DNA and RNA

By

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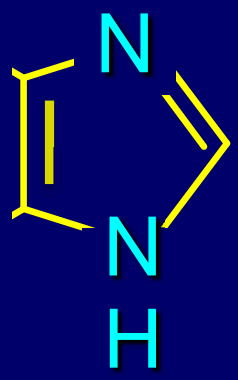
Pyrimidines and Purines

Pyrimidines and Purines

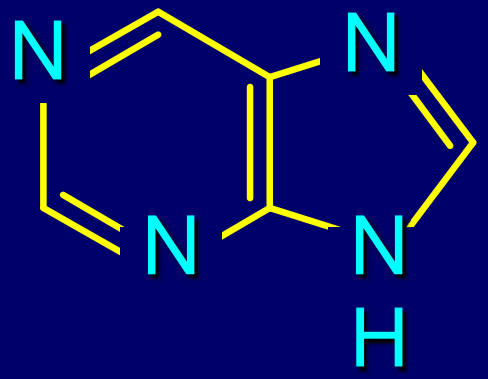
Pyrimidine and purine are the names of the parent compounds of two types of nitrogen-containing heterocyclic aromatic compounds.



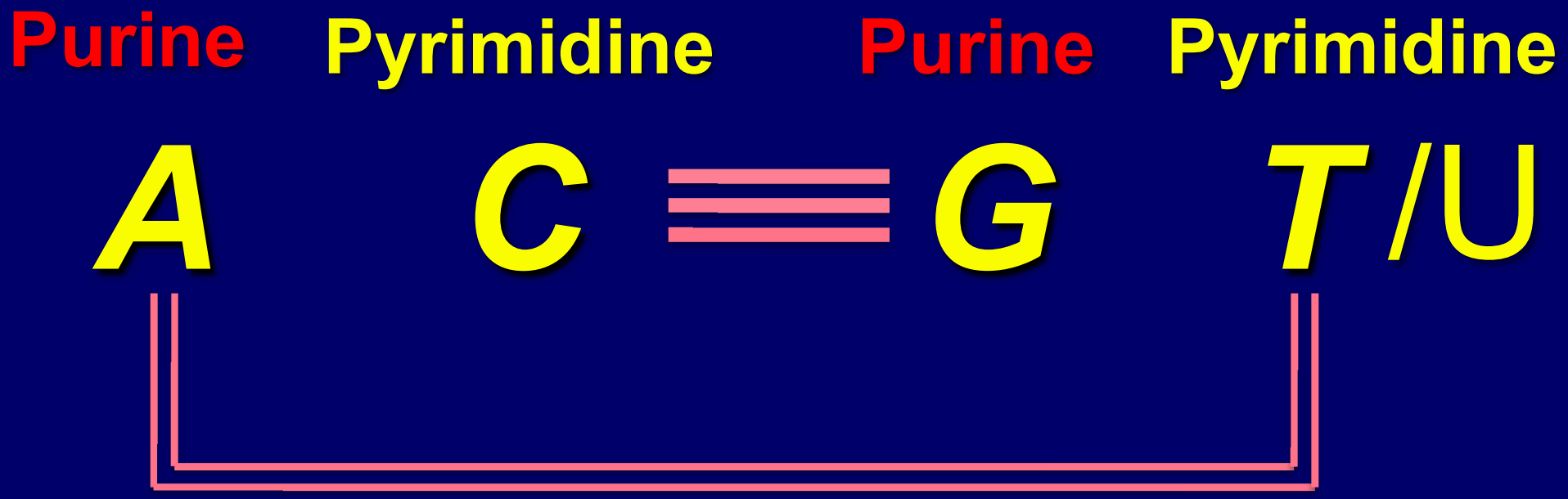
Imidazole

Pyridine

Pyrimidine

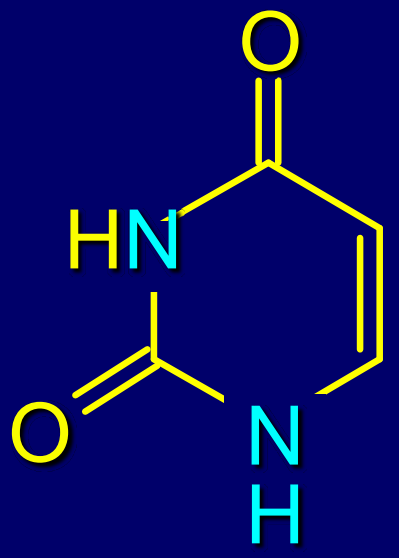


Purine

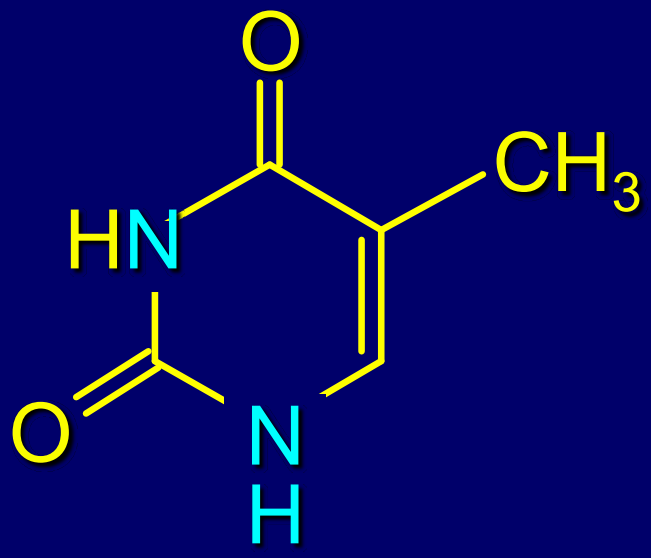


Important Pyrimidines

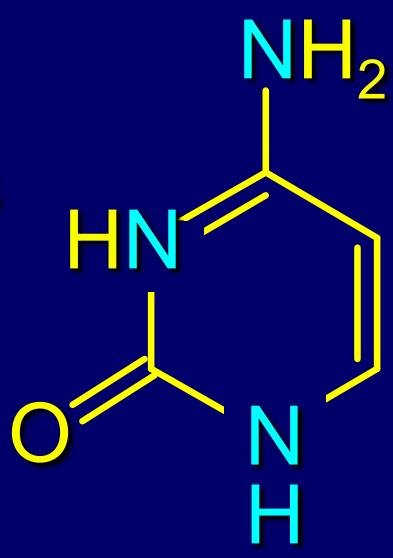
Pyrimidines that occur in DNA are cytosine and thymine. Cytosine and uracil are the pyrimidines in RNA.



