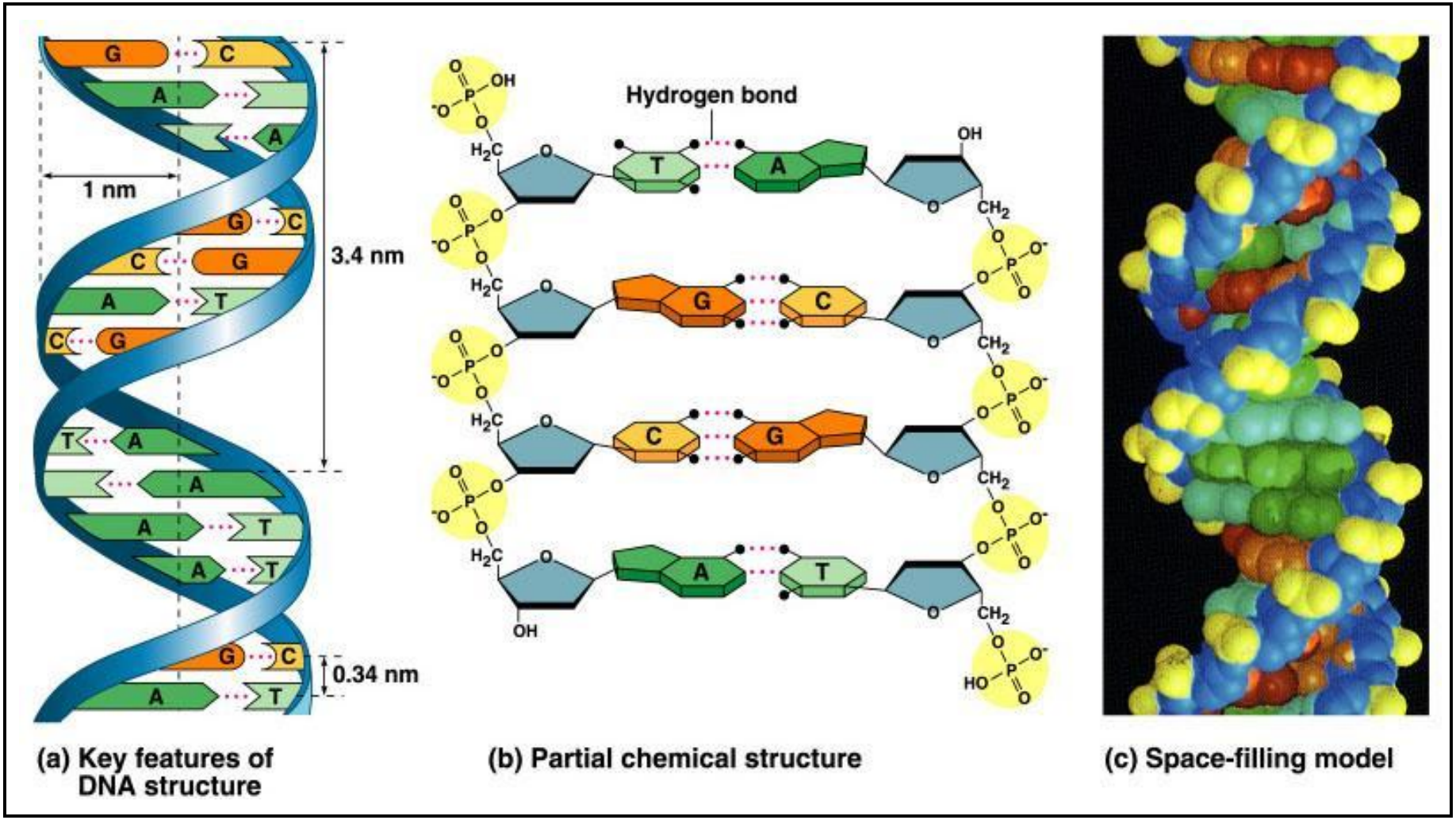
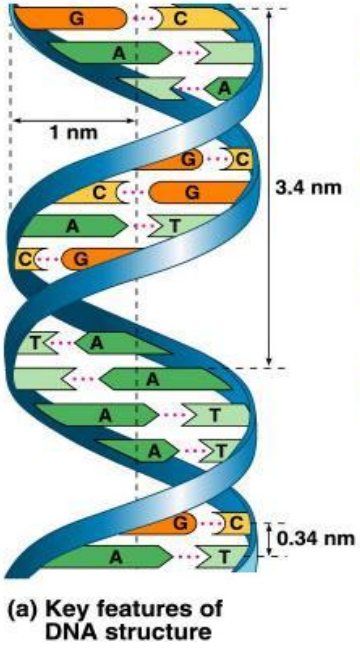
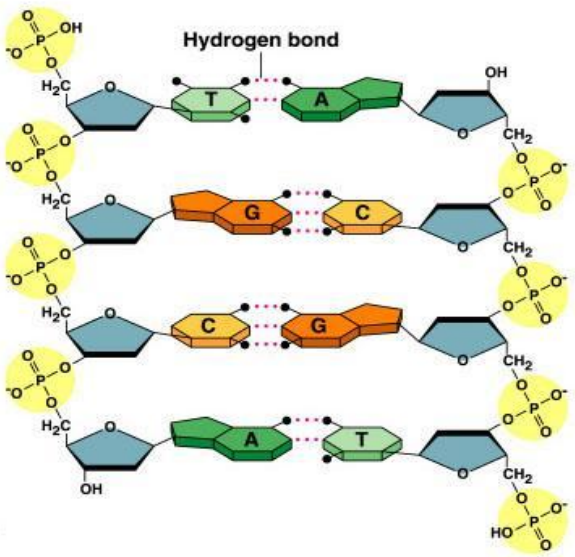
Nucleic acids (DNA & RNA)



