

ДНК

Презентация по дисциплине
«Биология»

Deoxyribonucleic acid (DNA) is a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms and some viruses. The information DNA contains is the long-term storage of instructions, or a recipe, for building and running the cells, such as proteins and RNA molecules. The DNA segments that carry this genetic information are called genes, but other DNA sequences have structural purposes, or are involved in regulating the use of this genetic information.

Chemically, DNA consists of two long polymers of single units called nucleotides, with phosphate groups joined by ester bonds. These two strands run in opposite directions to each other and are therefore anti-parallel. Attached to each sugar is one of four types of molecules called bases. It is the sequence of these four bases along the backbone that encodes biological information. This information is read using the genetic code, which specifies the sequence of the amino acids within proteins. The code is read by copying stretches of DNA into the related nucleic acid RNA, in a process called transcription.

Within cells, DNA is organized into long structures called chromosomes. These chromosomes are duplicated before cells divide, in a process called DNA replication. Eukaryotic organisms, animals, plants, fungi, and protists store most of their DNA inside the cell nucleus and some of their DNA is organized as mitochondria (or chloroplasts) in eukaryotes. In prokaryotes, bacteria and archaea store their DNA only in the cytoplasm. Within the chromosomes, chromatin proteins such as histones compact and organize DNA. These complex structures facilitate the interactions between DNA and other proteins, helping control which parts of the DNA are transcribed.

DNA is a double helix structure. The two strands are antiparallel and are held together by hydrogen bonds between the nitrogenous bases. The bases are adenine, thymine, guanine, and cytosine. The structure of DNA is a right-handed helix with a diameter of approximately 2 nm. The distance between two adjacent base pairs is approximately 0.34 nm. The length of a DNA molecule is typically several centimeters long.

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DNA exists in many possible conformations that include A-DNA, B-DNA and Z-DNA. A-DNA is a compact, wide, shallow groove structure. B-DNA is the standard right-handed helix. Z-DNA is a narrow, deep groove structure. The conformation of DNA is determined by the sequence of bases, the type and concentration of ions in the solution, and the presence of other molecules.

The first published reports of A-DNA X-ray diffraction patterns—and also B-DNA—were published by Rosalind Franklin and Maurice Wilkins in 1953. The structure of DNA was first proposed by James Watson and Francis Crick in 1953. The structure of DNA was first proposed by James Watson and Francis Crick in 1953. The structure of DNA was first proposed by James Watson and Francis Crick in 1953.

Compared to B-DNA, the A-DNA form is a wider, right-handed helix, with a shallow, wide major groove and a deep, narrow minor groove. The A-DNA form is a compact, wide, shallow groove structure. B-DNA is the standard right-handed helix. Z-DNA is a narrow, deep groove structure. The conformation of DNA is determined by the sequence of bases, the type and concentration of ions in the solution, and the presence of other molecules.

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1 курс 127 группа
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Самара 2015

Ознакомление с историей открытия нуклеиновых кислот, уровнями структурной организации и функциями ДНК.



Швейцарский биолог Йоган Фридрих
Мишер
Открыл нуклеиновые кислоты
в 1868 г.

«nucleus» - ядро
нуклеин содержит кислый
компонент, который
известен теперь как ДНК

Within all other DNA sequences, regions are called
genes, and these regions have structural
purposes, or are involved in regulating the use of this
genetic information.

Chemically, DNA consists of two long polymers of
single units called nucleotides, which are linked by
phosphate groups. These two strands run in opposite
directions to each other and are therefore anti-parallel.
Attached to each sugar is one of four types of molecules called bases. It
is the sequence of these four bases along the backbone
that encodes information. This information is read
using the genetic code, which specifies the sequence of
the amino acids within proteins. The code is read by
copying stretches of DNA into the related molecule, messenger
RNA, in a process called transcription.

Within cells, DNA is organized into long structures
called chromosomes. These chromosomes are
replicated before cells divide, in a process called DNA
replication. Eukaryotic organisms, animals, plants,
fungi, and protists store most of their DNA inside the
cell nucleus and some of their DNA in organelles, such as
mitochondria and chloroplasts. In contrast, most
prokaryotic bacteria and archaea store their DNA only
in the cytoplasm. Within the chromosomes, chromatin
structures such as nucleosomes compact and organize DNA.
These compact structures gain their characteristic
properties from the way they are packaged. The
DNA sequence is also affected by epigenetic marks
which parts of the DNA are transcribed.

Each nucleotide is linked to a phosphate group, which
is attached to the sugar. The phosphate group is
linked to the phosphate group of the next nucleotide,
forming a chain of phosphate groups. The phosphate
groups are linked to the sugar groups by phosphodiester
bonds. The phosphate groups are linked to the sugar
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The backbone of the DNA strand is made of
phosphate groups and deoxyribose sugar residues. The
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Compared to B-DNA, the A-DNA form is a wider
right-handed spiral, with a shallower, more minor groove
and a deeper major groove. The A-DNA form is
favored under non-physiological conditions, particularly
in the presence of high salt concentrations. The A-DNA
form is also favored in the presence of certain
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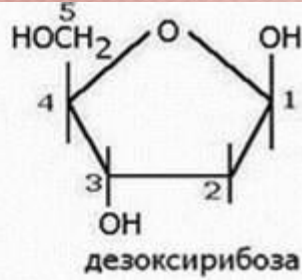
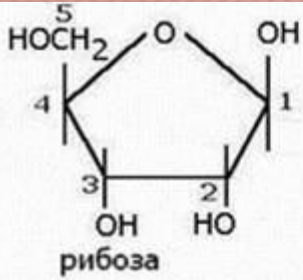
Watson and Crick's model of DNA structure was
based on the work of other scientists, including
Rosalind Franklin and Maurice Wilkins. Their work
was crucial in understanding the structure of DNA.
The structure of DNA is a double helix, with two
strands of DNA twisted around each other. The
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Although the B-DNA form is most common under the
conditions found in cells, it is not a well-defined
conformation, but a family of related DNA
conformations that occur at the high hydration
level present in living cells. Their corresponding X-ray
diffraction and scattering patterns are characteristic of
molecular poly-crystals with a significant degree of
order (1953).

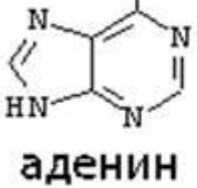
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Нуклеотид