Uracil



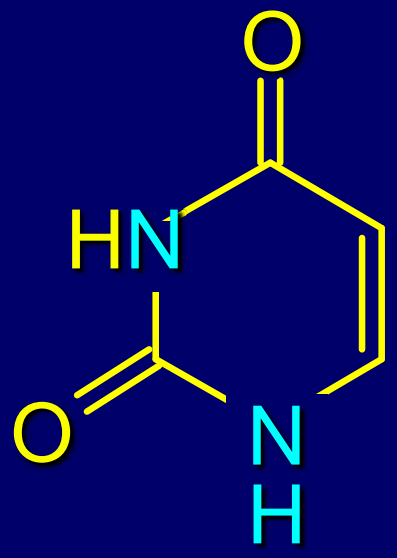
Thymine



Cytosine

Uracil

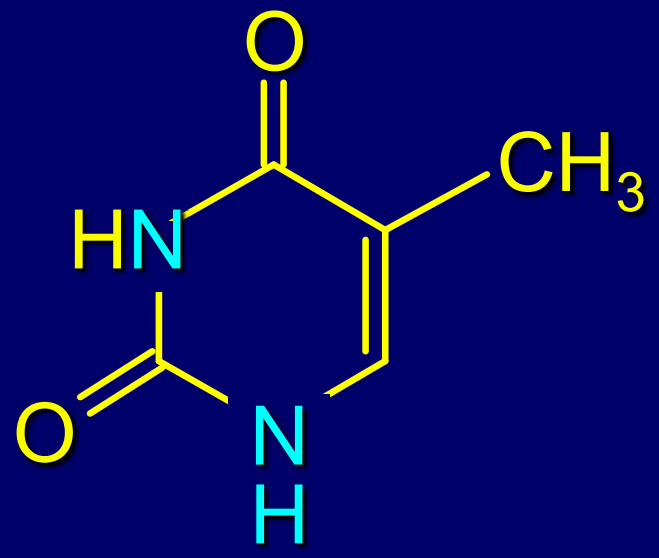
Pyrimidines with 2 carbonyls



Uracil

Thymine

Methylated Uracil



Thymine

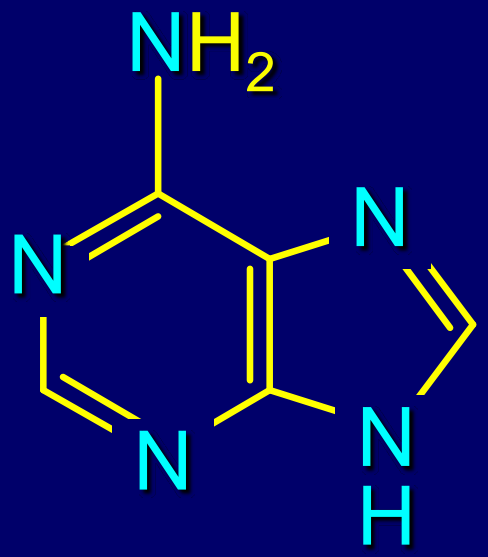
Cytosine

Ammoniated Uracil

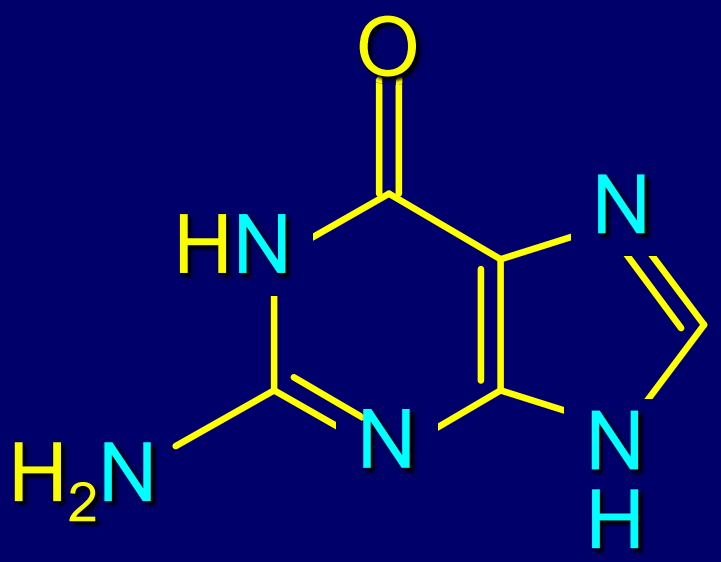
Cytosine

Important Purines

Adenine and guanine are the principal purines of both DNA and RNA.