Watson and Crick discovered the double helix by building models to conform to X-ray data



(a) Key features of DNA structure



(b) Partial chemical structure

In April 1953, James Watson and Francis Crick shook the scientific world with an elegant double-helical model or the structure of deoxyribonucleic acid or DNA.

Watson and Crick began to work on a model of DNA with two strands, the double helix.

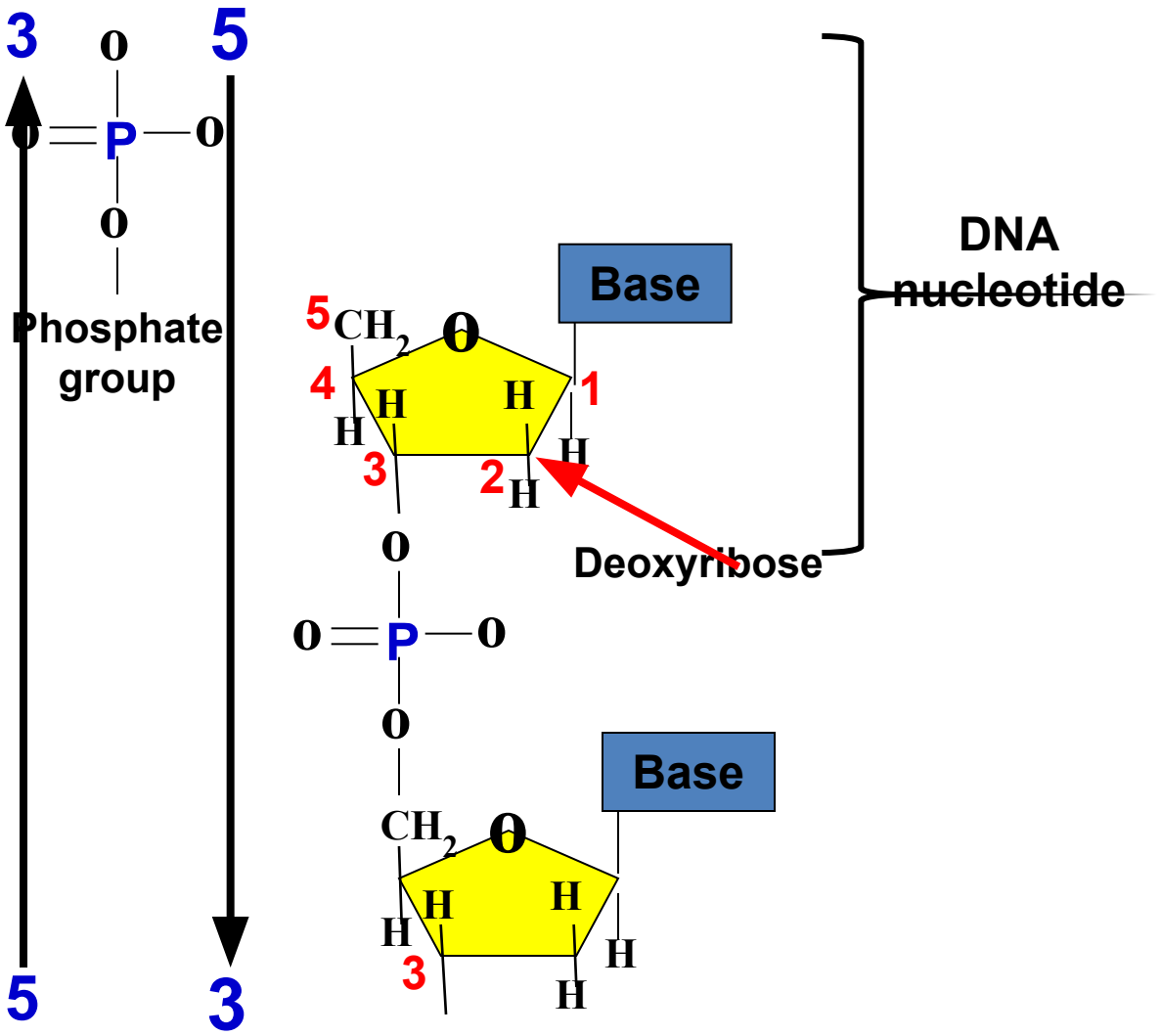
A gene is a small region in the DNA.