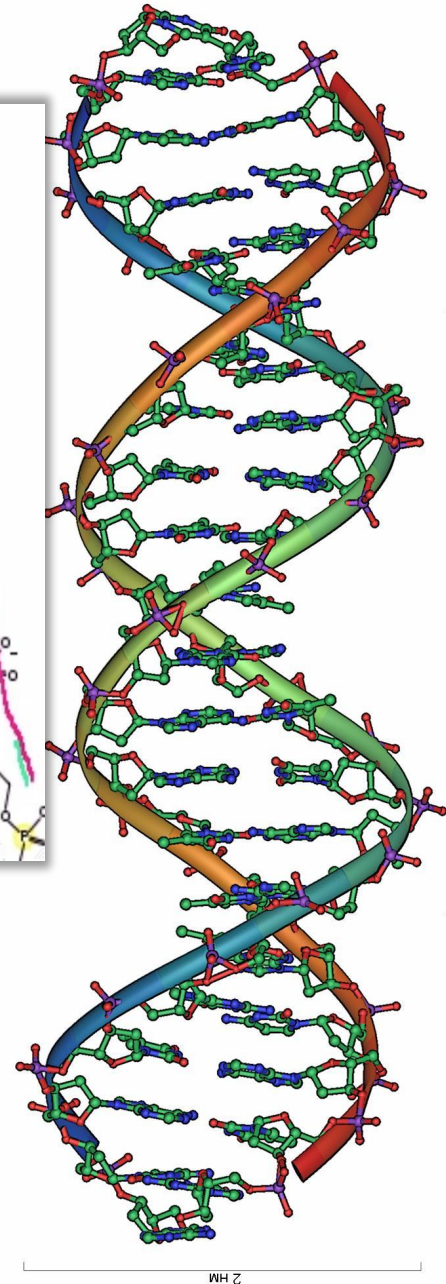
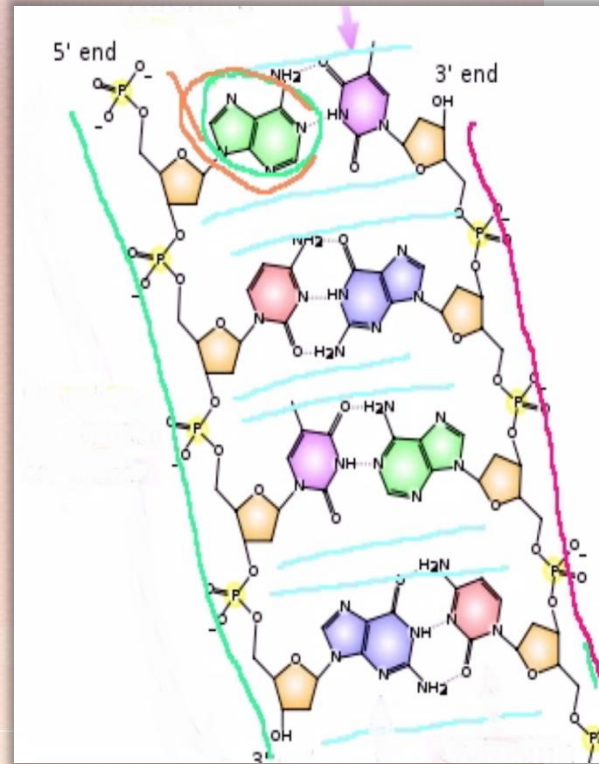
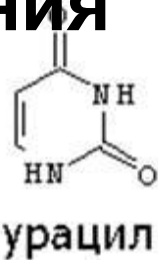
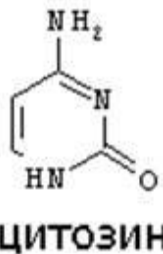
Моносахариды



Пуриновые основания



Пиримидиновые основания

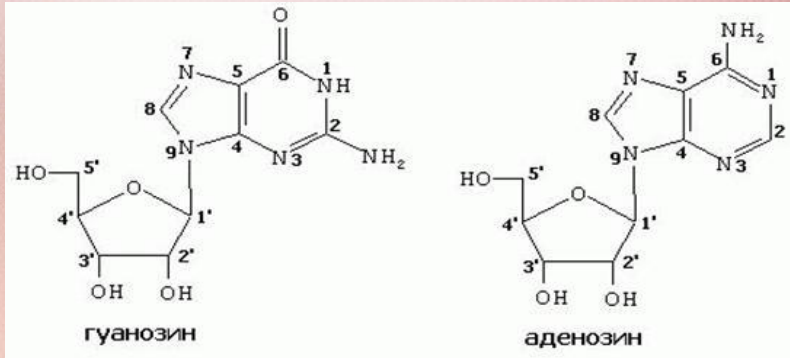


1 оборот спирали = 10 комплементарных пар = 3,4 нм

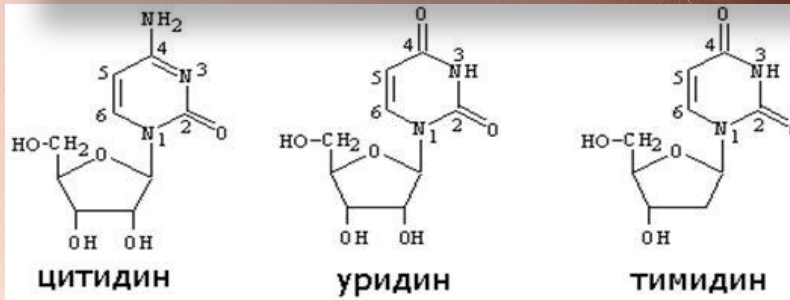
2 нм

Нуклеозиды

Пуриновые



Пиримидиновые

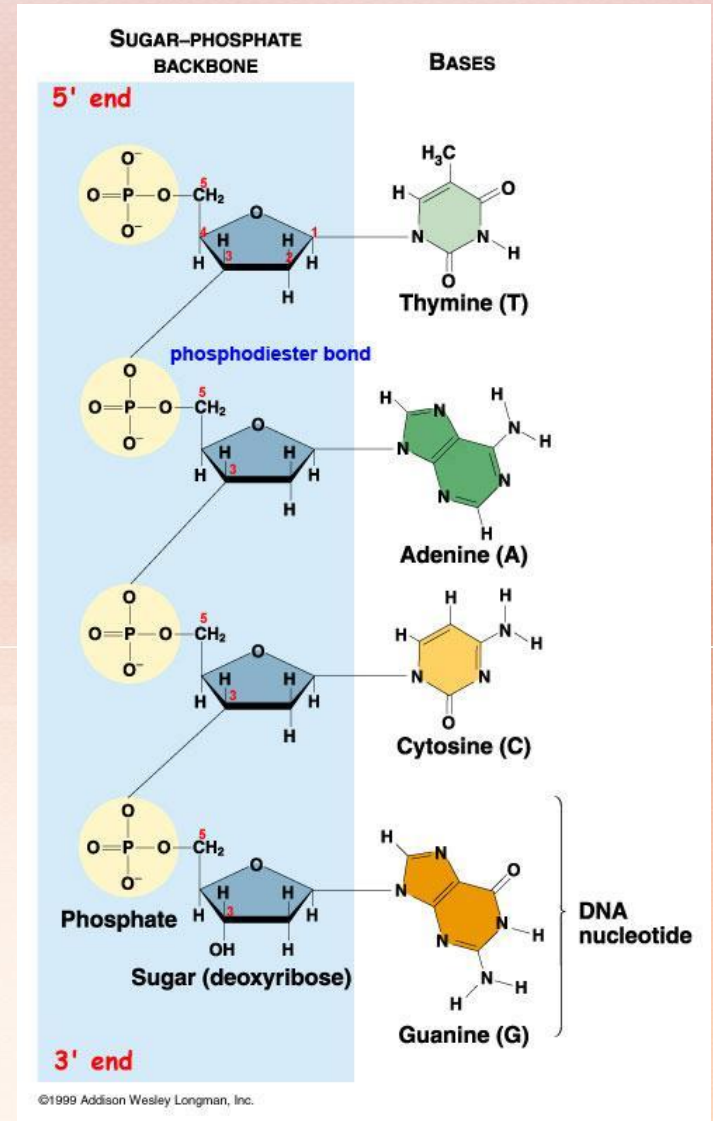
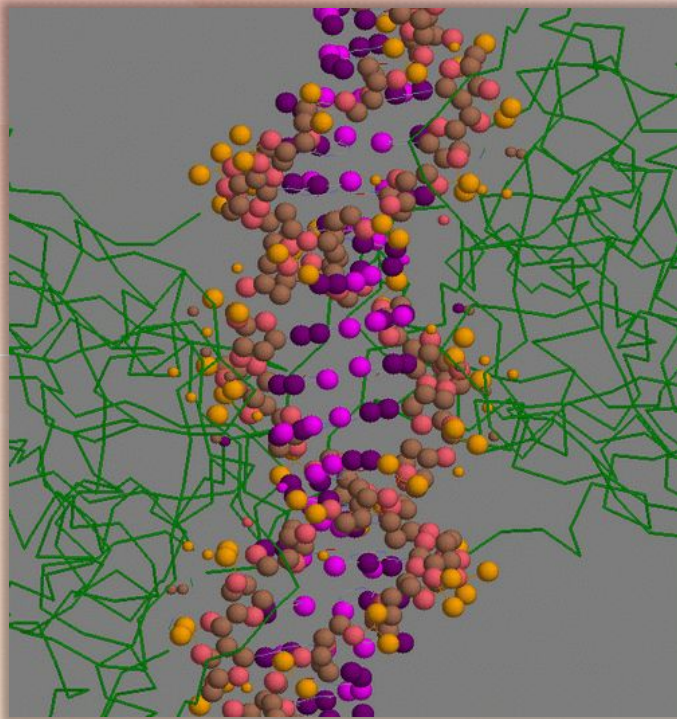


