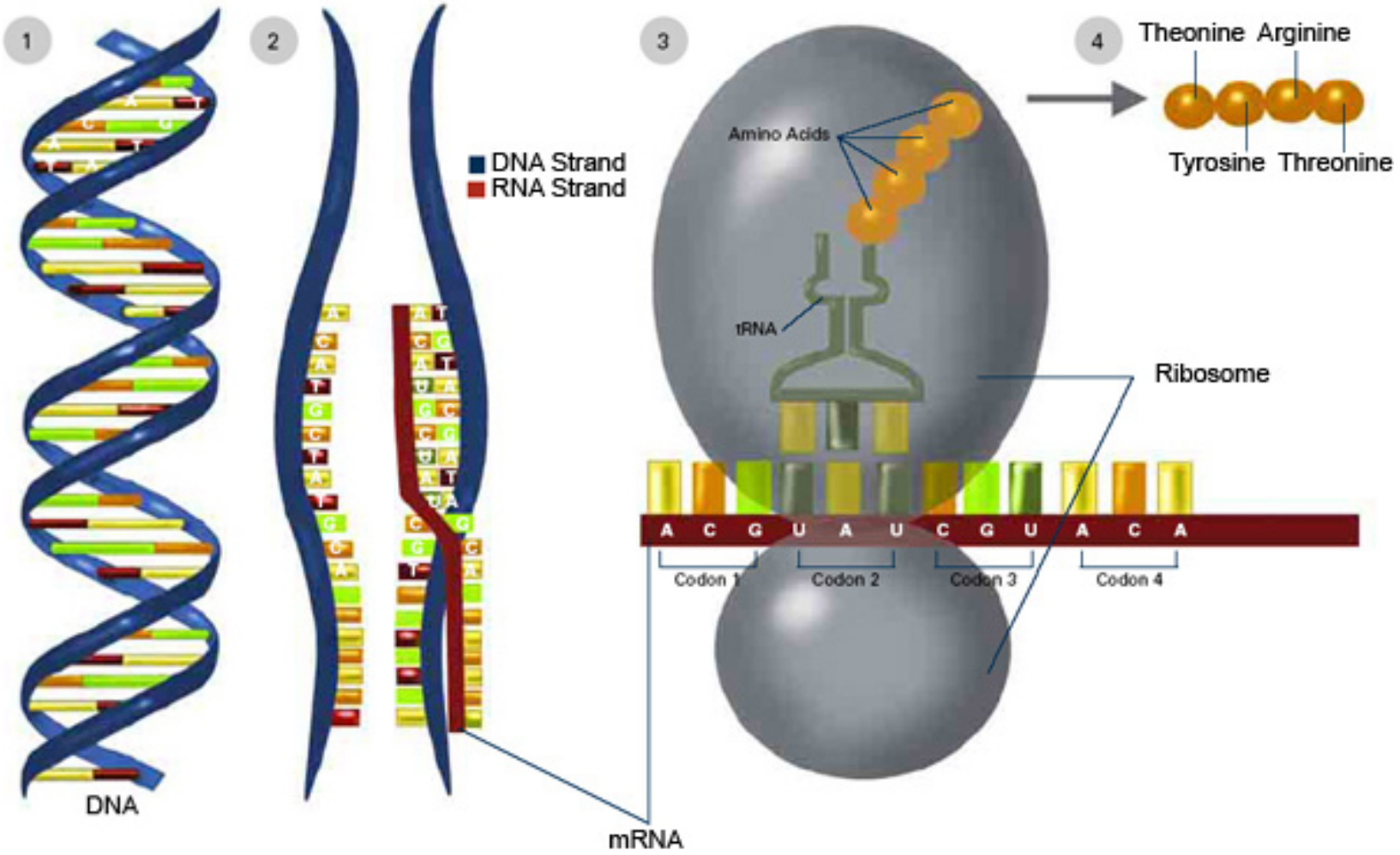
Objectives of this lecture

By the end of this lecture you will be able to:

1. Describe DNA structure and function
2. Identify different types of nucleic acids
3. Understand the process of gene expression
4. Recognize posttranslational modifications