- **Nucleic acids store and transmit hereditary information.**
- **There are two types of nucleic acids:**

  1)- ribonucleic acid (RNA);

  2)- deoxyribonucleic acid (DNA).
- **DNA also directs mRNA synthesis, thus, controls protein synthesis.**
- **Organisms inherit DNA from their parents.**
  - **Each DNA molecule is very long and usually consists of hundreds to thousands of genes.**
  - **When a cell divides, its DNA is copied and passed to the next generation of cells.**
- **The mRNA interacts with ribosomes to direct the synthesis of amino acids in a polypeptide (protein)**

Structures of nucleic acids (DNA & RNA)



Bases

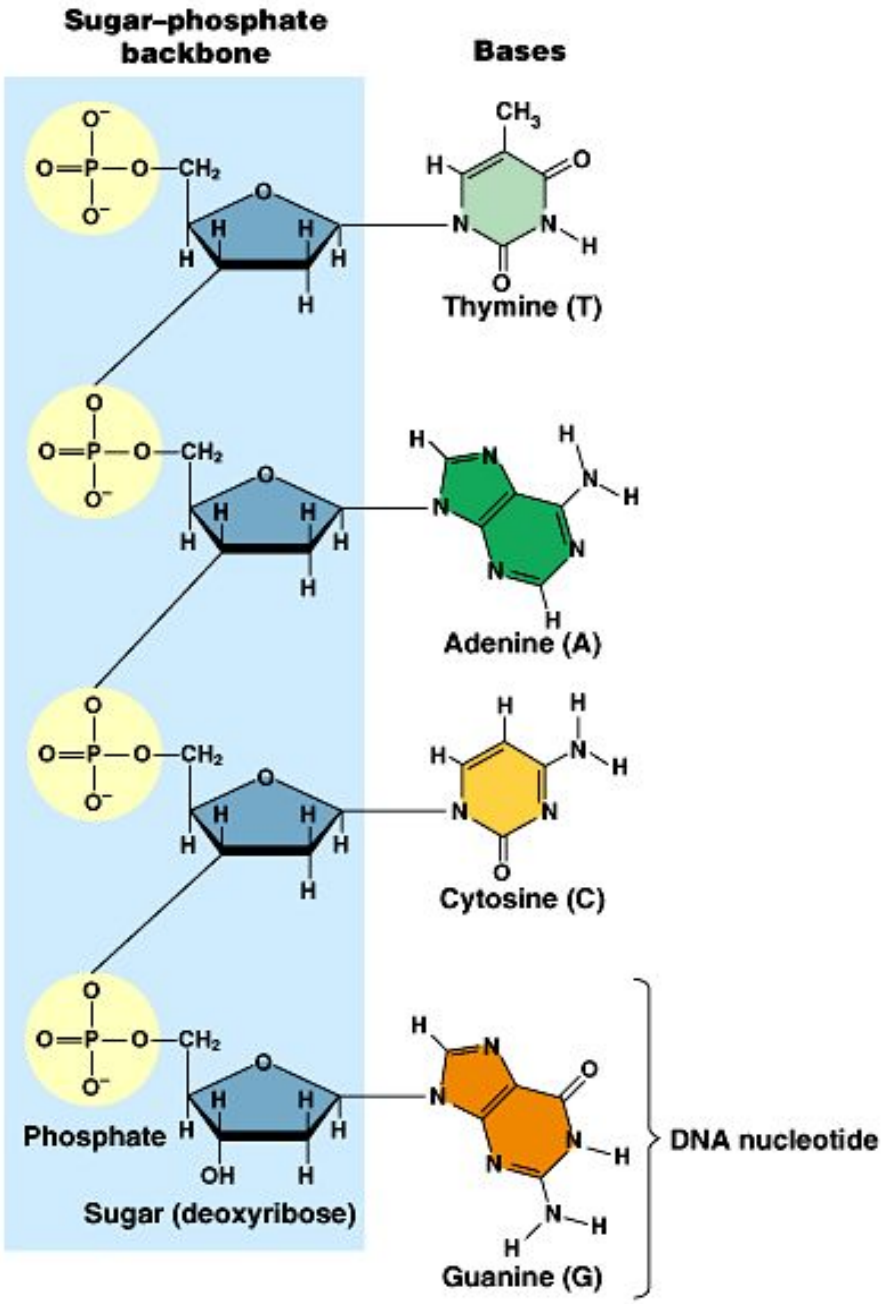
- Adenine (A)
- Guanine (G)

Purine

- Cytosine (C)
- Thymine (T)

Pyrimidine

- The PO_4 group of one nucleotide is attached to the sugar of the next nucleotide in line.
- The result is a "backbone" of alternating phopates and sugars, from which the bases starts.



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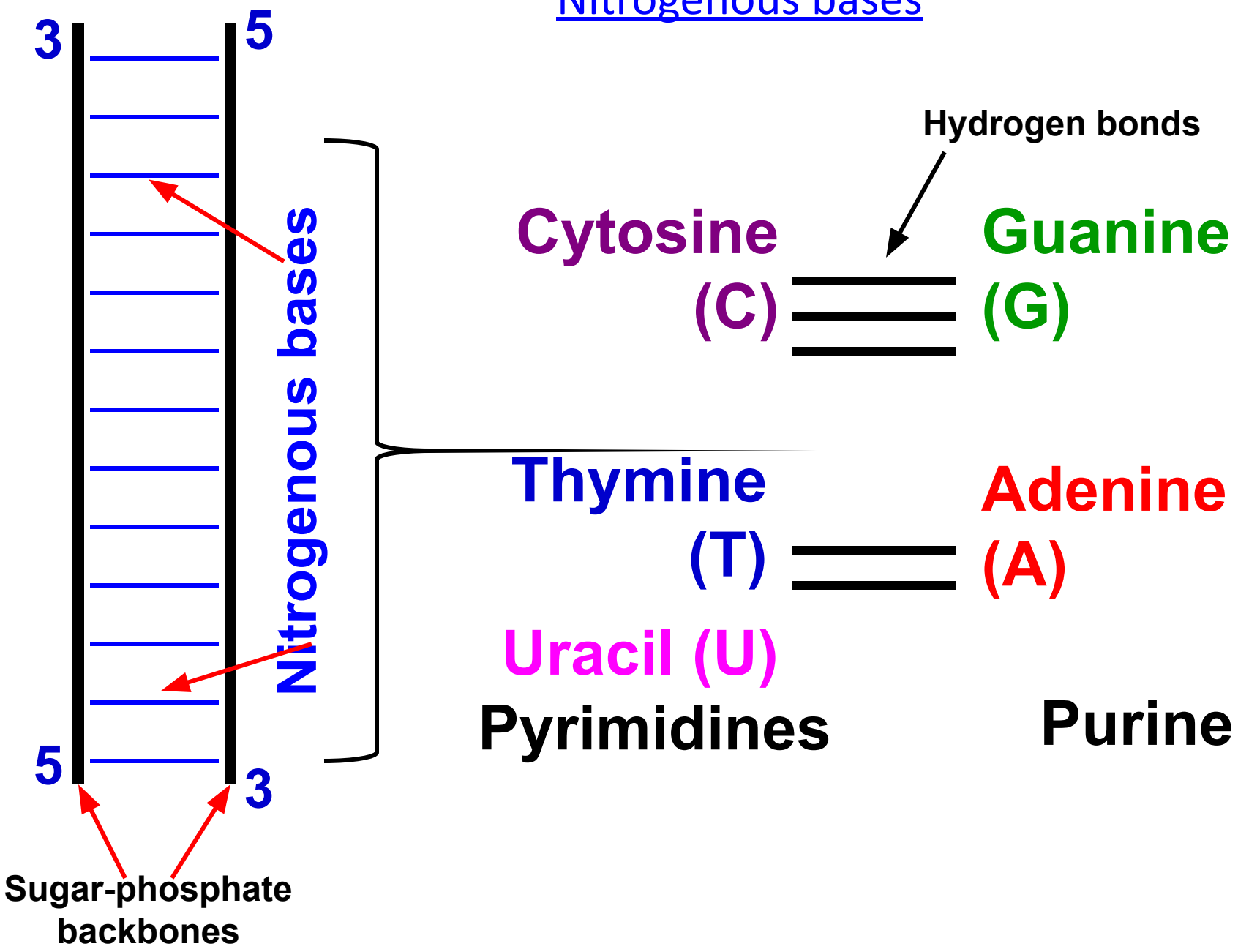
Nitrogenous bases