Азотистые основания	Нуклеозиды	Нуклеотиды	
Полное название	Сокращенное название		
Аденин	Аденозин	Аденозинмонофосфат	АМФ
Гуанин	Гуанозин	Гуанозинмонофосфат	ГМФ
Цитозин	Цитидин	Цитидинмонофосфат	ЦМФ
Урацил	Уридин	Уридинмонофосфат	УМФ
Тимин	Тимидин	тиминмонофосфат	ТМФ

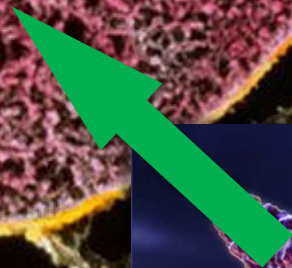
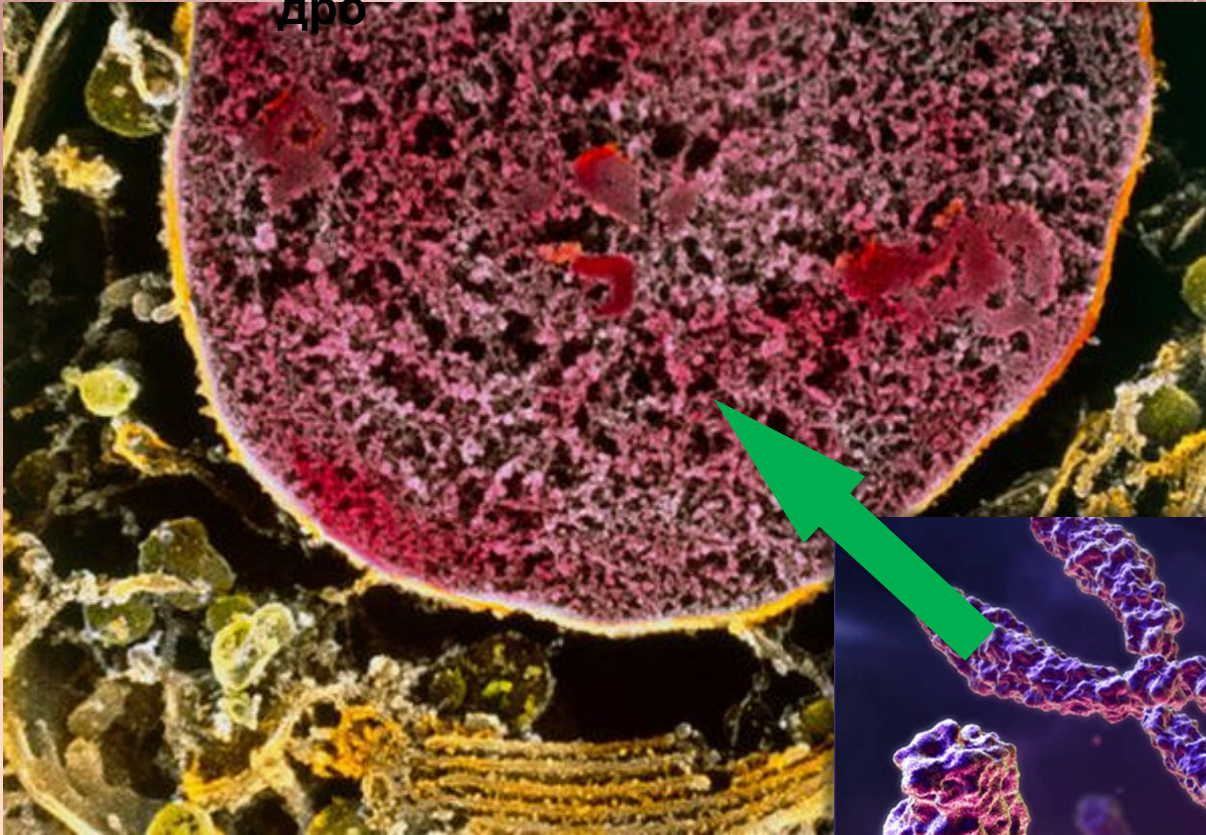
ДНК и РНК обладают первичной, вторичной, третичной структурами.

Первичная структура ДНК – последовательность нуклеотидов в молекуле ДНК.

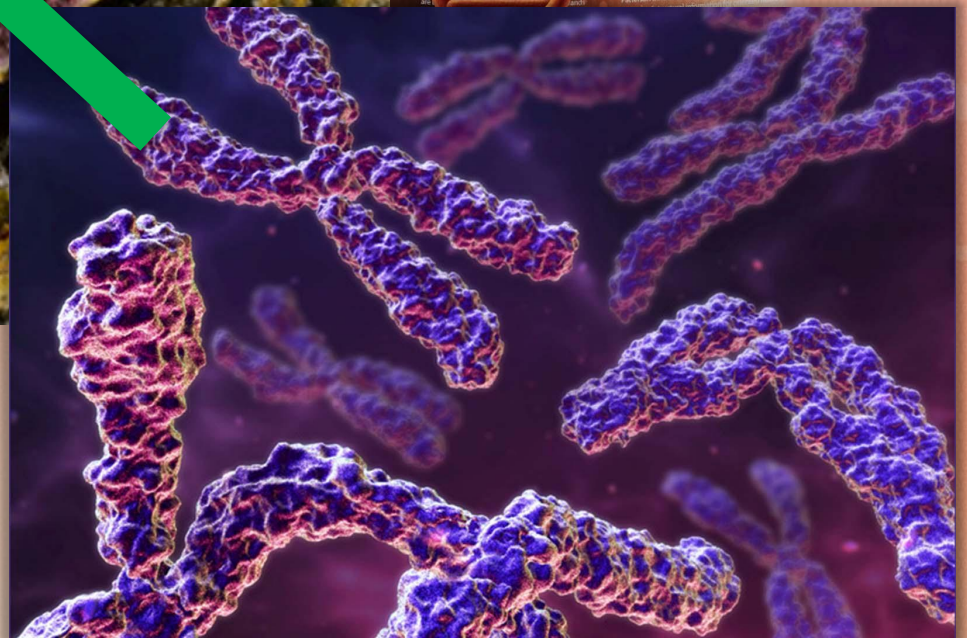
5'-НО-Г-А-А-Т-Ц-Т-А-Ц-А-...3'