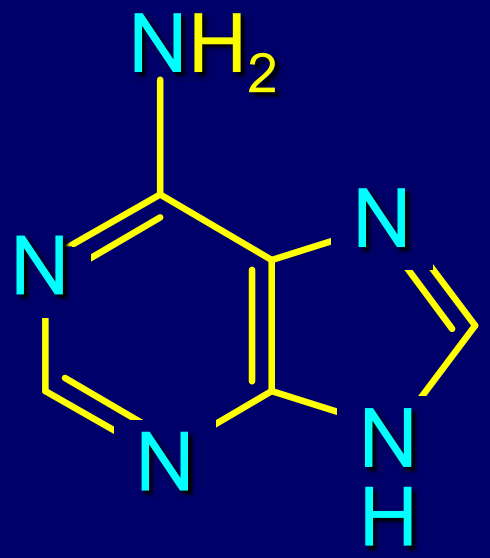
Adenine



Guanine

Adenine

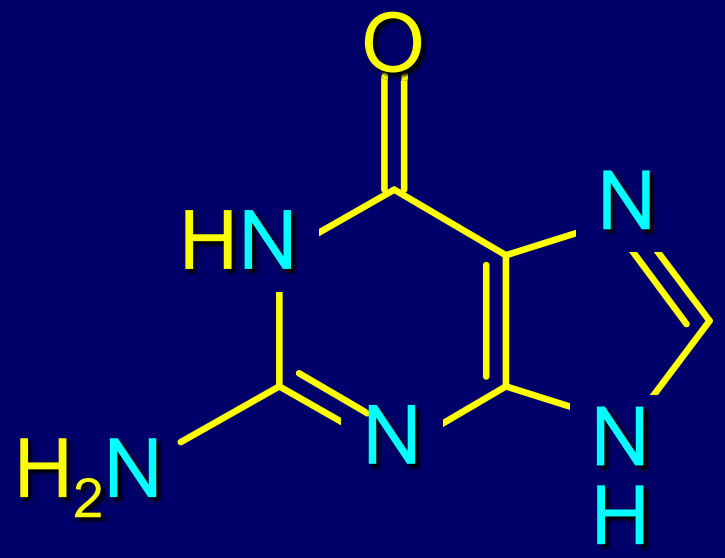
Ammoniated Purine



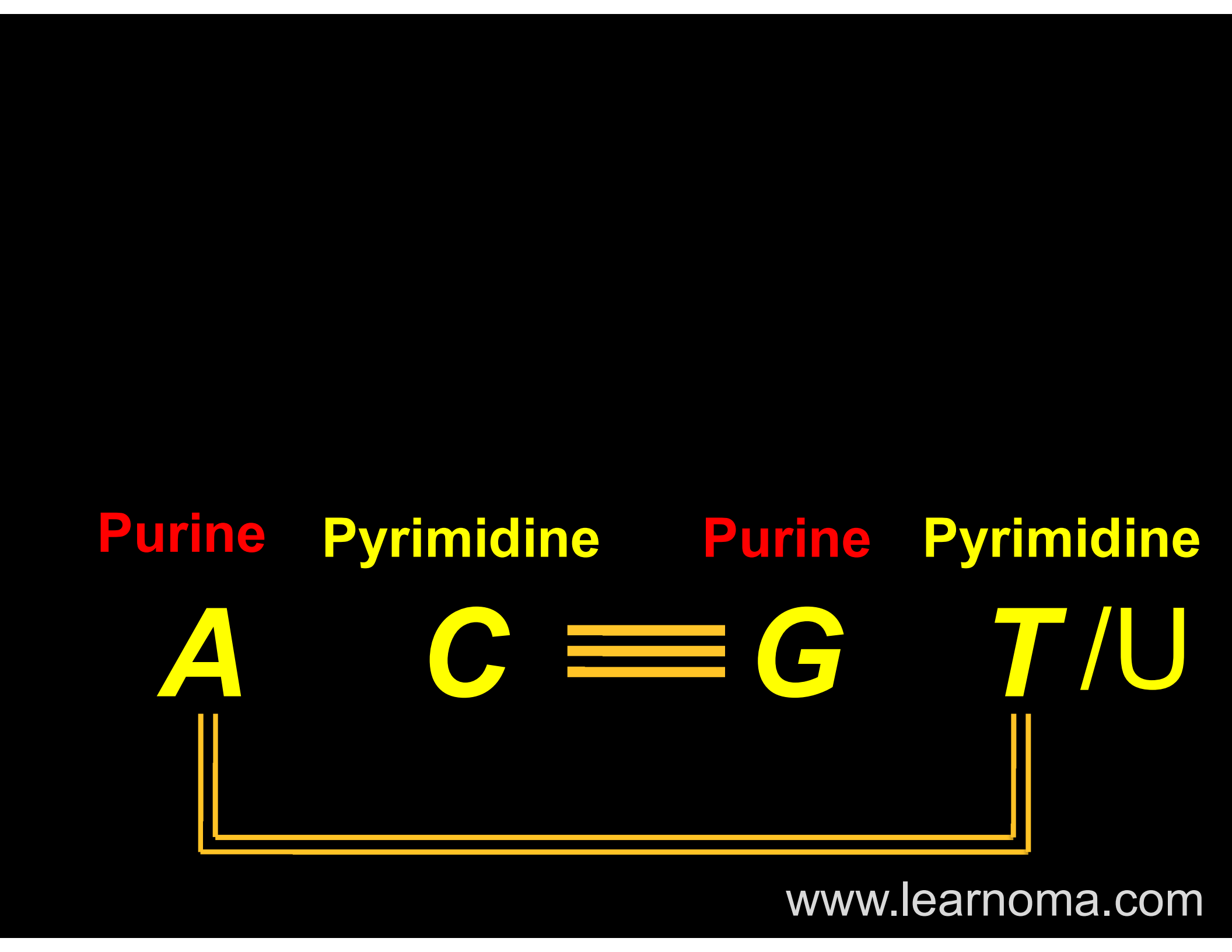
Adenine

Guanine

Mono ammoniated mono carbonylated Purine



Guanine



Nucleosides

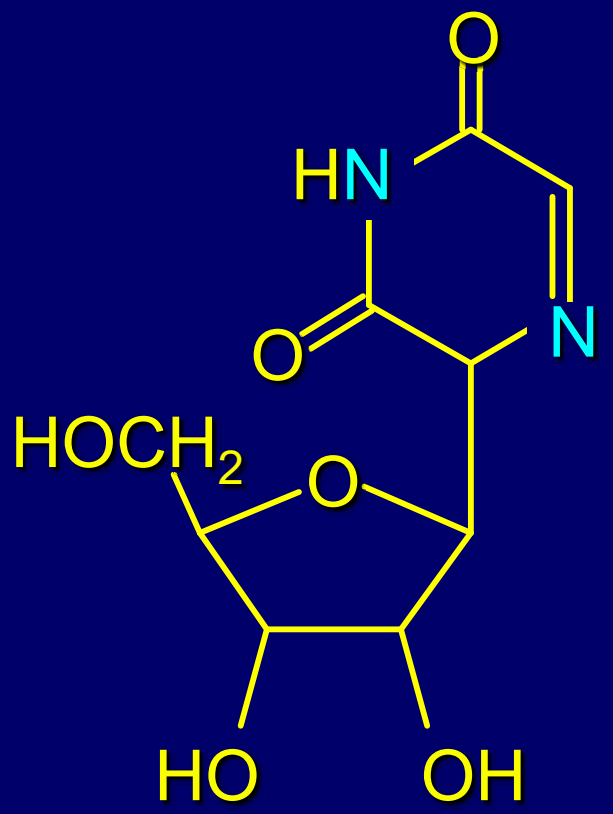
Sides:

N-Glycosides of Ribose / Deoxyribose Sugars.

The purine or pyrimidine part of a nucleoside is referred to as a *purine or pyrimidine base*.