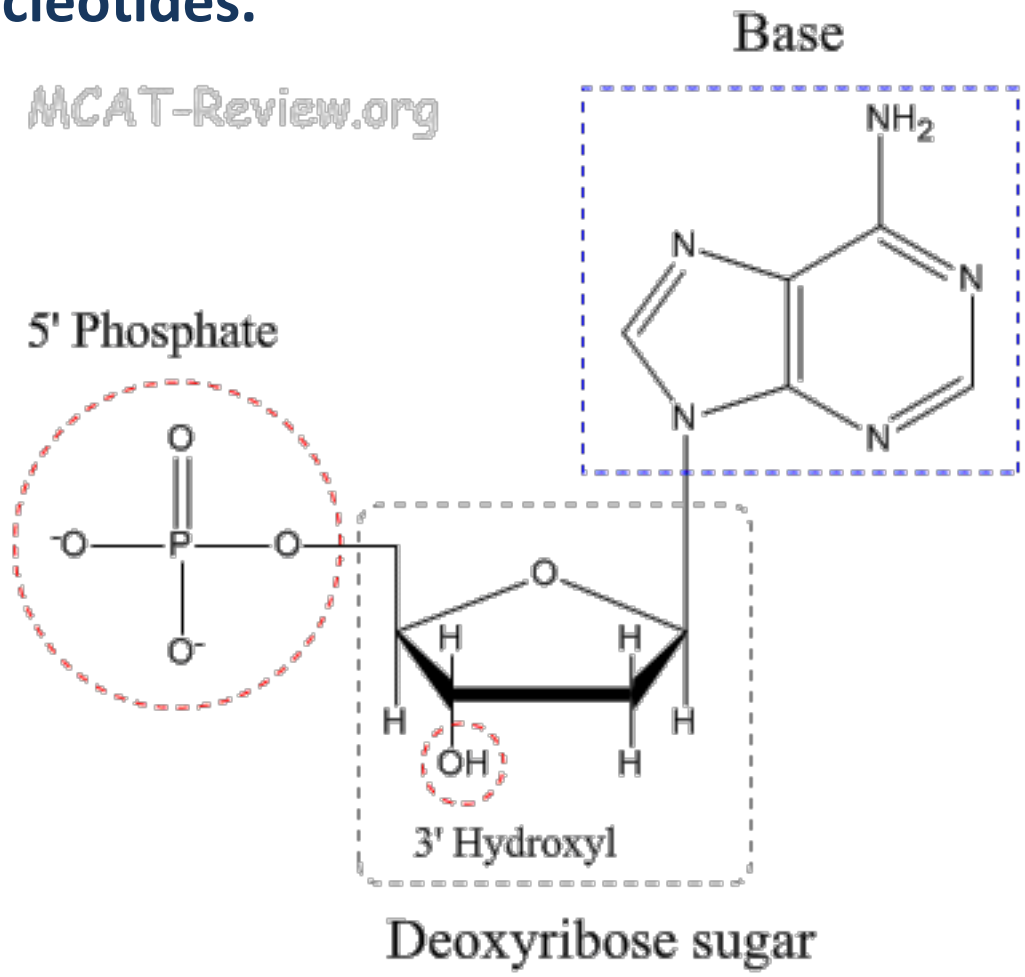
Gene expression

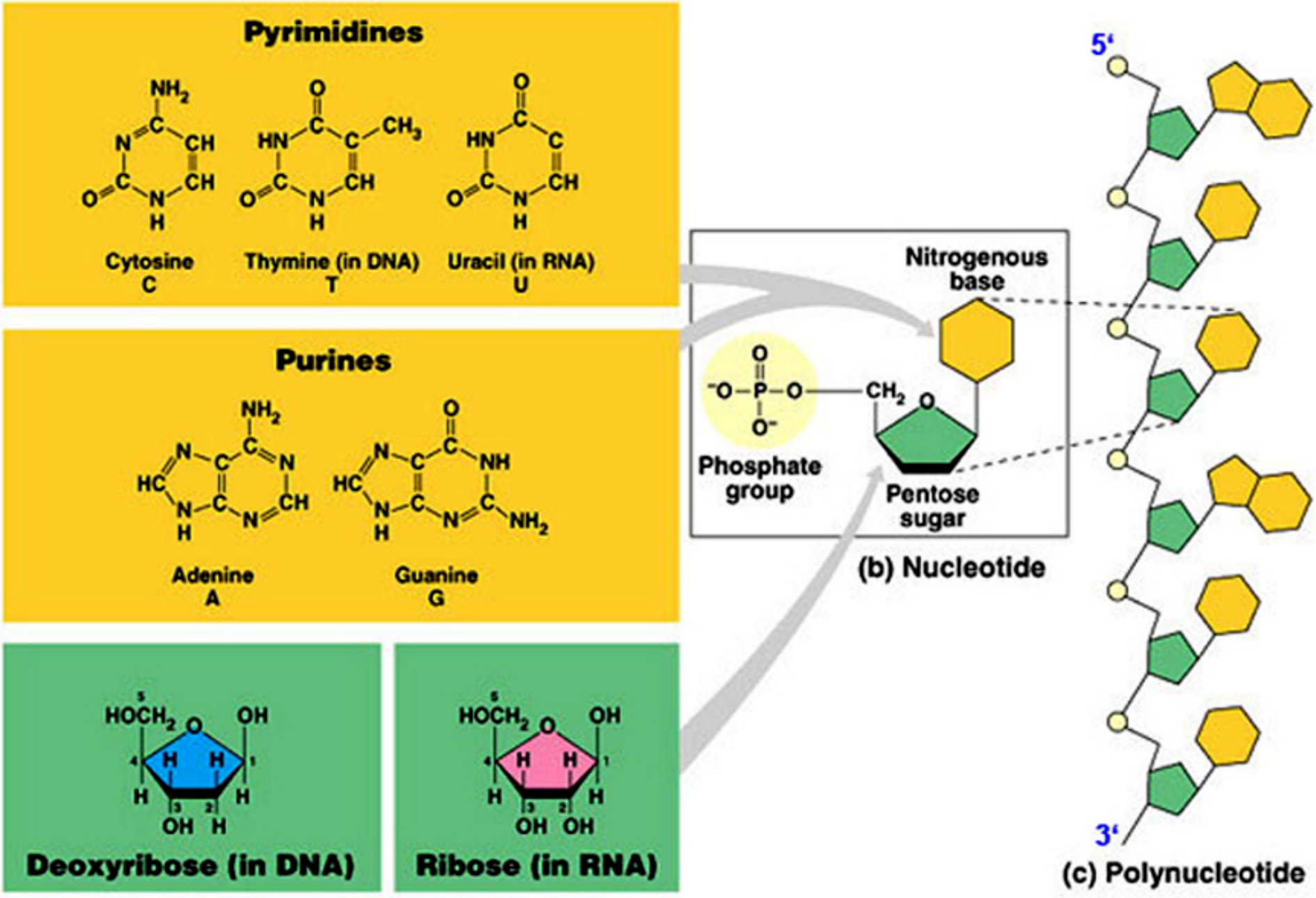
The Central Dogma in Molecular Biology



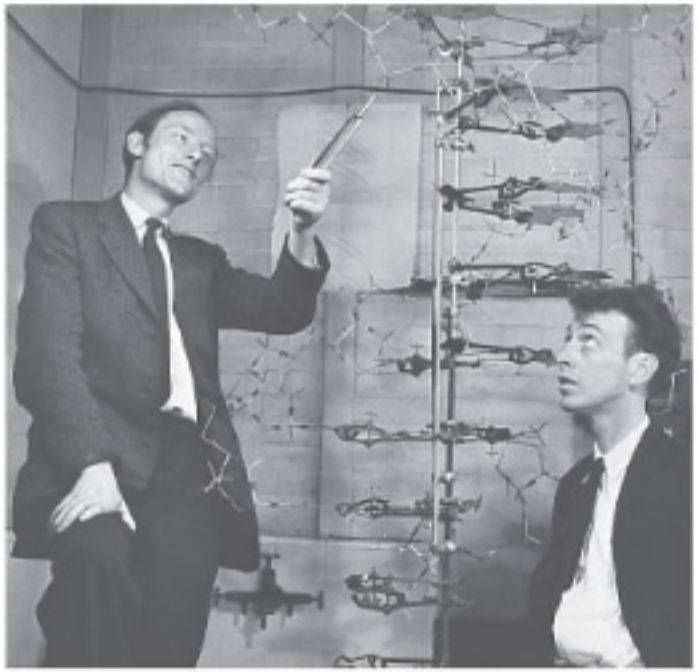
DNA structure and function

DNA is a "polymer" consisting of double strands of helically oriented nucleotides.