Срез клетки через клеточное ядро



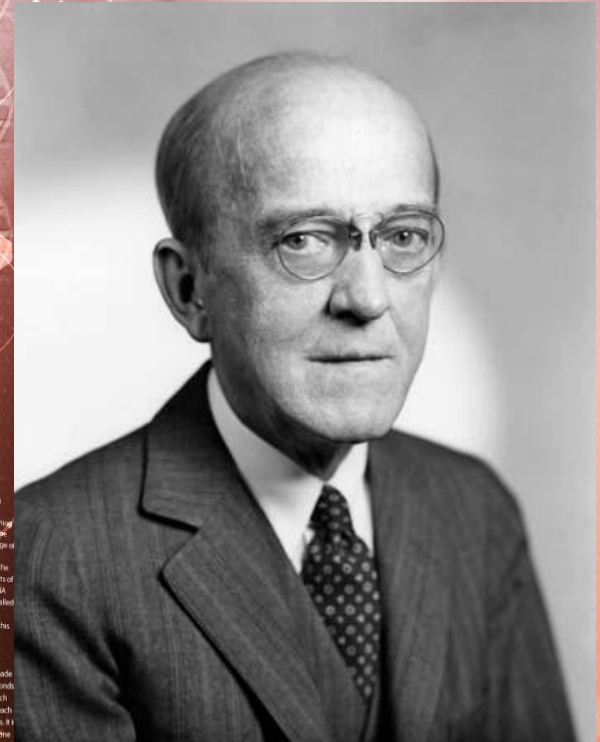
DNA is a long molecule that carries the genetic instructions for the development, functioning, growth and reproduction of all known organisms and many viruses. In a cell, DNA is packed into chromosomes. The DNA molecule is a double helix, consisting of two strands of DNA that are twisted around each other. The strands are made of a sugar-phosphate backbone, with nitrogenous bases attached to the sugar. The bases are the letters of the genetic code: Adenine (A), Thymine (T), Guanine (G), and Cytosine (C). The sequence of these bases determines the sequence of amino acids in a protein, which in turn determines the protein's function. The DNA molecule is also associated with proteins called histones, which help to package the DNA into a compact structure. The DNA molecule is also associated with enzymes called DNA polymerases, which are responsible for the replication of DNA.



Информация ДНК наследуется

В 1943 г. Освальд Эвери и его сотрудники из Рокфеллеровского института обнаружили, что непатогенный (неболезнетворный) штамм бактерии пневмококка может быть трансформирован в патогенный простым добавлением ДНК, выделенной из патогенных пневмококков (свойство патогенности наследуется).

Вывод: ДНК может содержать генетическую информацию.



Deoxyribonucleic acid (DNA) is a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms and some viruses. The information DNA contains is the long-term storage of blueprints or a recipe, as it were, since it contains the instructions needed to construct other components of cells, such as proteins and RNA molecules. The DNA segments that carry this genetic information are called genes, but other DNA sequences have structural purposes, or are involved in regulating the use of this genetic information.

Chemically, DNA consists of two long polymers of single units called nucleotides, with the bases made of sugars and phosphate groups joined by ester bonds. These two strands run in opposite directions to each other and are therefore anti-parallel. Attached to each sugar is one of four types of molecules called bases. If the sequence of these bases along the backbone encodes information, this information is read using the genetic code, which specifies the sequence of the amino acids within proteins. The code is read by copying stretches of DNA into the related nucleic acid RNA, in a process called transcription.

The backbone of the DNA strand is made of alternating phosphate and sugar residues (10).

Although the B-DNA form is most common under the conditions found in cells, it is not a well-defined conformation, but a family of related DNA conformations (14) that occur at the high hydration level present in living cells. Their corresponding X-ray diffraction and scattering patterns are characterized

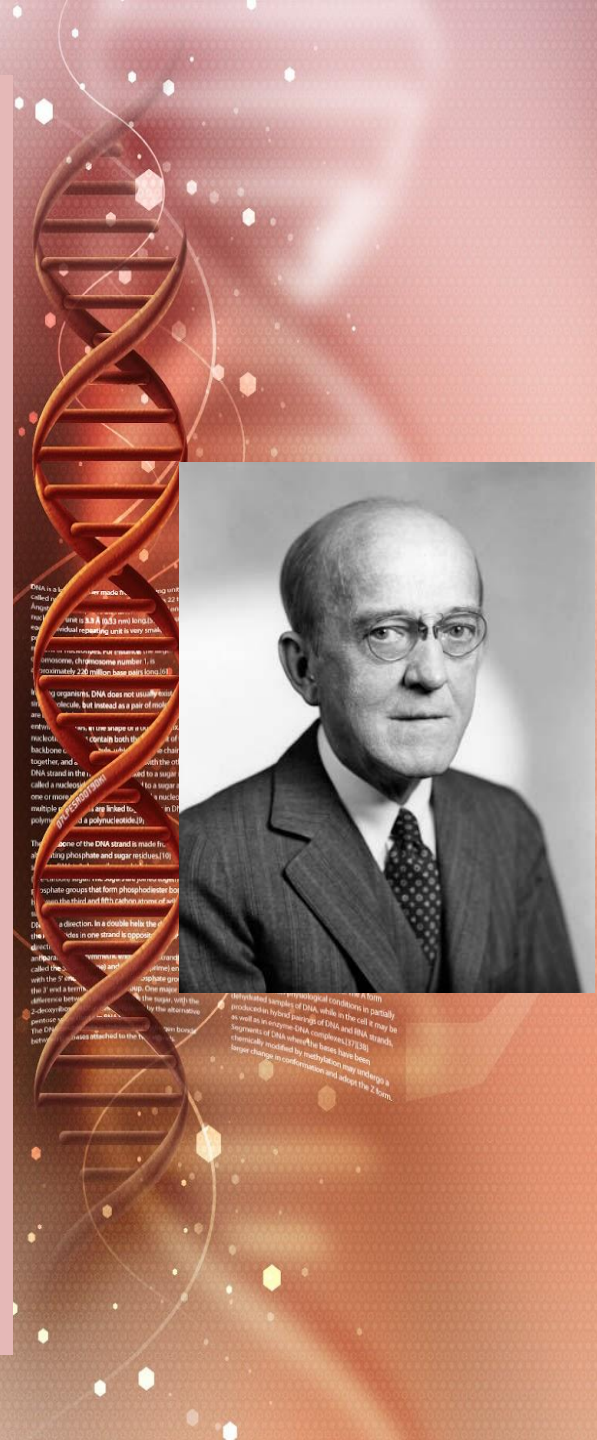


Было установлено, что:

- 1. Содержание ДНК** в любой клетке или организме **строго постоянно**;
- 2. Содержание ДНК в клетке увеличивается с возрастанием сложности клетки**, следовательно, с возрастанием генетической информации в клетке. Чем сложнее организм, тем больше ДНК в его клетках;
- 3. Гаплоидные половые клетки высших организмов** (содержащие одинарный набор хромосом) **содержат точно половину количества ДНК**, которое обнаружено в диплоидных клетках того же организма;
- 4. ДНК-содержащие вирусы бактерий** (бактериофаги) **и вирусы животных**, имеющие лишь несколько генов, **содержат очень мало ДНК**.