The nucleic acid strand is a polymer of nucleotides

- **Nucleic acids are polymers of monomers called nucleotides.**
- **Each nucleotide consists of three parts: a nitrogen base, a pentose sugar, and a phosphate group.**
- **The nitrogen bases (**rings of carbon and nitrogen**) come in two types: Purines and Pyrimidines.**
- **The pentose sugar joined to the nitrogen base is ribose in nucleotides of RNA and deoxyribose in DNA.**
- **The only difference between the sugars is the lack of an oxygen atom on carbon 2 in deoxyribose.**

- **Polynucleotides are synthesized by connecting the sugars of one nucleotide to the phosphate of the next with a phosphodiester link.**

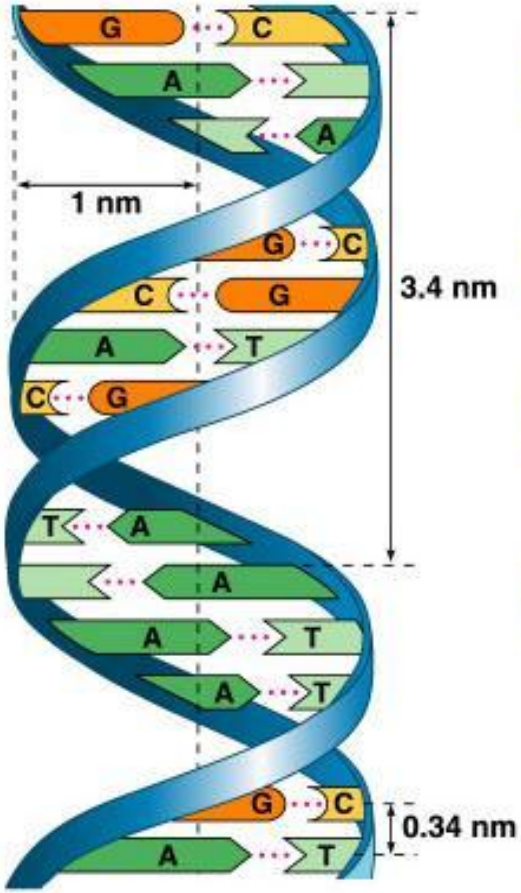
- **This creates a repeating backbone of sugar-phosphate units with the nitrogen bases as appendages.**

- **The sequence of nitrogen bases along a DNA or mRNA polymer is unique for each gene.**