Uridine

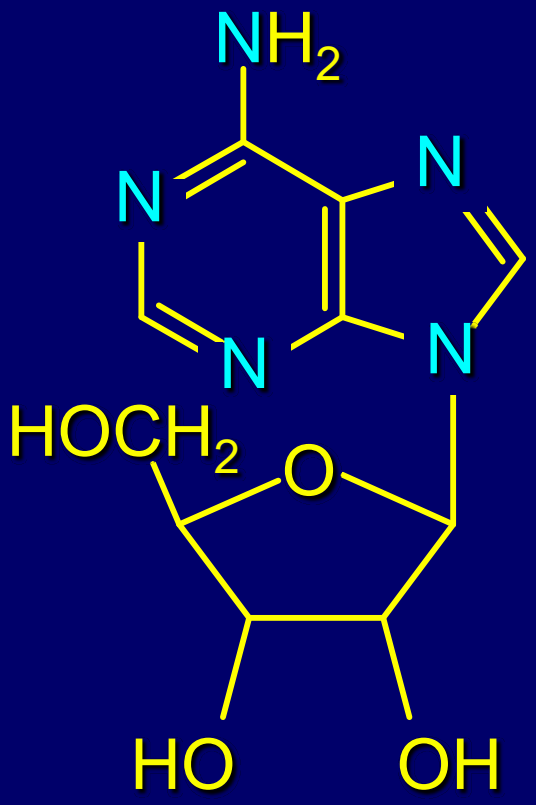
Uridine : Pyrimidine nucleoside made up of Ribose sugar and Uracil Nitrogenous base.



Uridine
(a pyrimidine nucleoside)

Adenosine

Adenosine: A Purine nucleoside made up of deoxyRibose sugar and Adenine Nitrogenous base.



Adenosine
(a purine nucleoside)

Nucleotides

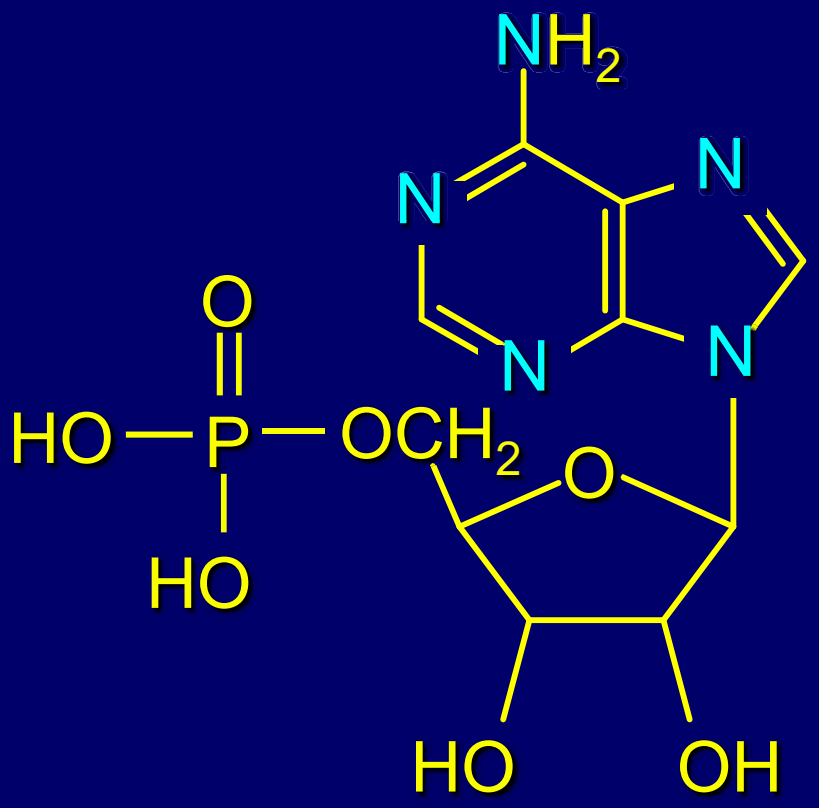
Nucleotides

Nucleotides are phosphoric acid esters of nucleosides.