Это указывает на генетическую функцию ДНК:

ДНК хранит генетическую информацию.



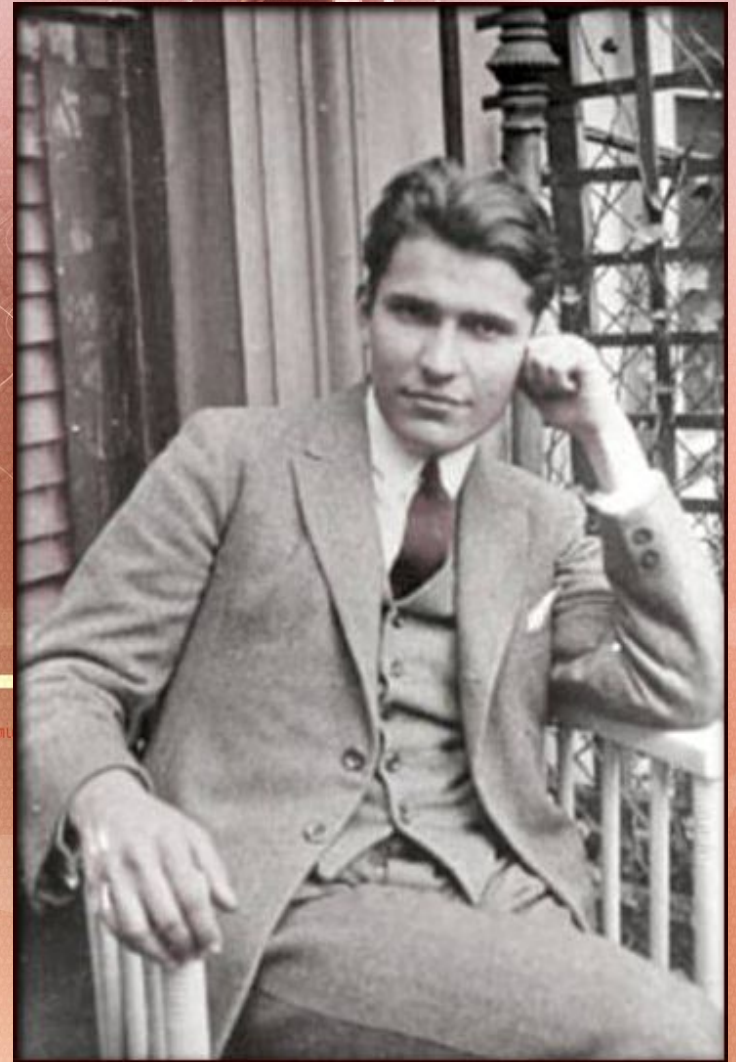
Правила Чаргаффа

1. Препараты ДНК, выделенные из разных тканей одного и того же организма, имеют одинаковый нуклеотидный состав.
2. Нуклеотидный состав ДНК у разных видов различен.
3. Число адениновых остатков в любой ДНК независимо от вида организма равно числу тиминовых остатков ($A=T$), а число гуаниновых остатков всегда равно числу цитозиновых остатков ($G=C$).

Следовательно:

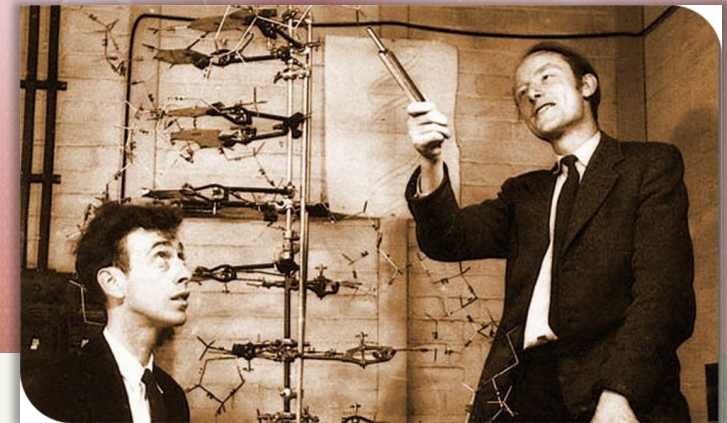
сумма пуриновых остатков равно сумме пиримидиновых, т.е. $A + G = T + C$

Было установлено, что ДНК близких видов имеют сходный нуклеотидный состав, а эволюционно отдаленные организмы заметно отличаются по нуклеотидному составу.



Вторичная структура ДНК

1953 год. Американский генетик Джеймс Уотсон и английский физик Френсис Крик предложили трехмерную модель двойной спирали ДНК.



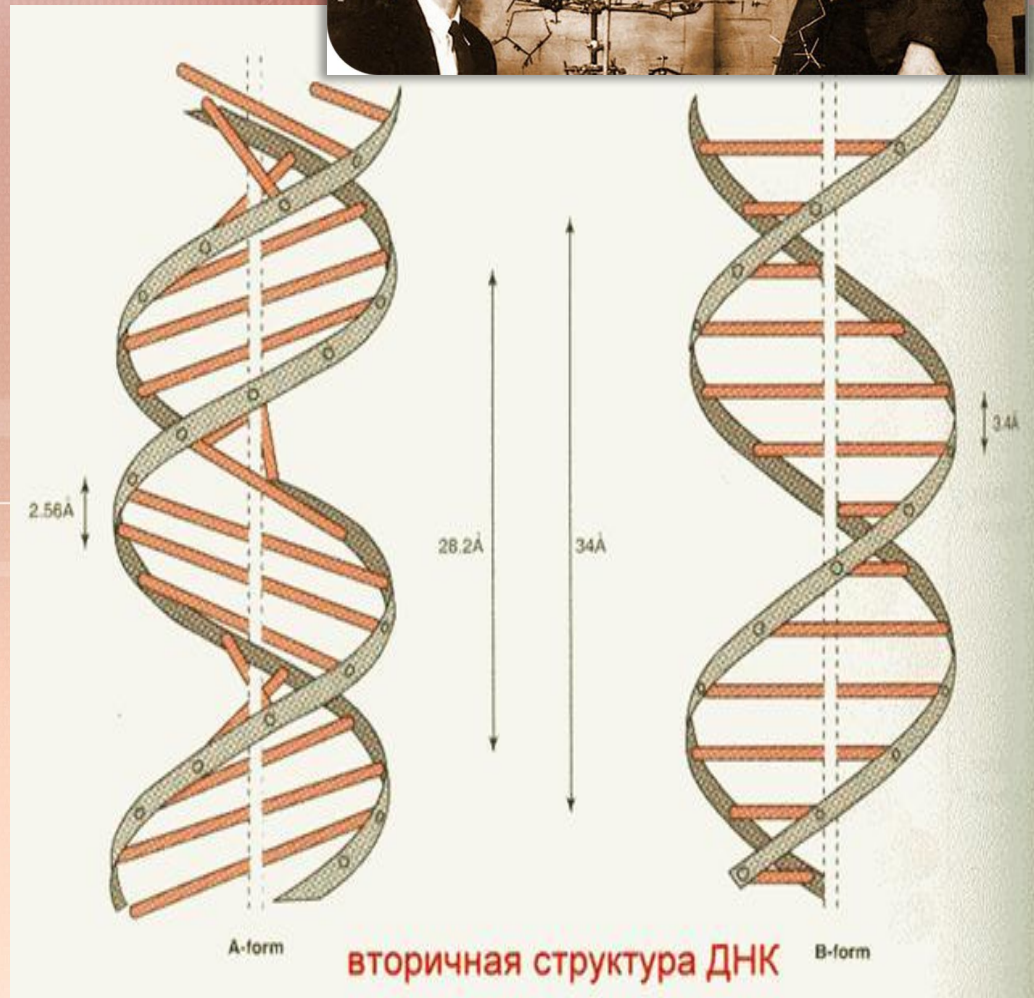
С помощью данных рентгеноструктурного анализа установлено, что:

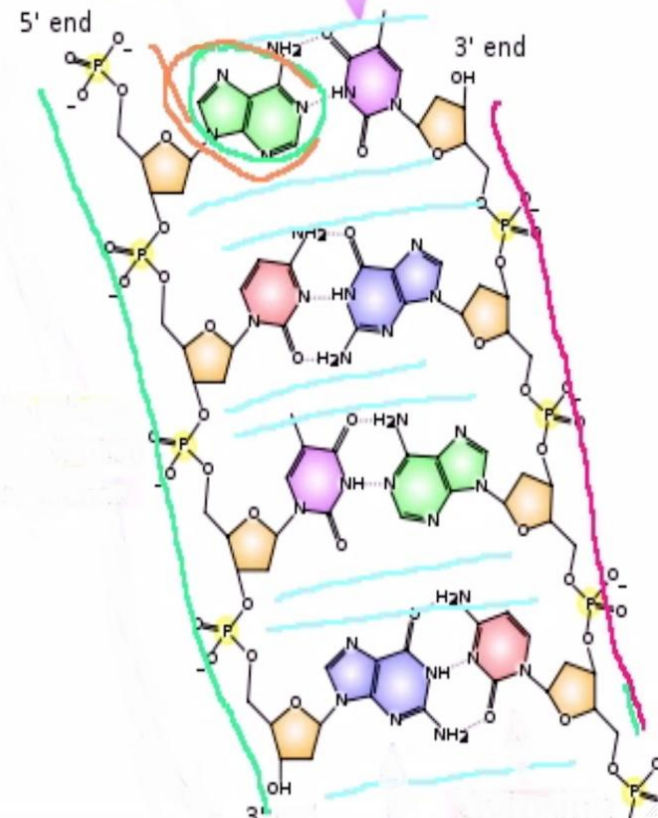
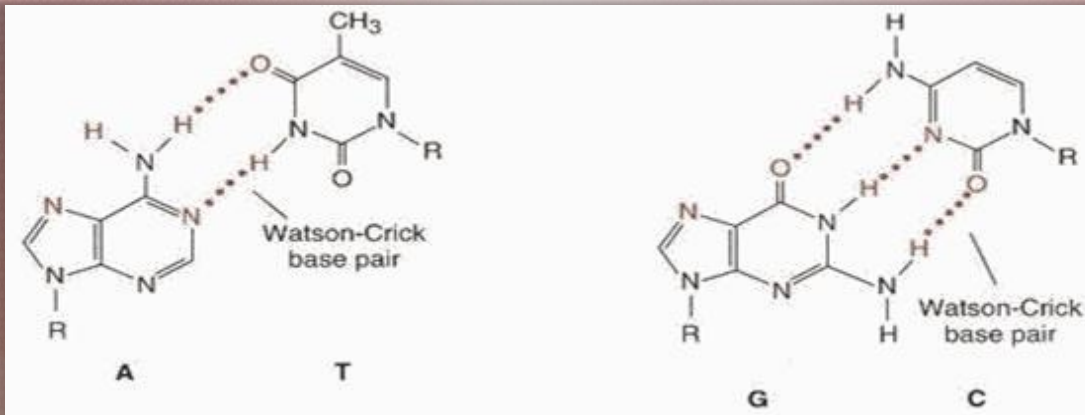
1. Молекула ДНК имеет постоянный диаметр 2 нм ($1 \text{ нм} = 10^{-9} \text{ м}$)
молекула пурина 1,2 нм
молекула пиримидина 0,8 нм
 $1,2 + 0,8 = 2 \text{ нм}$

Количество пуриновых оснований равно количеству пиримидиновых оснований.

2. Основания уложенных стопкой внутри двойной спирали ДНК и располагаются на расстояниях 0,34 нм друг от друга.

3. На каждый полный оборот двойной спирали приходится 10 пар оснований. Следовательно, молекула ДНК имеет периодичность в структуре равную 3,4 нм.