(A)



(B)

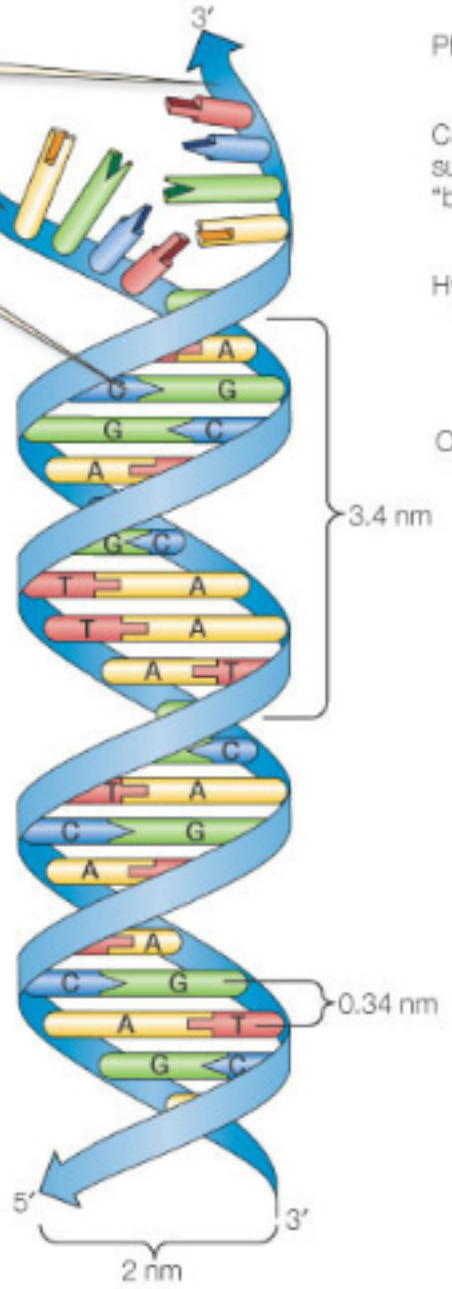
The blue bands represent the two sugar–phosphate chains.

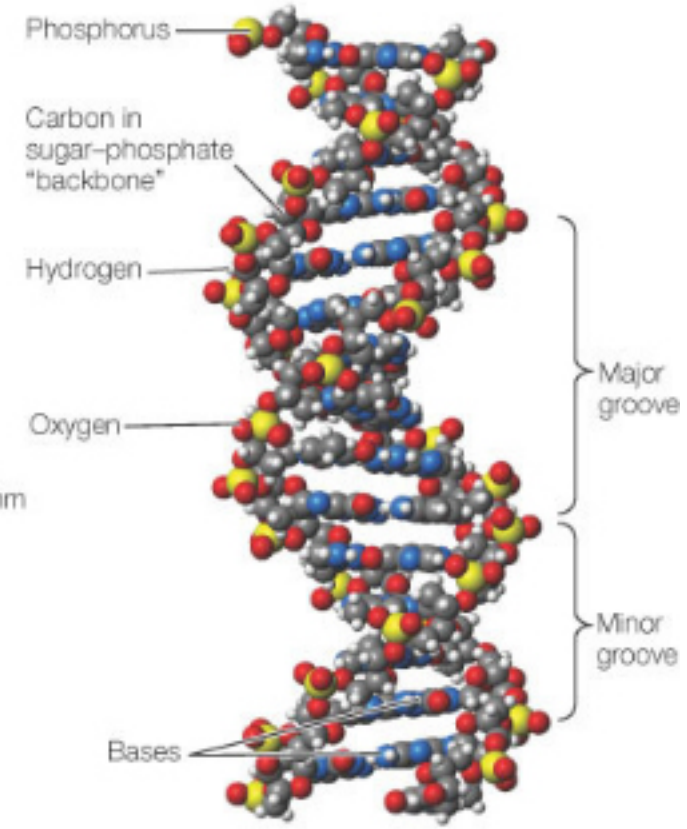
Pairs of bases form horizontal connections between the chains.

The two chains run in opposite directions:

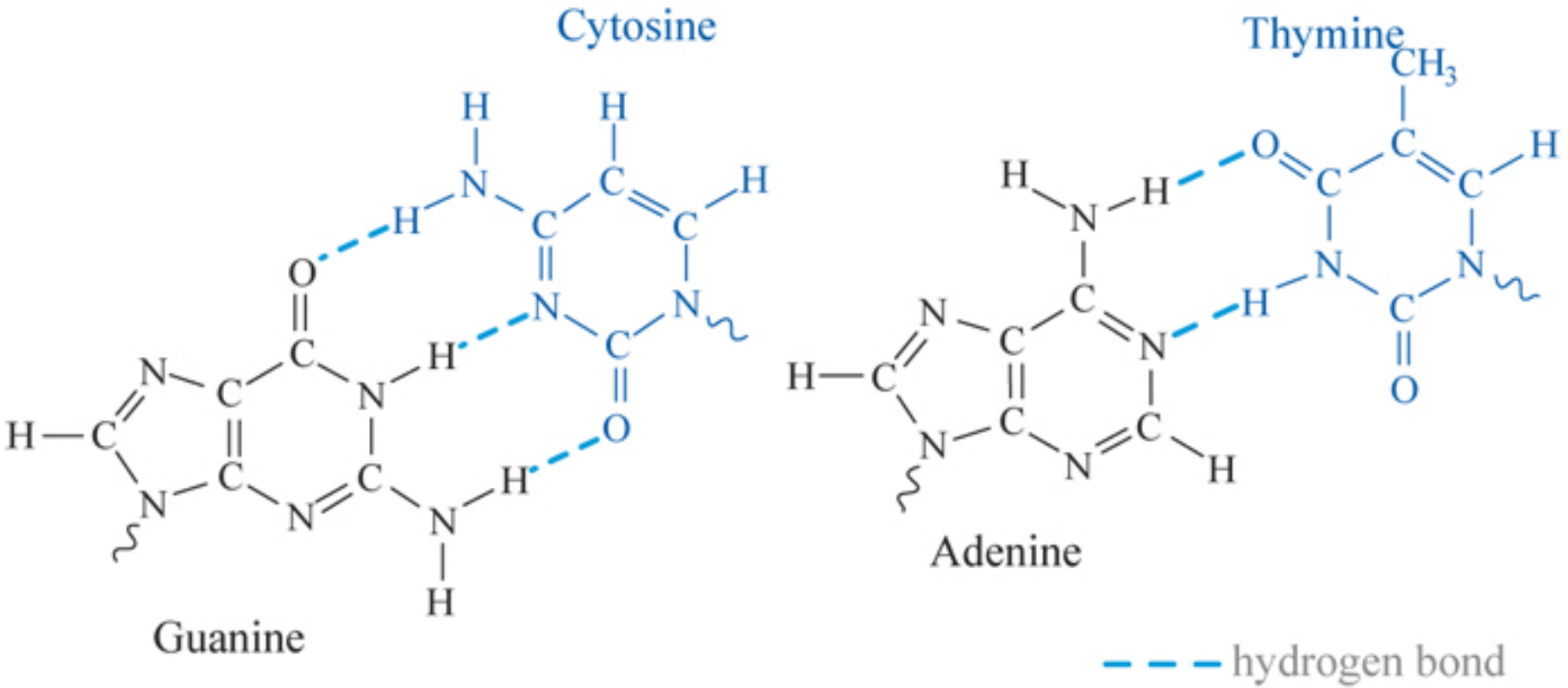
5′ 3′

3′ 5′





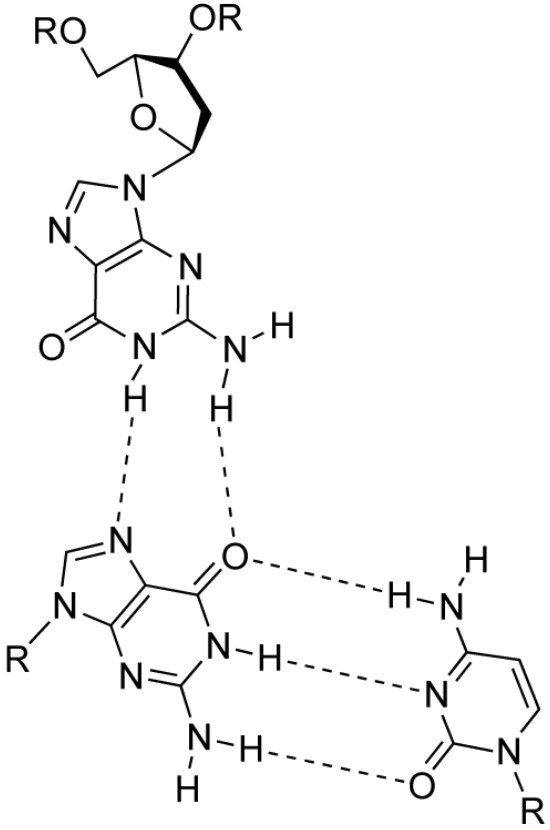
Watson-Crick base pairing



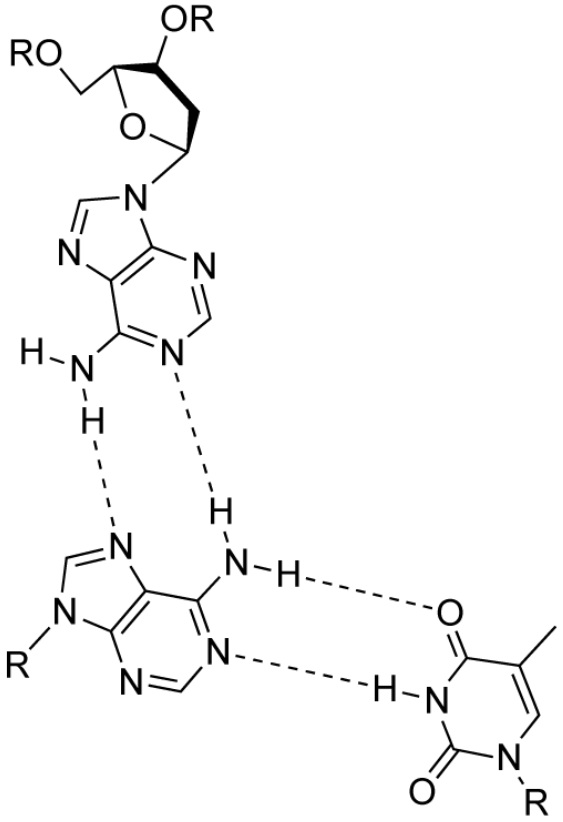
A (purine) with T (pyrimidine)
G (purine) with C (pyrimidine)

Why not:
A (purine) with C (pyrimidine)
G (purine) with T (pyrimidine)