Phosphate + Sugar+ Nitrogenous Base

Adenosine 5'-Monophosphate (AMP)

Adenosine 5'-monophosphate (AMP) is also called 5'-adenylic acid.



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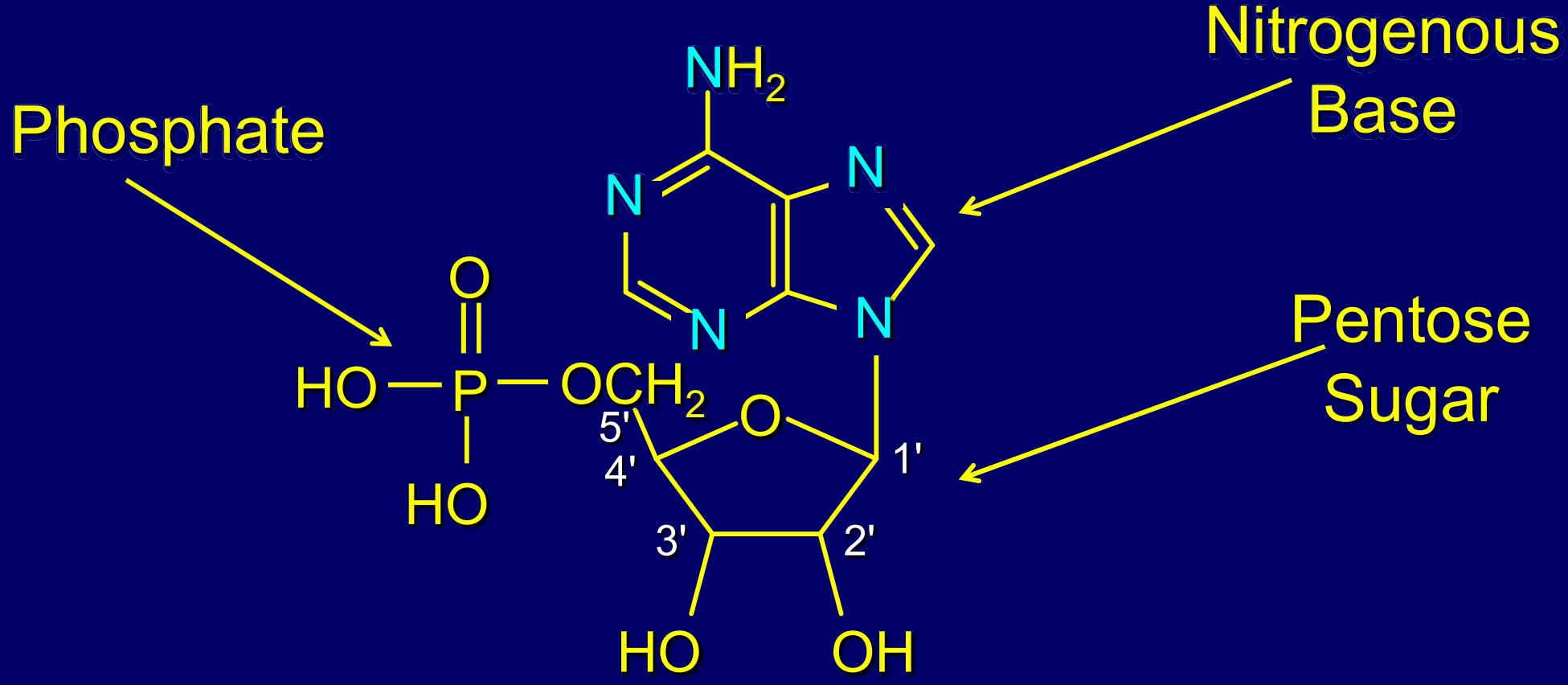
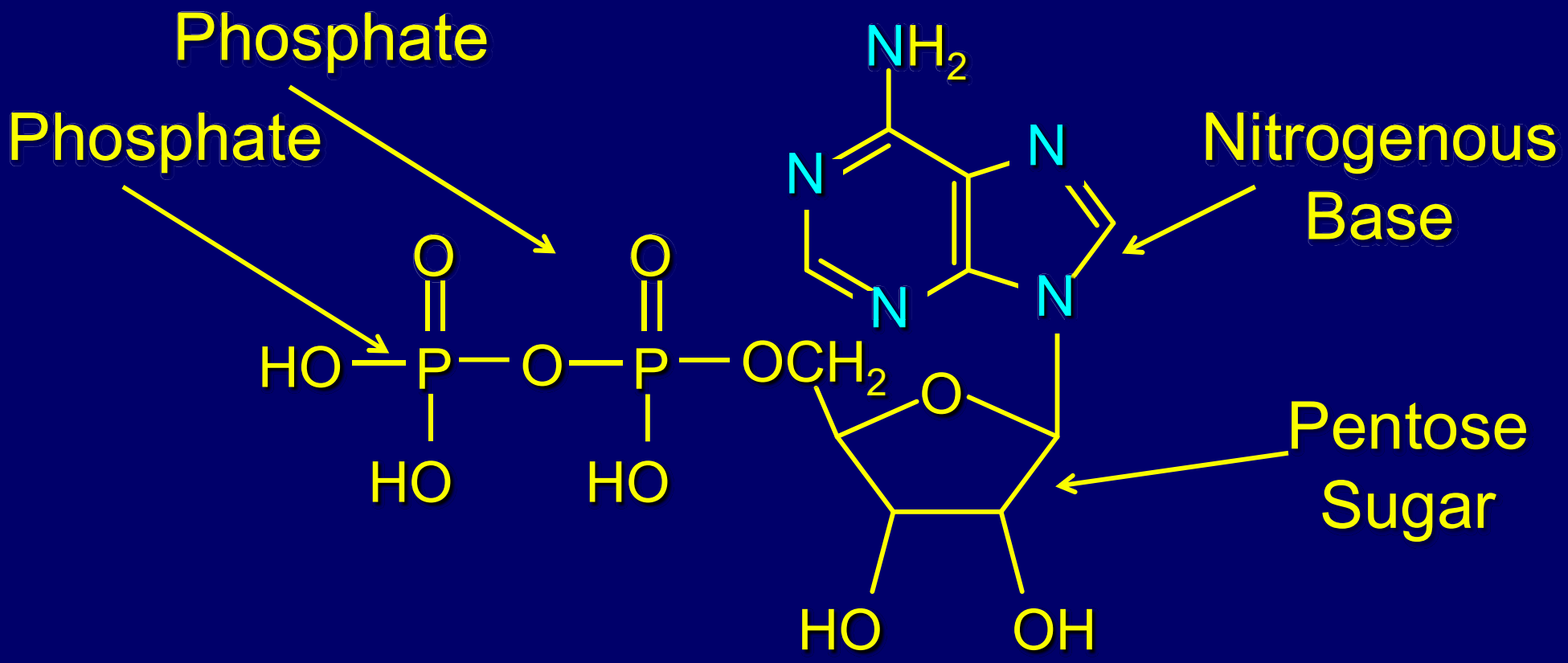
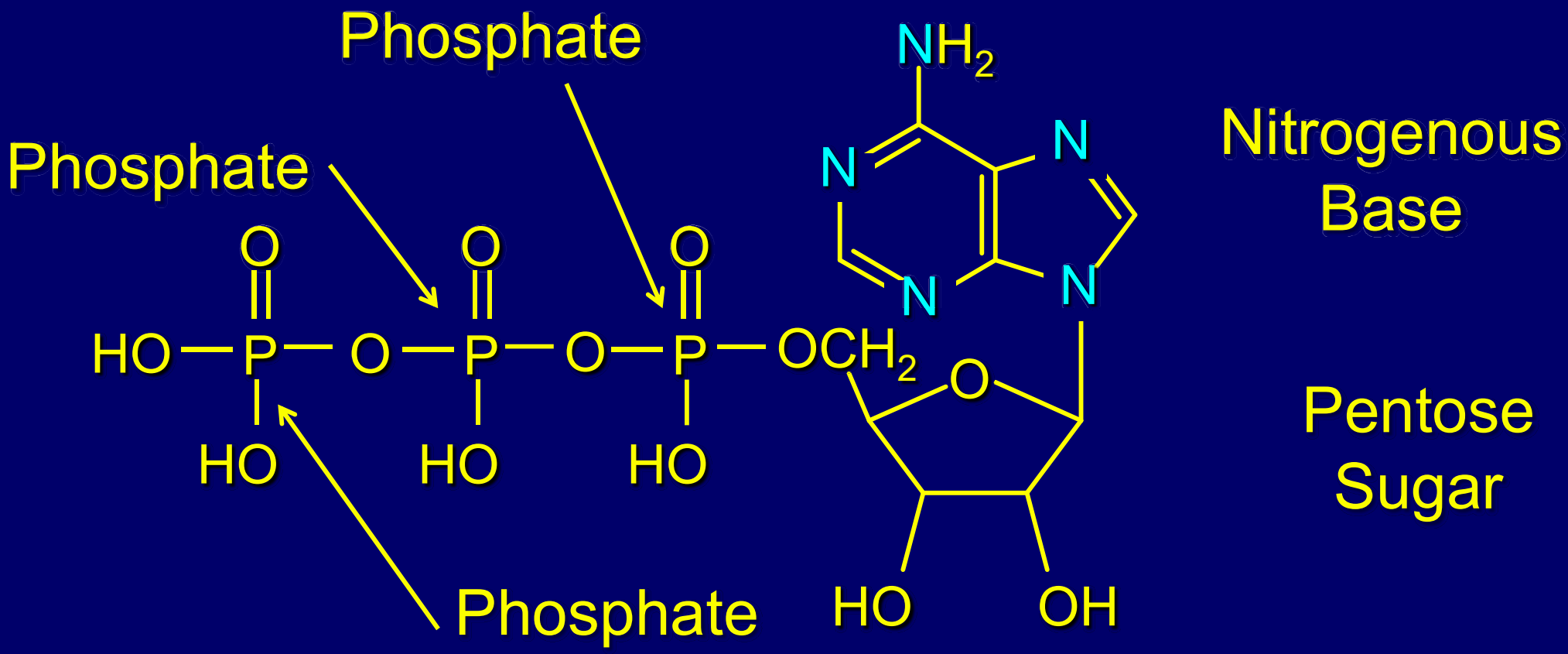