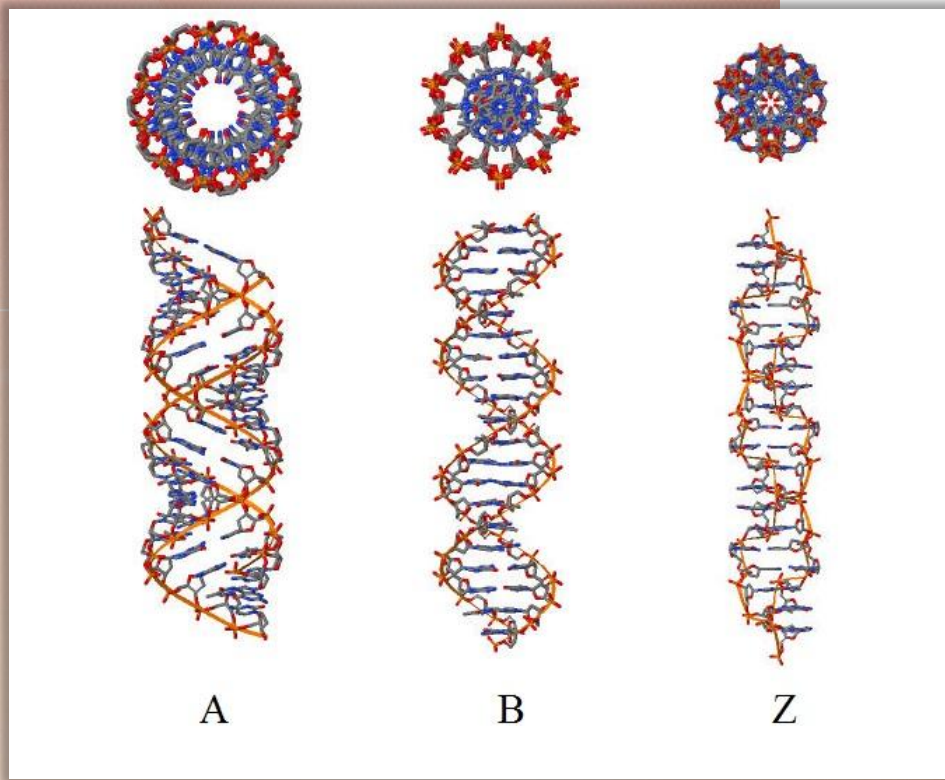
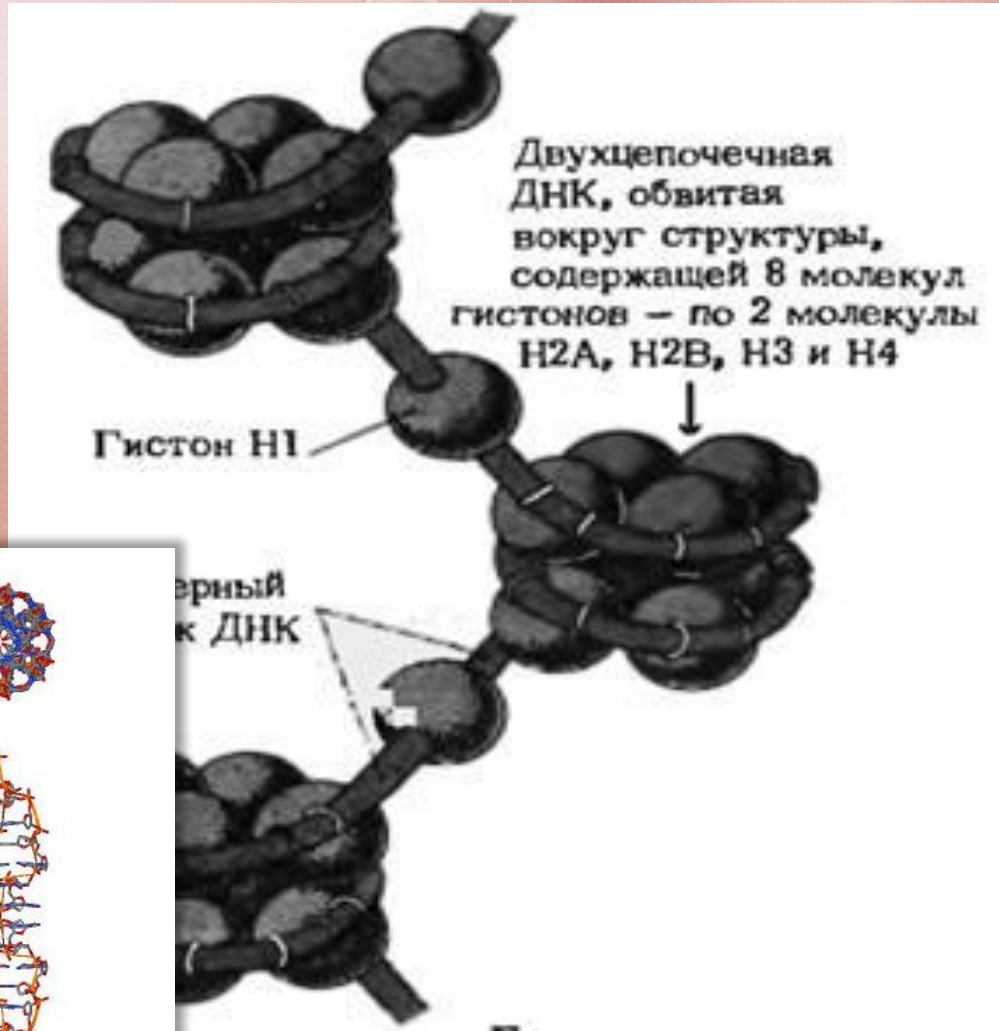
1. **Молекула ДНК** имеет постоянный **диаметр 2 нм** ($1 \text{ нм} = 10^{-9} \text{ м}$): молекула пурина 1,2 нм; молекула пиримидина 0,8 нм **$1,2 + 0,8 = 2 \text{ нм}$**
 Количество пуриновых оснований равно количеству пиримидиновых оснований.

2. **Основания** уложенных стопкой внутри двойной **спирали ДНК** располагаются **на расстояниях 0,34 нм друг от друга.**

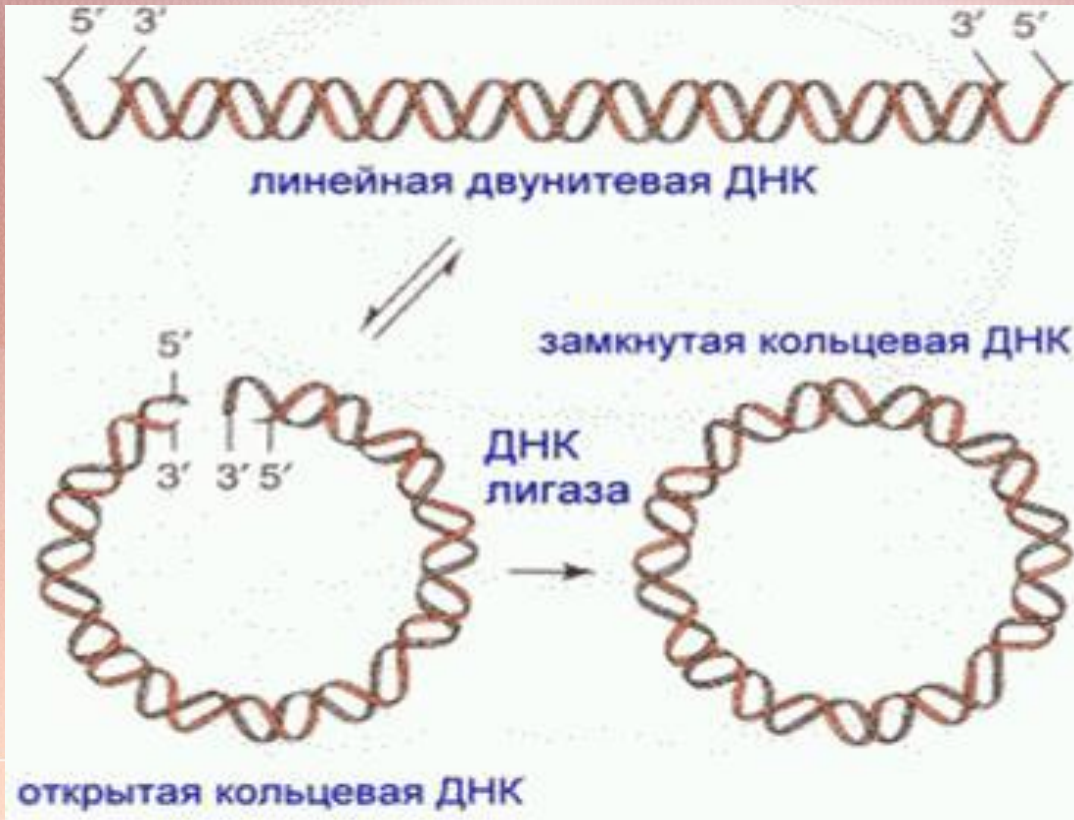
3. На каждый **полный оборот двойной спирали** приходится **10 пар оснований.** Следовательно, молекула ДНК имеет периодичность в структуре равную 3,4 нм.

Стабилизация двойной спирали происходит:

1. за счет водородных связей между комплементарными основаниями $A = T, G \equiv C$.
2. за счет гидрофобных взаимодействий между основаниями, благодаря чему основания оказываются спрятанными внутрь двойной спирали и защищены от соприкосновения с водой.



Третичная структура ДНК



Размер типичной эукариотической клетки, например, клетки печени человека, составляет в поперечнике ~ 25 мкм. Ее ядро, размером ~ 5 мкм в диаметре, содержит 46 хромосом, суммарная длина ДНК которых равна 2 м. Эукариоты содержат значительно больше ДНК, чем прокариоты. Общая длина всей ДНК, выделенной из клеток организма взрослого человека, составляет $\sim 2 \times 10^{13}$ м или 2×10^{10} км, что превышает окружность земного шара (4×10^4 км) и расстояние от Земли до Солнца ($1,44 \times 10^8$ км).