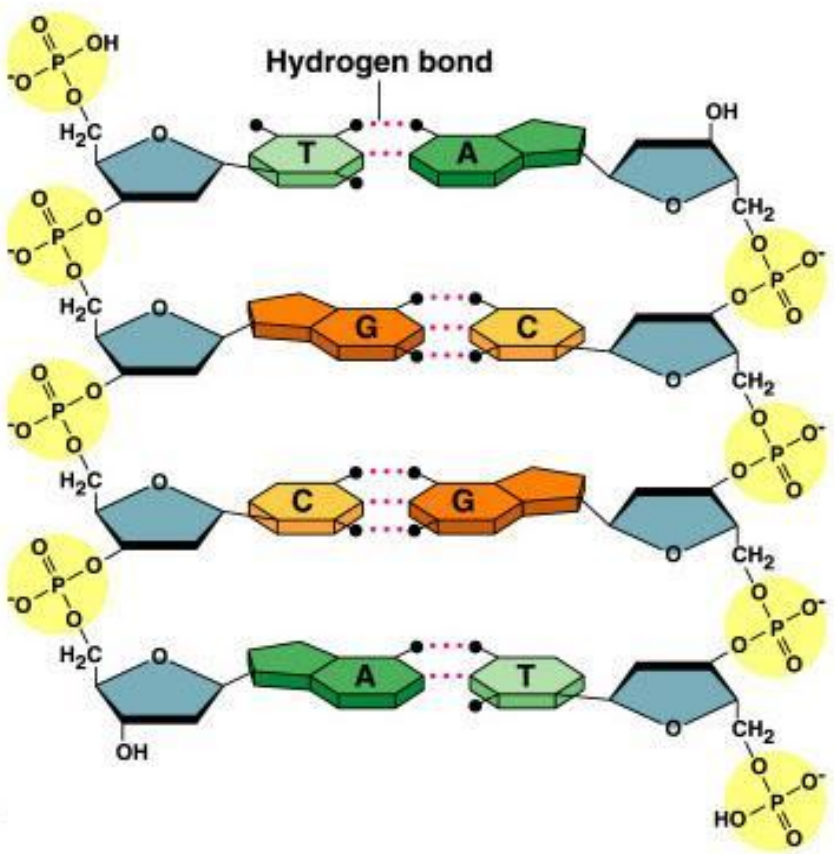
- **Genes are normally hundreds to thousands of nucleotides long.**

- **The linear order of bases in a gene specifies the order of amino acids (**the monomers of a protein**).**

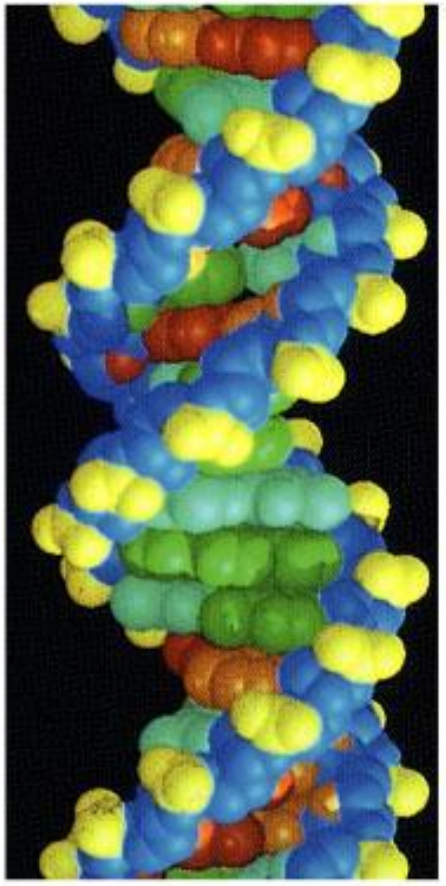
- **An RNA molecule is single polynucleotide chain** (single strand).
- **DNA molecules have two polynucleotide strands** (double strand) **that spiral around to form a double helix.**