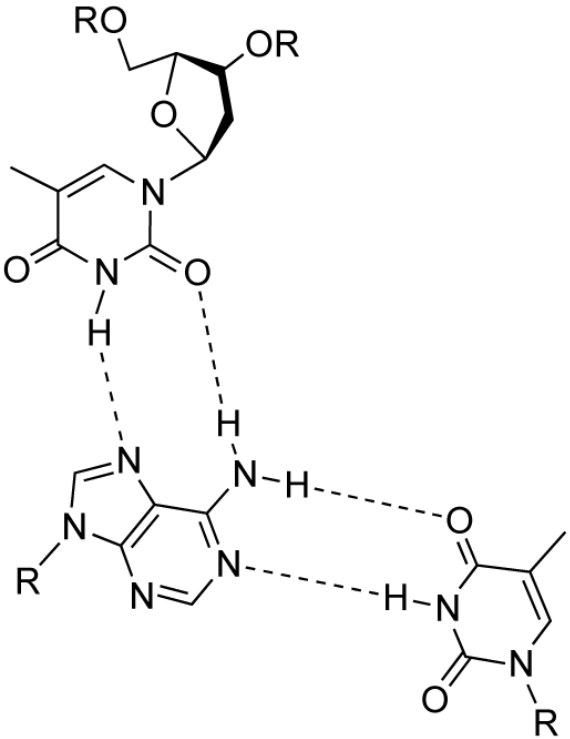
Hoogsteen base pairing



G·GC



A·AT



T·AT

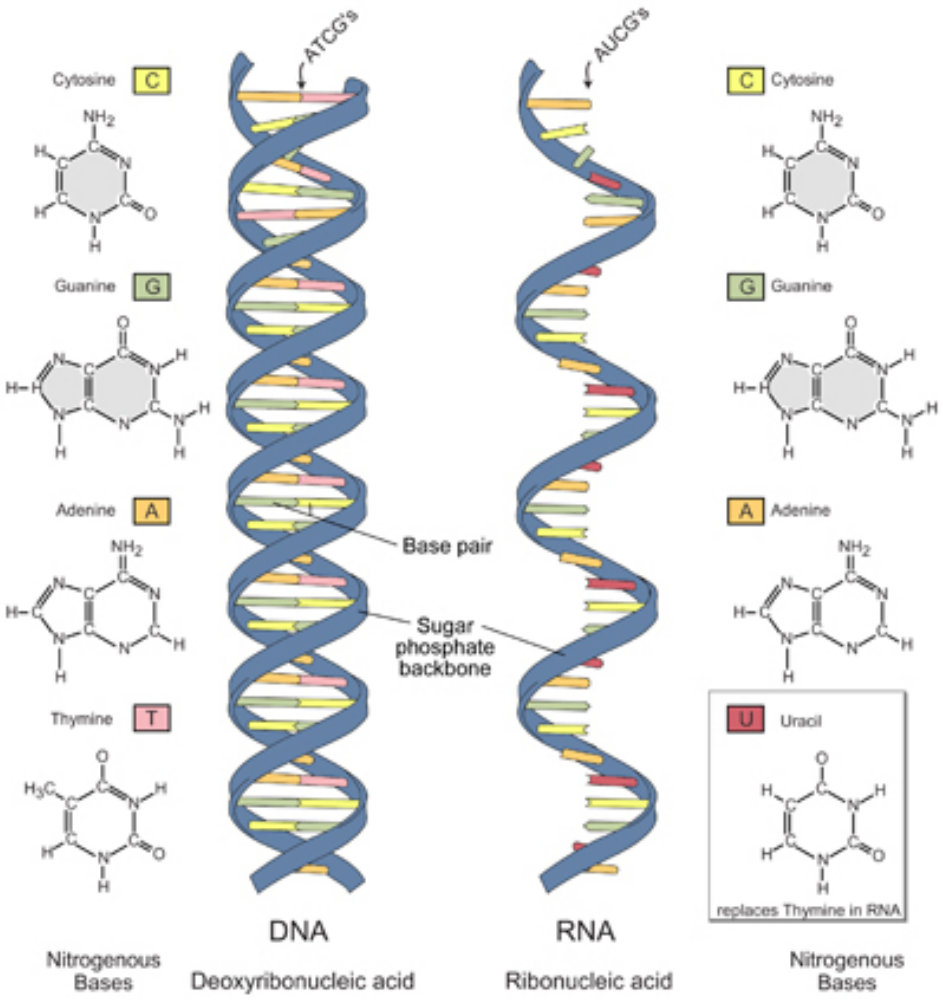
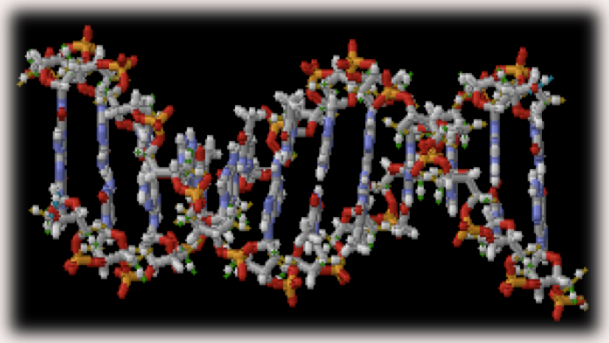
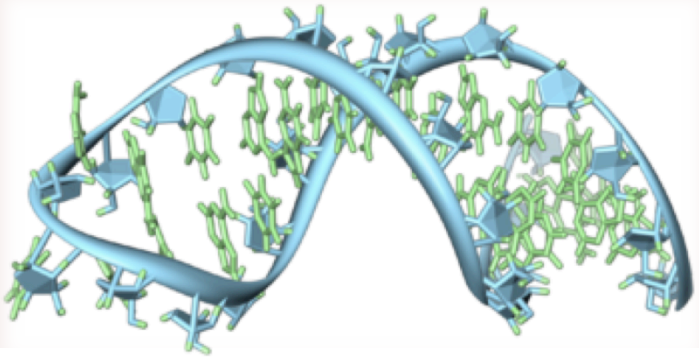
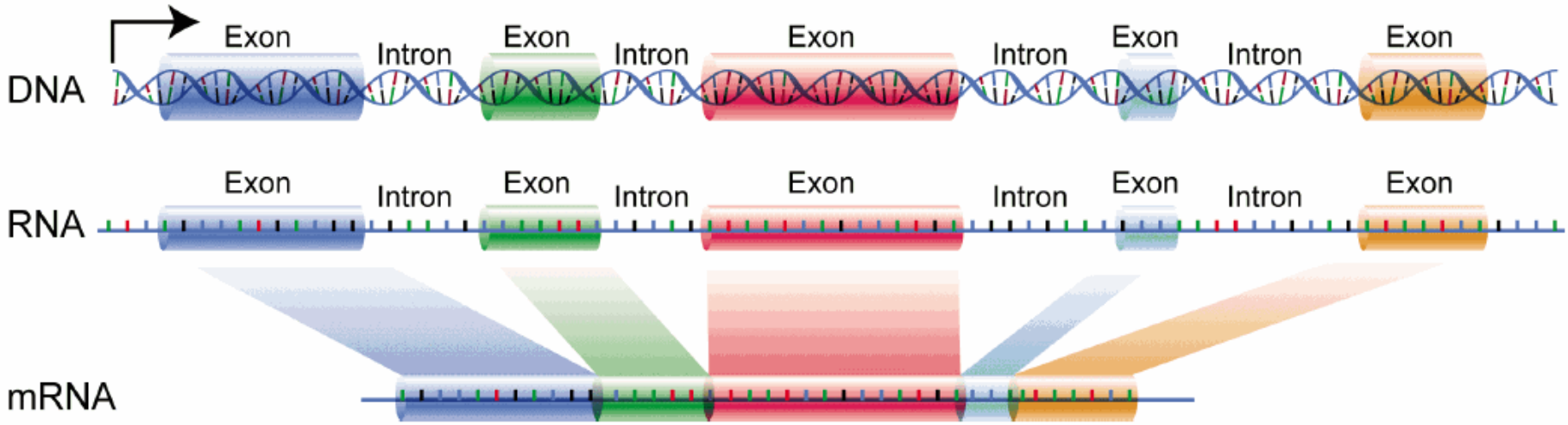
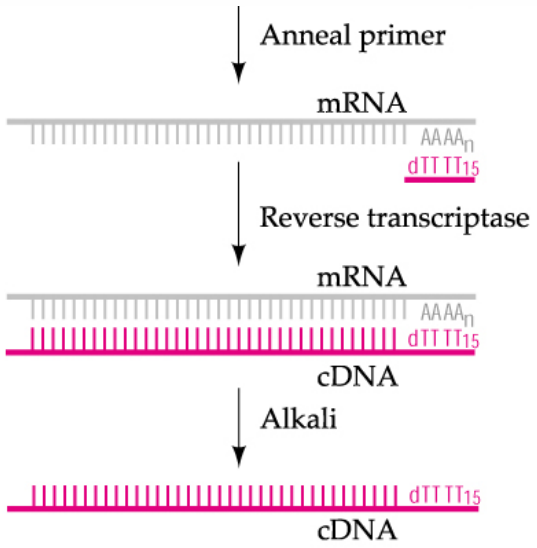