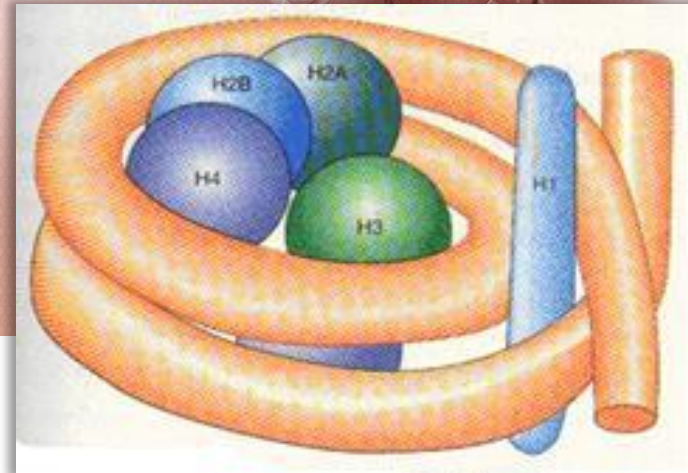


Срез клетки через

ядро

Нуклеосома

Нуклеосома состоит из белков-гистонов. Каждая нуклеосома содержит 8 молекул гистонов – по 2 молекулы H2A, H2B, H3, H4. Двухцепочечная ДНК обвивает нуклеосому дважды.



genetic information, ... the use of this ...

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... certain both ...

... DNA strand in the ...

... a polynucleotide ...

... phosphate and sugar residues ...

... direction, in a double helix the ...

... compared to B-DNA, the A-DNA form is a wider ...

... major groove ...

... partially ...

... DNA strands ...

... base pairs ...

... base change in conformation and adjust the 2.5nm ...

Упаковка ДНК в хромосоме

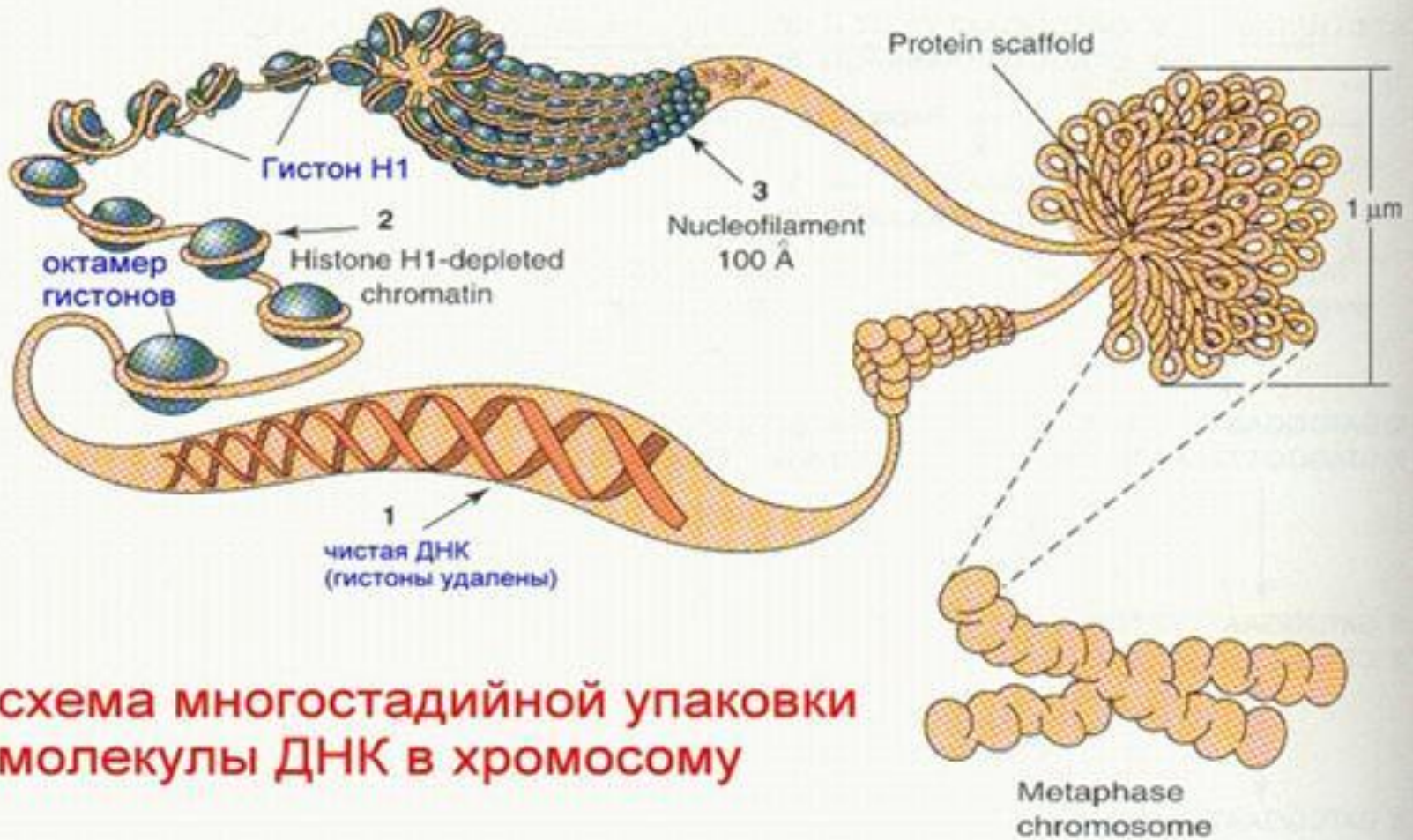
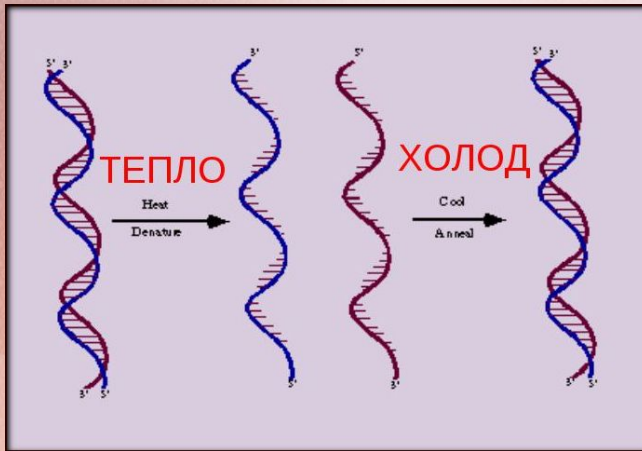


схема многостадийной упаковки молекулы ДНК в хромосому

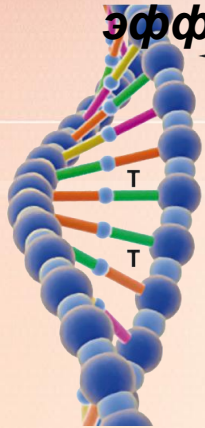
Физико-химические свойства ДНК



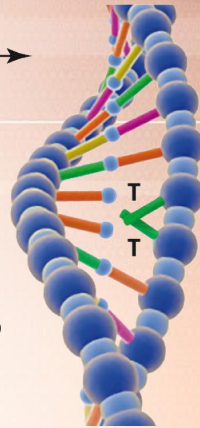
$t \geq 80^{\circ}\text{C}$ и выше

гиперхромным
эффектом

Структура
ДНК



Воздействие
ультрафиолетового
излучения



гипохромным

$t < 80^{\circ}\text{C}$



Функции ДНК

- закодирована генетическая информация
- обеспечение воспроизводства самой себя
- обеспечение синтеза белков
- РЕНАТУРАЦИЕЙ
-

Спасибо за внимание