Phosphate + Sugar+

Adenosine Diphosphate (ADP)



Adenosine Triphosphate (ATP)



ATP Stores Energy

Each step is endothermic.

Energy for each step comes from carbohydrate metabolism (glycolysis).

Reverse process is exothermic and is the source of biological energy.

$\Delta G°$ for hydrolysis of ATP to ADP is –35 kJ/mol

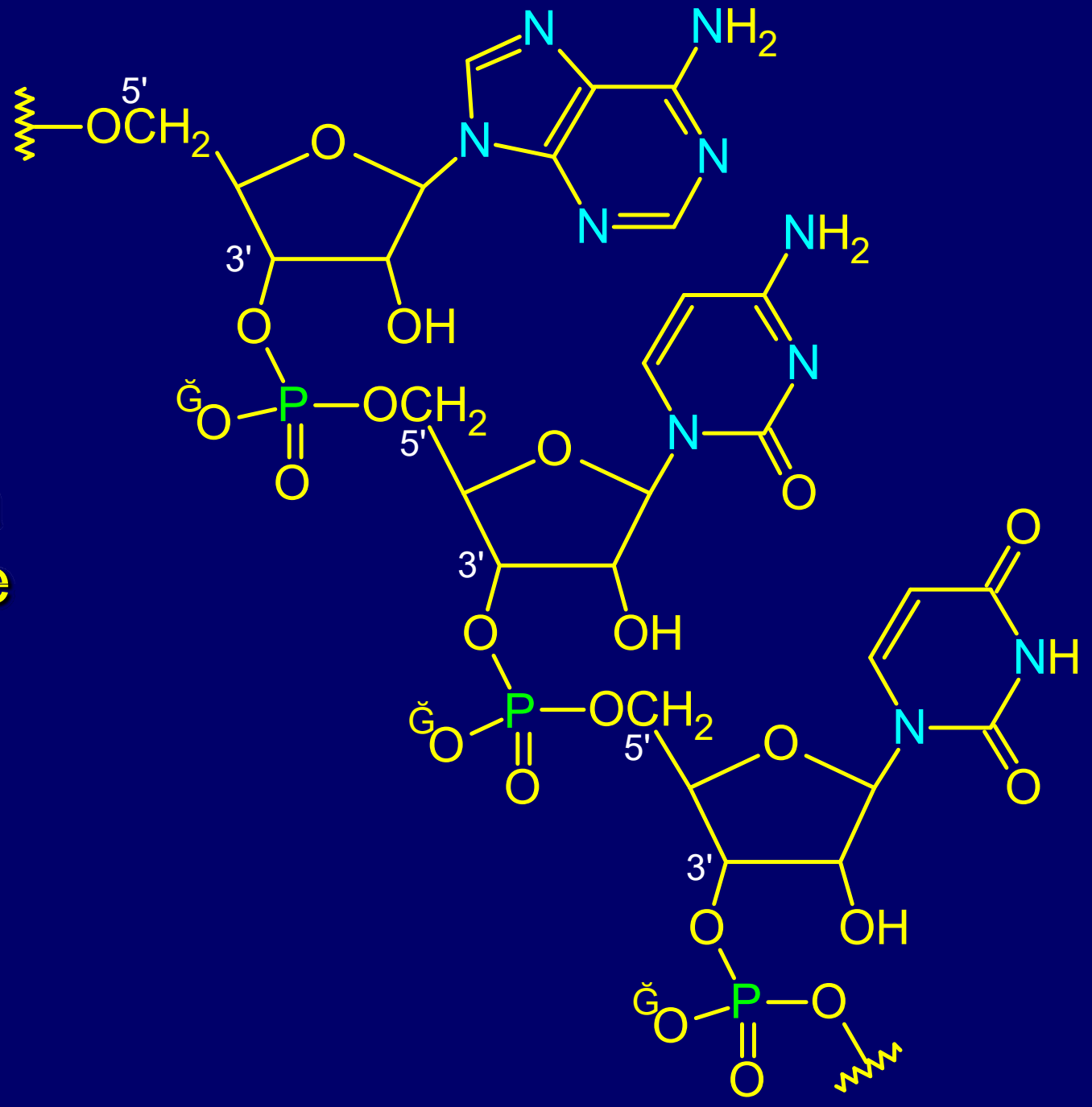
Nucleic Acids

Nucleic Acids

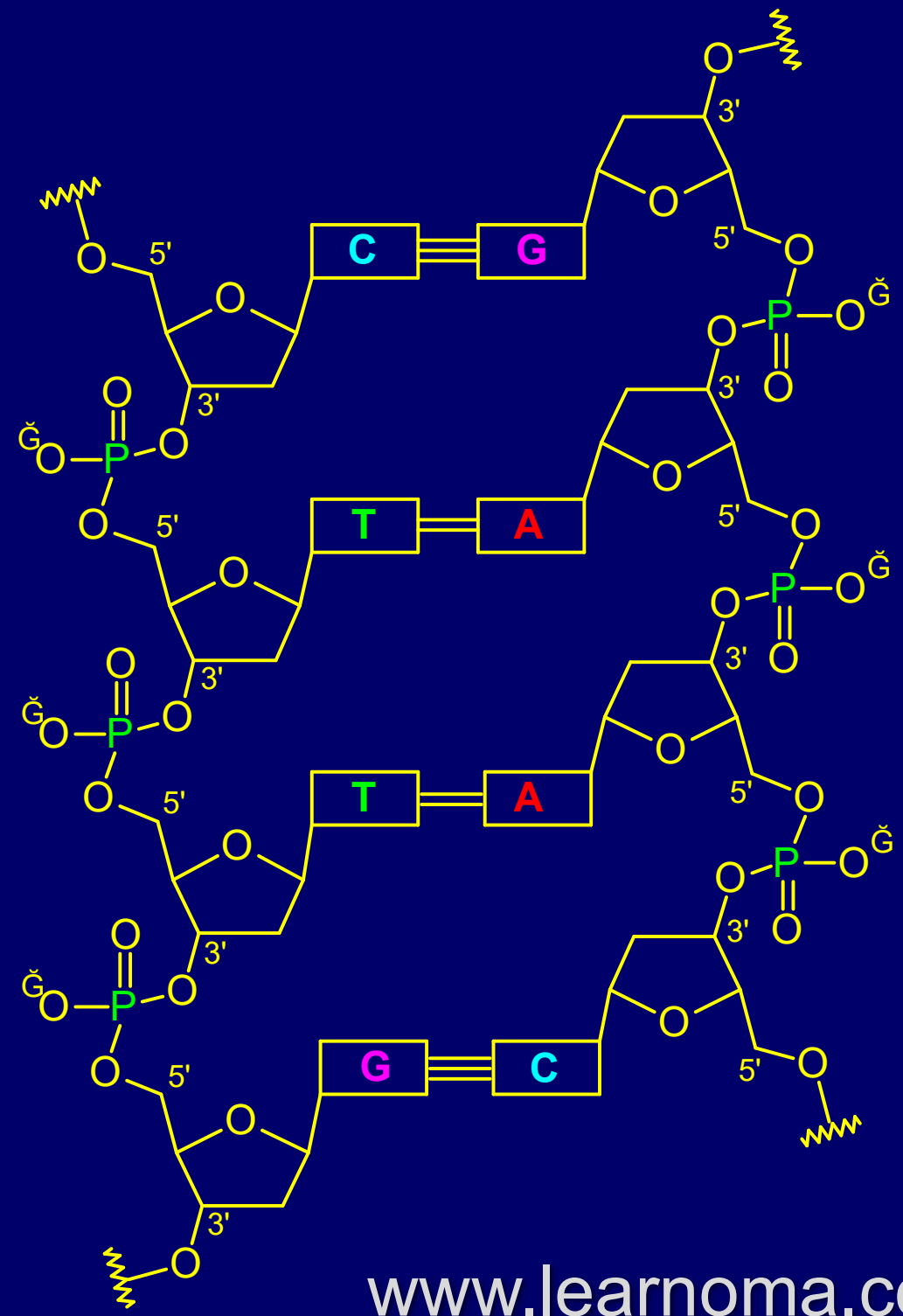
Nucleic acids are polymeric nucleotides

5' Oxygen of one nucleotide is linked to the 3' oxygen of another via phosphate.

A section of a polynucleotide chain.



Two antiparallel strands of DNA are paired by hydrogen bonds between purine and pyrimidine bases.



Comparing DNA & RNA

	DNA	RNA
Sugar is deoxyribose	√	
Sugar is ribose		√
Adenine base is present	√	√
Cytosine base is present	√	√

Comparing DNA & RNA

	DNA	RNA
Guanine base is present	√	√
Thymine base is present	√	
Uracil base is present		√
Shape is double helix	√	

Comparing DNA & RNA

	DNA	RNA
Shape is single stranded		√
Located in nucleus	√	√
Located in cytoplasm		√
Stores genetic information	√	

Comparing DNA & RNA

	DNA	RNA
Functions in protein synthesis	√	√
Composed of nucleotides	√	√
Template for synthesis of proteins	√	
Transcribes the Template		√
More than one type		√

DNA (deoxyribonucleic acid) bases:

Thymine (T) Cytosine (C) Adenine (A) Guanine (G)

Pyrimidines: single ring bases

Purines: double ring bases

Complimentary binding pattern:

- Adenine + Thymine (share 2 hydrogen bonds)
- Cytosine + Guanine (share 3 hydrogen bonds)

RNA: ribonucleic acid

Similar to DNA except:

- Sugar in RNA = ribose
- Base "uracil" instead of thymine
- Single stranded

Structure and Replication of DNA:

Composition of DNA

Erwin Chargaff studied DNAs from various sources and analyzed the distribution of purines and pyrimidines in them.

The distribution of the bases adenine (A), guanine (G), thymine (T), and cytosine (C) varied among species.

But the total purines (A and G) and the total pyrimidines (T and C) were always equal.