(a) Key features of DNA structure

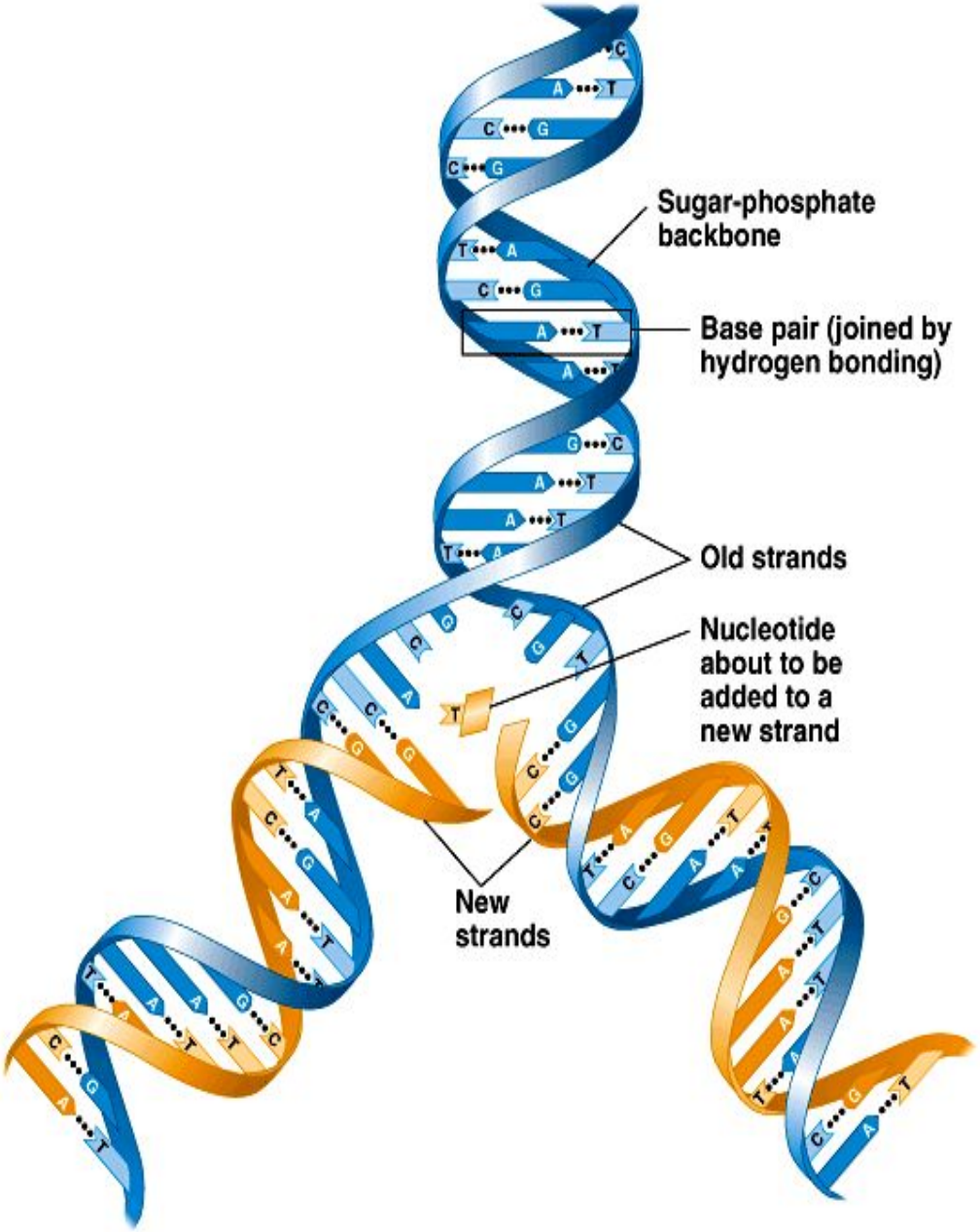


(b) Partial chemical structure



(c) Space-filling model

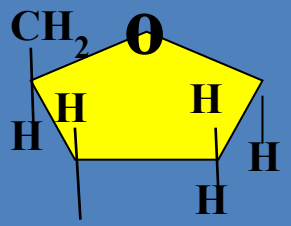
- **The sugar-phosphate backbones of the two polynucleotides are on the outside of the helix.**
- **Pairs of nitrogenous bases (one from each strand) connect the polynucleotide chains with hydrogen bonds.**
- **Most DNA molecules have thousands to millions of base pairs (bP).**



ribonucleic acid (RNA)