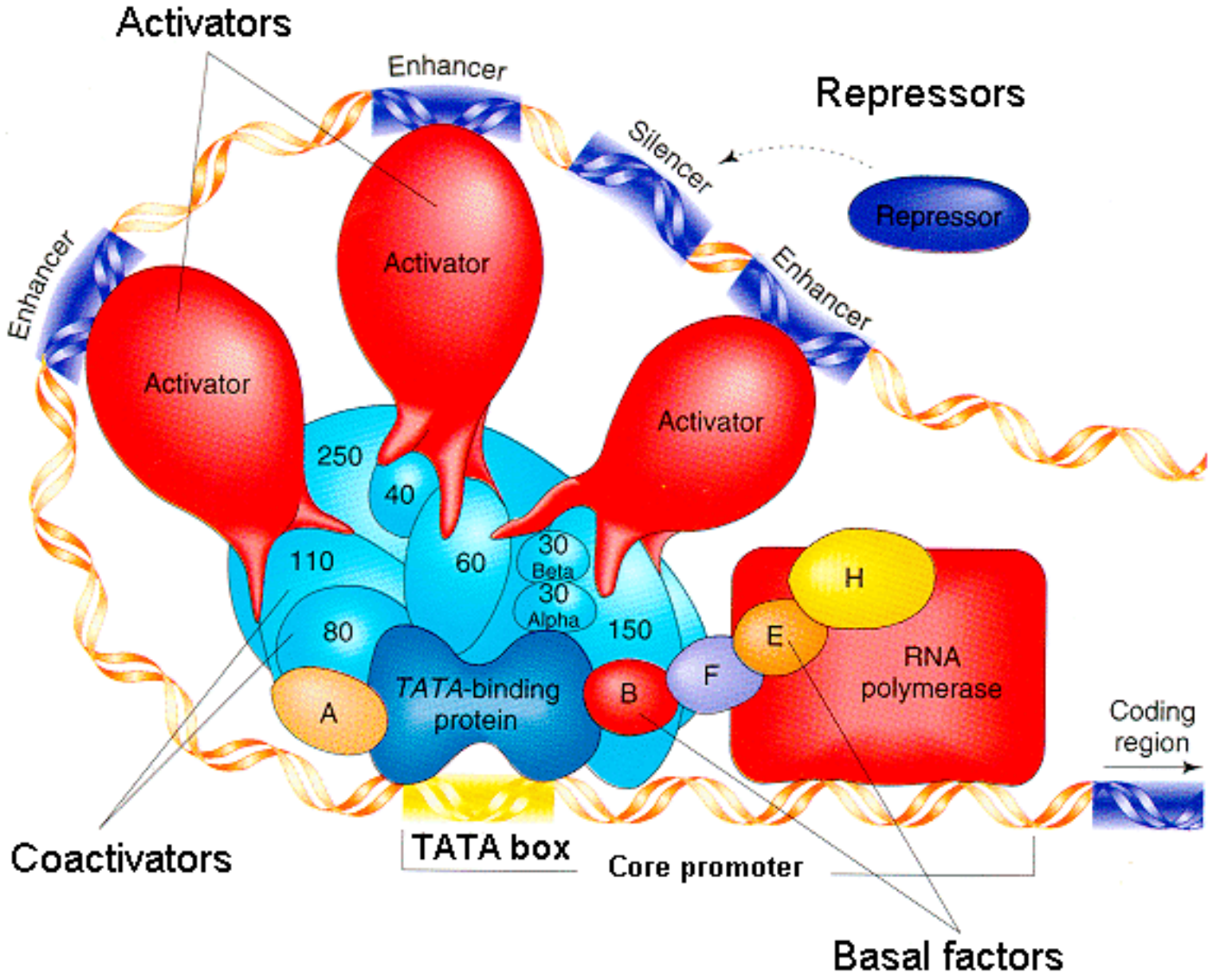
Image adapted from: National Human Genome Research Institute.

DNA	RNA
ATCG	AUCG
More stable in nucleases	Less stable in nucleases
Less stable in UV light	More stable in UV light
	

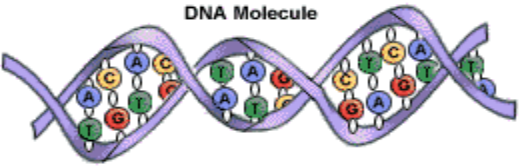
Exons and Introns



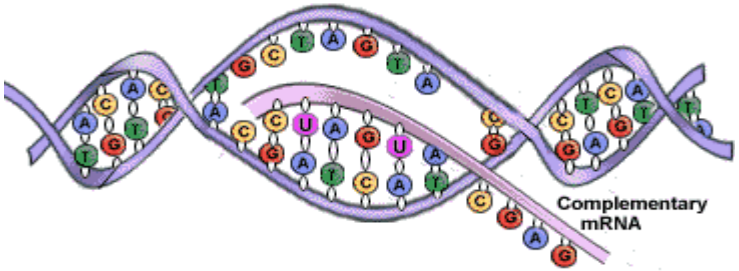



Activators
Enhancer
Repressors
Silencer
Repressor
Enhancer
Enhancer
Activator
Activator
Activator
250
40
110
60
30
Beta
30
Alpha
80
150
H
E
F
B
A
TATA-binding
protein
RNA
polymerase
Coding
region
Coactivators
TATA box
Core promoter
Basal factors

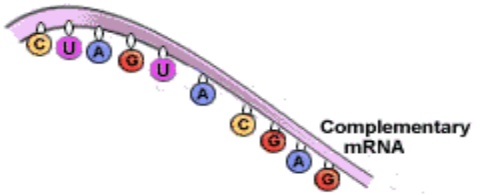
DNA Molecule

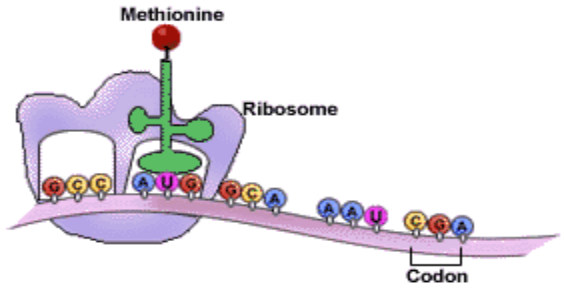


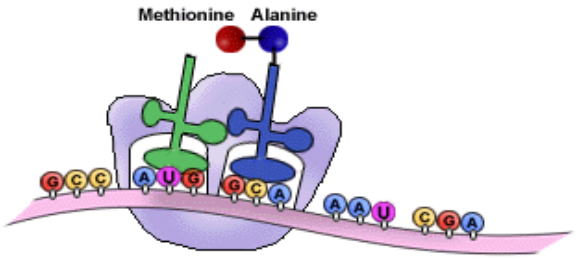
DNA Molecule Unravelled - One Strand is a Template for Synthesis of mRNA