%A = %T,

and %G = %C

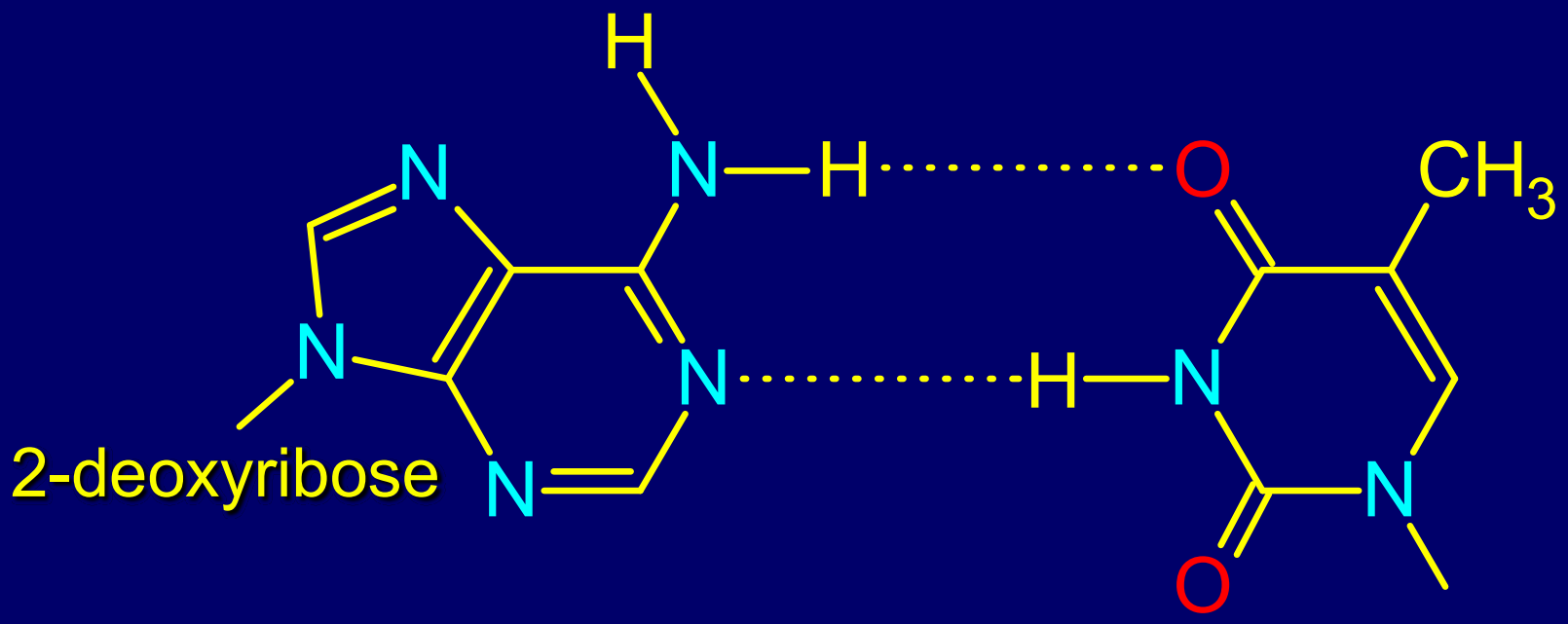
Composition of Human DNA

For example:

Purine	Pyrimidine
Adenine (A) 30.3%	Thymine (T) 30.3%
Guanine (G) 19.5%	Cytosine (C) 19.9%
Total purines: 49.8%	Total pyrimidines: 50.1%

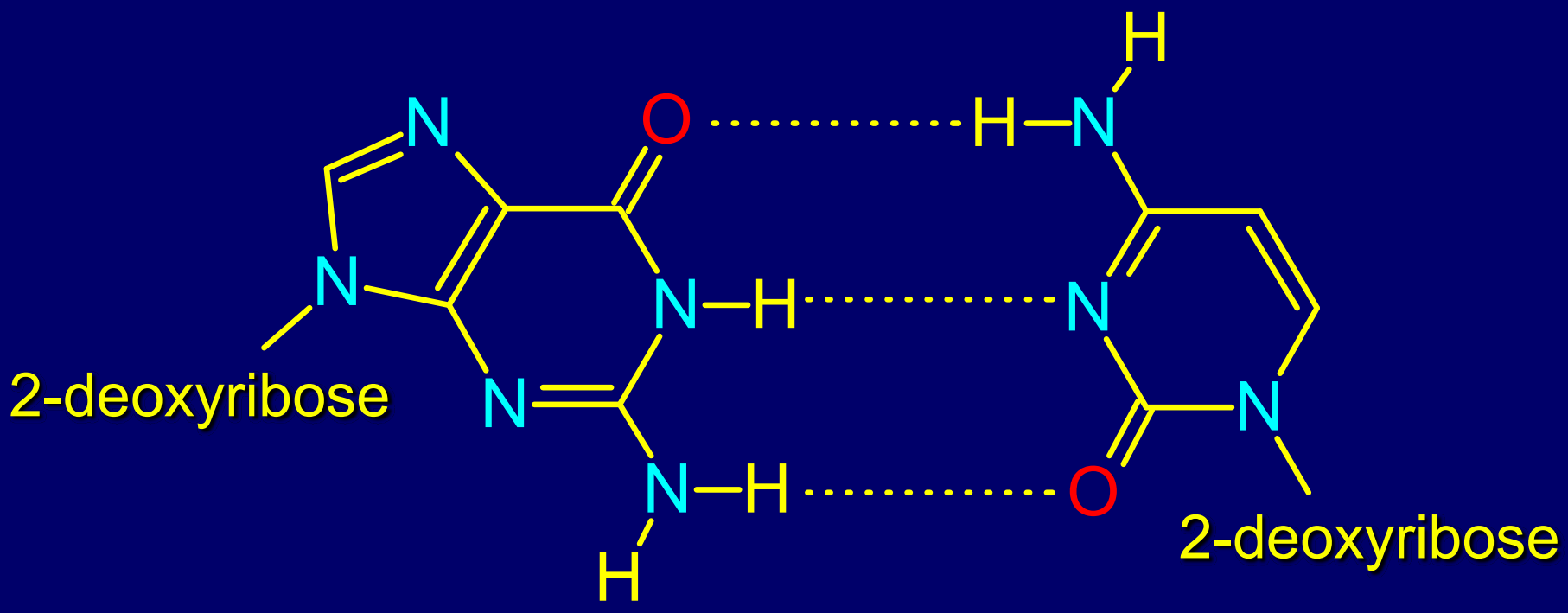
Base Pairing

Watson and Crick proposed that A and T were equal because of complementary hydrogen bonding.



Base Pairing

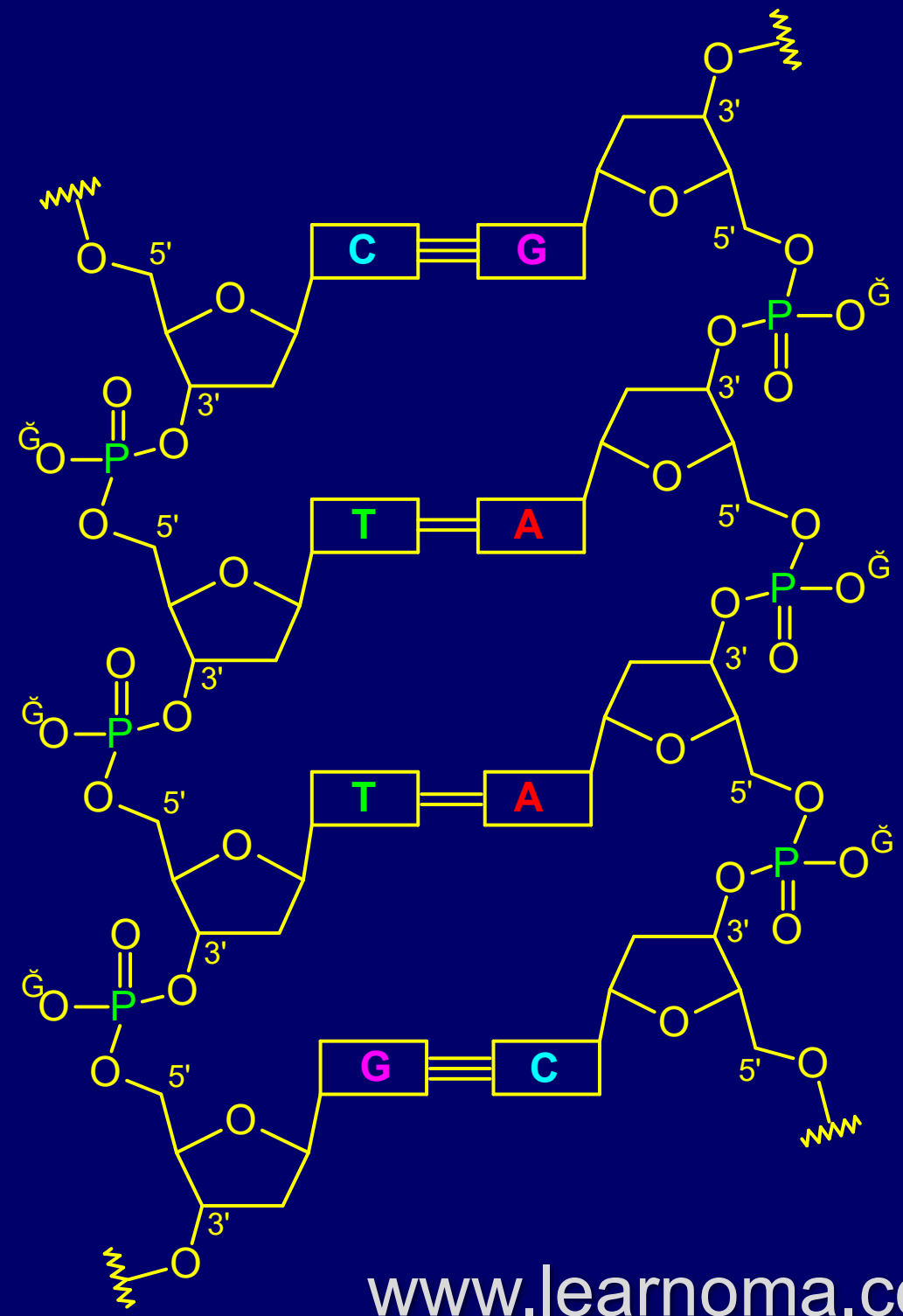
Likewise, the amounts of G and C were equal because of complementary hydrogen bonding.