- **a)- Messenger RNA (mRNA) is the blueprint for construction of a protein.**
- **b)- Ribosomal RNA (rRNA) is the construction site where the protein is made in the ribosome.**
- **c)- Transfer RNA (tRNA) is the truck delivering the proper amino acid to the site at the right time.**

DNA



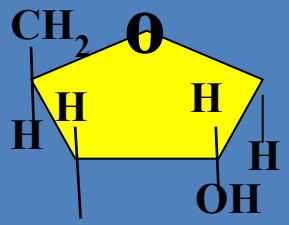
Deoxyribose sugar
(O on C2 is missed)

Deoxiribo-Nucleic-Acid

Double stranded nucleic acid

Bases: A, G, C, T

RNA



Ribose sugar
(no missed O)

Ribo-Nucleic-Acid

Single stranded nucleic acid

Bases: A, G, C, U

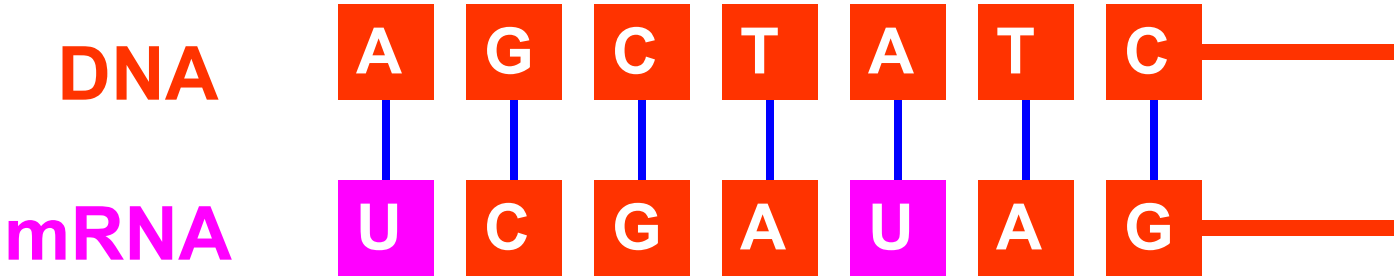
Repeated Sugar - Phosphate → DNA backbone

Sugar–Phosphate-Base → One nucleotide

Polynucleotide → DNA Molecule

DNA Double stranded

RNA single stranded



Comparison	DNA	RNA
Name	DeoxyriboNucleic Acid	RiboNucleic Acid
Function	Long-term storage of genetic information; transmission of genetic information to make other cells and new organisms.	Used to transfer the genetic code from the nucleus to the ribosomes to make proteins. RNA is used to transmit genetic information in some organisms and may have been the molecule used to store genetic blueprints in primitive organisms.
Structural Features	B-form double helix. DNA is a double-stranded molecule consisting of a long chain of nucleotides.	A-form helix. RNA usually is a single-strand helix consisting of shorter chains of nucleotides.
Composition of Bases and Sugars	deoxyribose sugar phosphate backbone adenine, guanine, cytosine, thymine bases	ribose sugar phosphate backbone adenine, guanine, cytosine, uracil bases
Propagation	DNA is self-replicating.	RNA is synthesized from DNA on an as-needed basis.
Base Pairing	AT (adenine-thymine) GC (guanine-cytosine)	AU (adenine-uracil) GC (guanine-cytosine)

Terminology

English	Russian	Kazakh
Nucleic acids	Нуклеиновая кислота	Нуклеин қышқылы
Deoxyribonucleic acid	Дезоксирибонуклеиновая кислота	Дезоксирибонуклеин қышқылы
Ribonucleic acid	Рибонуклениновая кислота	Рибонуклеин қышқылы
Nucleotide	Нуклеотид	Нуклеотид
Nitrogenous bases	Азотистые основания	Азоттық негіздер
Phosphate group	Фосфатная группа	Фосфат тобы
Pentose sugar	Сахар пентоза	Қант пентоза
Purines	Пурины	Пуриндер
Pyrimidines	Пиримидины	Пиримидиндер
Amino acids	Аминокислоты	Аминқышқылы
Protein	Белок	Ақуыз