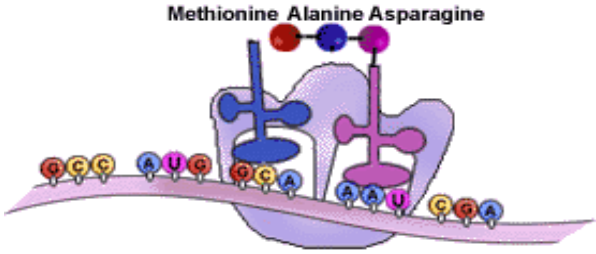


Result of Transcription

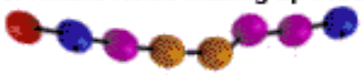




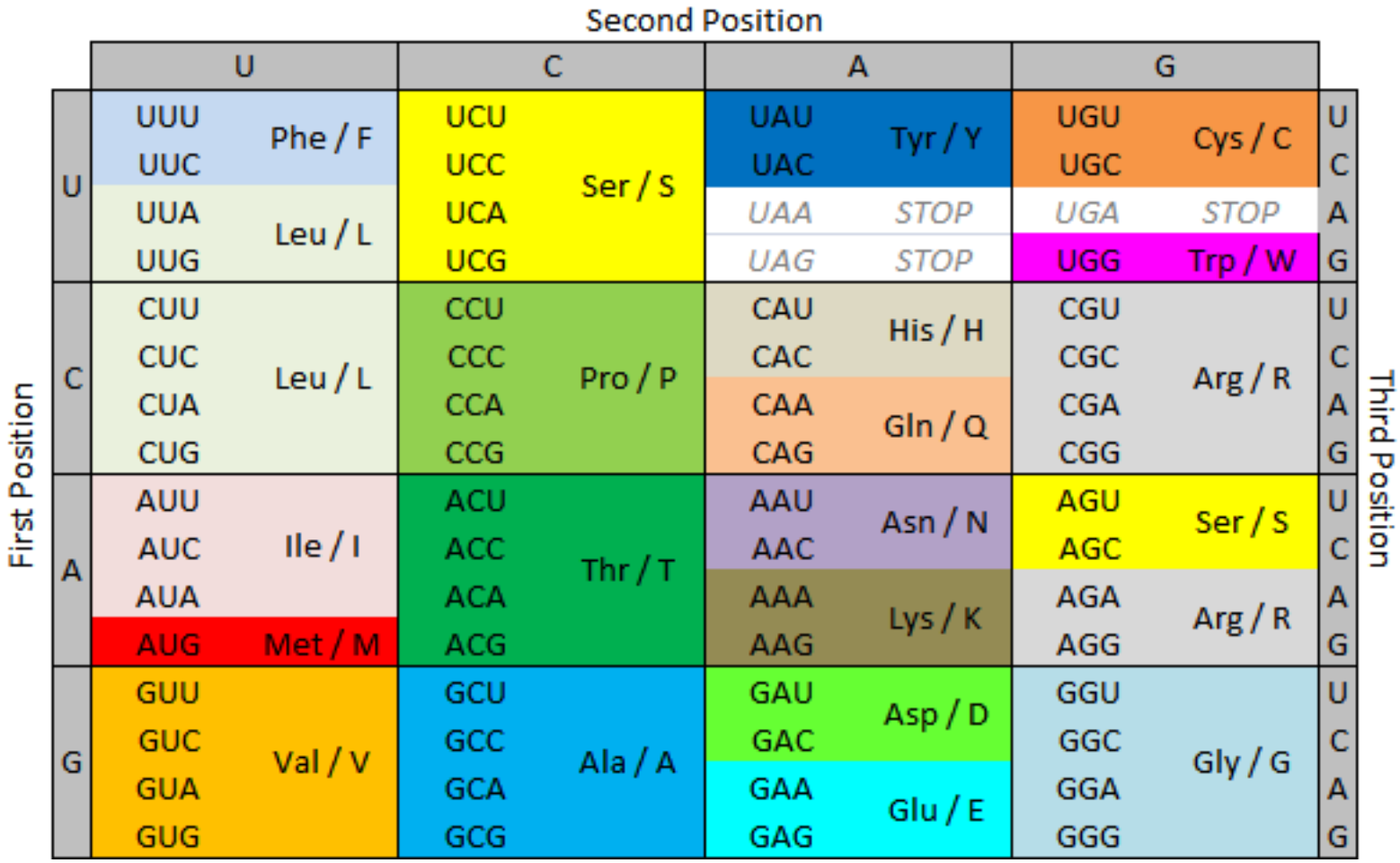




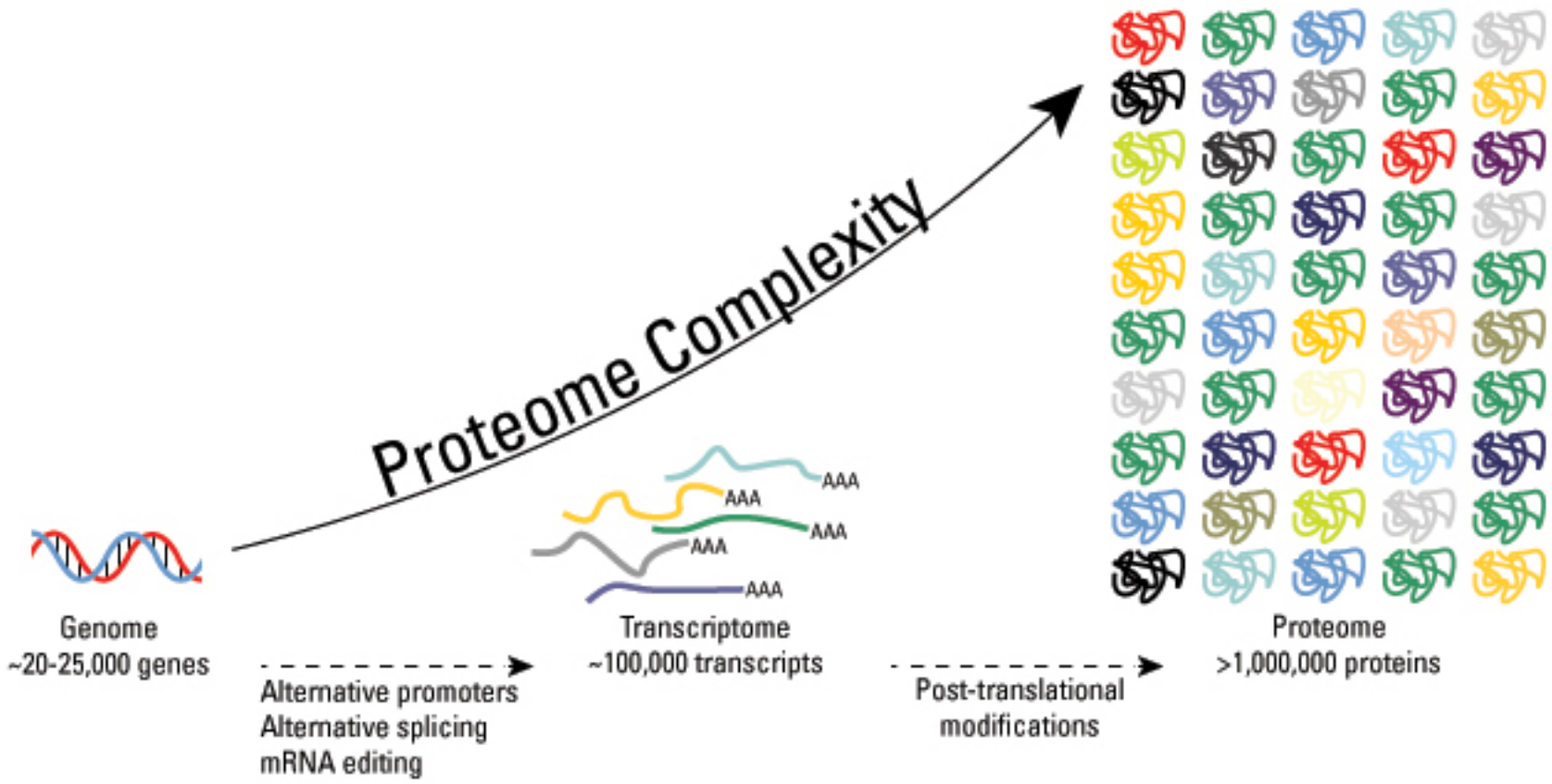
Result of Translation:
Chain of Amino Acids making up Protein