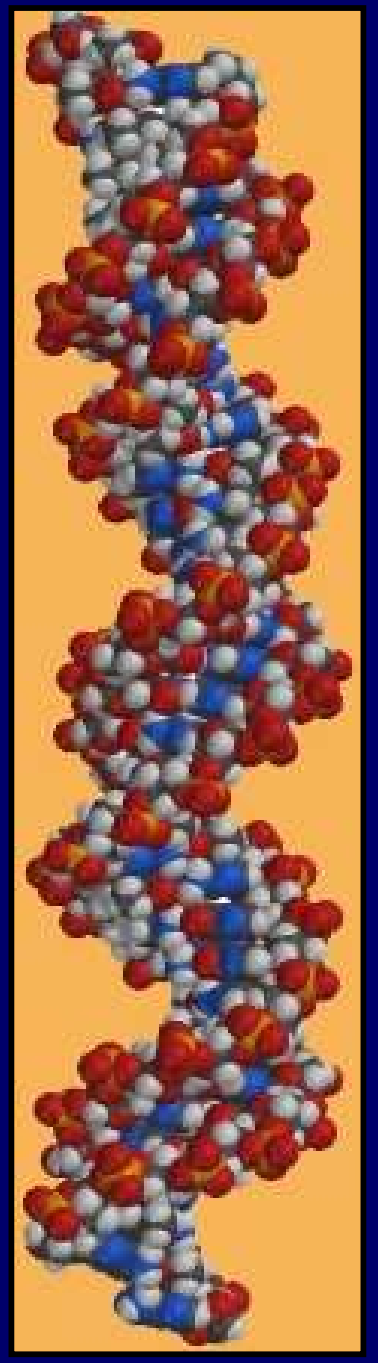
The DNA Duplex

Watson and Crick proposed a double-stranded structure for DNA in which a purine or pyrimidine base in one chain is hydrogen bonded to its complement in the other.

Two antiparallel strands of DNA are paired by hydrogen bonds between purine and pyrimidine bases.

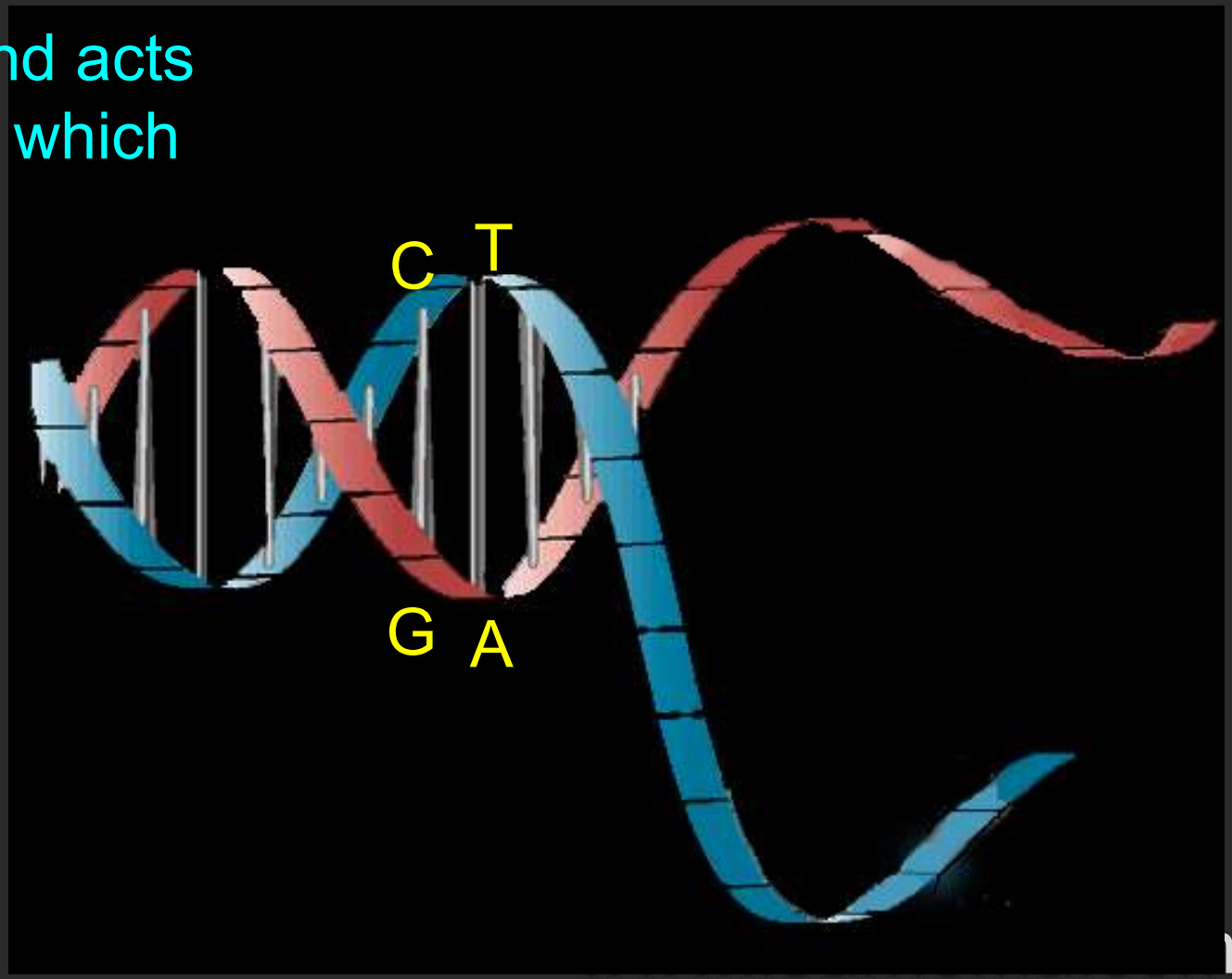


Helical structure of DNA. The purine and pyrimidine bases are on the inside, sugars and phosphates on the outside.



DNA Replication

As the double helix unwinds, each strand acts as a template upon which its complement is constructed.



DNA Replication