Codon to Amino Acids



Posttranslational modifications



Posttranslational modifications

- **Increase the functional diversity of the proteome by the covalent addition of functional groups or proteins, proteolytic cleavage of regulatory subunits or degradation of entire proteins**

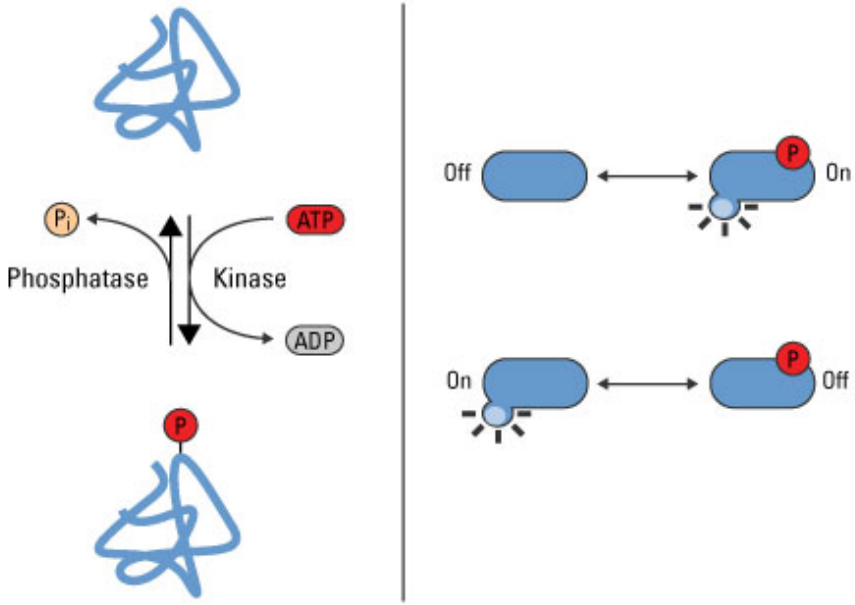
- **Include phosphorylation, glycosylation, ubiquitination, nitrosylation, methylation, acetylation, lipidation and proteolysis**

Posttranslational modifications

- **Play a key role in functional proteomics, because they regulate activity, localization and interaction with other cellular molecules such as proteins, nucleic acids, lipids, and cofactors.**

Phosphorylation

- **Reversible process**
- **Mainly on serine, threonine or tyrosine**
- **Regulation of many cellular processes including cell cycle, growth, apoptosis and signal transduction pathways**



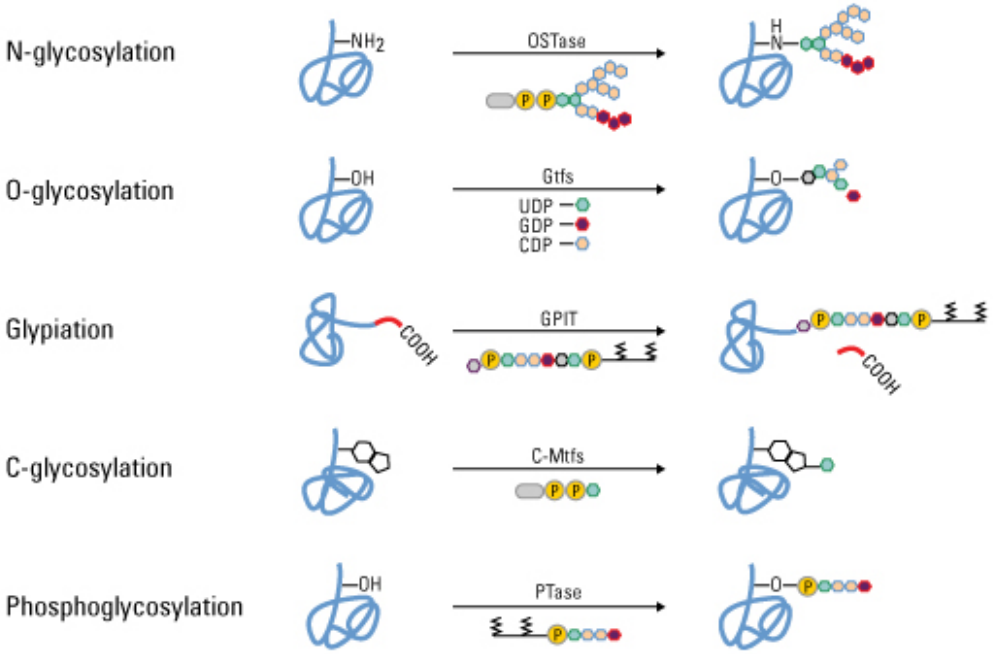
Glycosylation

- **One of the major post-translational modifications, with significant effects on protein folding, conformation, distribution, stability and activity.**

- **Additions of simple monosaccharide to highly complex branched polysaccharide to proteins.**

Glycosylation

N-glycosylation	Glycan bind to the amino group of asparagine in the ER
O-glycosylation	Monosaccharides bind to the hydroxyl group of serine or threonine in the ER, Golgi, cystosol and nucleus
Glypiation	Glycan core links a phospholipid and a protein
C-glycosylation	Mannose binds to the indole ring of tryptophan
Phosphoglycosylation	Glycan binds to serine via phosphodiester bond



You are now able to:

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- ✓ Identify different types of nucleic acids
- ✓ Understand the process of gene expression
- ✓ Recognize posttranslational modifications