

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, which are linked together 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 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 in organelles such as chloroplasts. In contrast, most prokaryotic 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 give the chromosomes their characteristic shape and other proteins, helping control which parts of the DNA are transcribed.

DNA is a double helix structure. The two strands are held together by hydrogen bonds between the nitrogenous bases. The bases are attached to the sugar-phosphate backbone. The distance between two adjacent bases is 0.34 nm. The length of one full rotation of the helix is 3.4 nm. The diameter of the helix is 2 nm.

The DNA double helix is a right-handed helix. The two strands are antiparallel. The bases are attached to the sugar-phosphate backbone. The distance between two adjacent bases is 0.34 nm. The length of one full rotation of the helix is 3.4 nm. The diameter of the helix is 2 nm.

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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. Their model was based on the X-ray diffraction patterns of DNA. The structure of DNA is a right-handed helix with a diameter of 2 nm. The distance between two adjacent bases is 0.34 nm. The length of one full rotation of the helix is 3.4 nm.

Compared to B-DNA, the A-DNA form is a wider, more compact, and more rigid structure. It is found in dehydrated DNA and in DNA from certain organisms. The A-DNA form is a right-handed helix with a diameter of 2 nm. The distance between two adjacent bases is 0.34 nm. The length of one full rotation of the helix is 3.4 nm.

random|plasmid

Выполнил: Фадеев С.В..
1 курс 127 группа
Преподаватель: Первова Ю.В.
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

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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. Only prokaryotic bacteria and some archaea store their DNA only as a single molecule or chromosome in the cytoplasm. Within the chromosomes, chromatin proteins such as histones compact and organize DNA. These compact structures guarantee the efficient transfer of DNA and other genetic information between cells and other processes, including control which parts of the DNA are transcribed.

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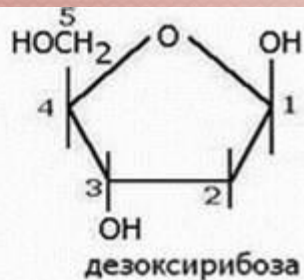
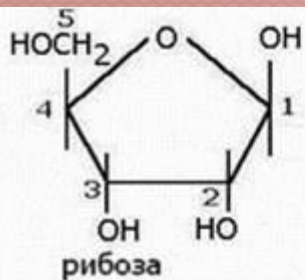
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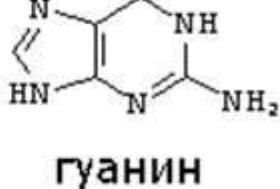
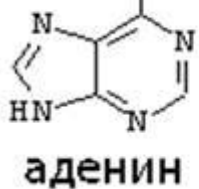
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Нуклеотид

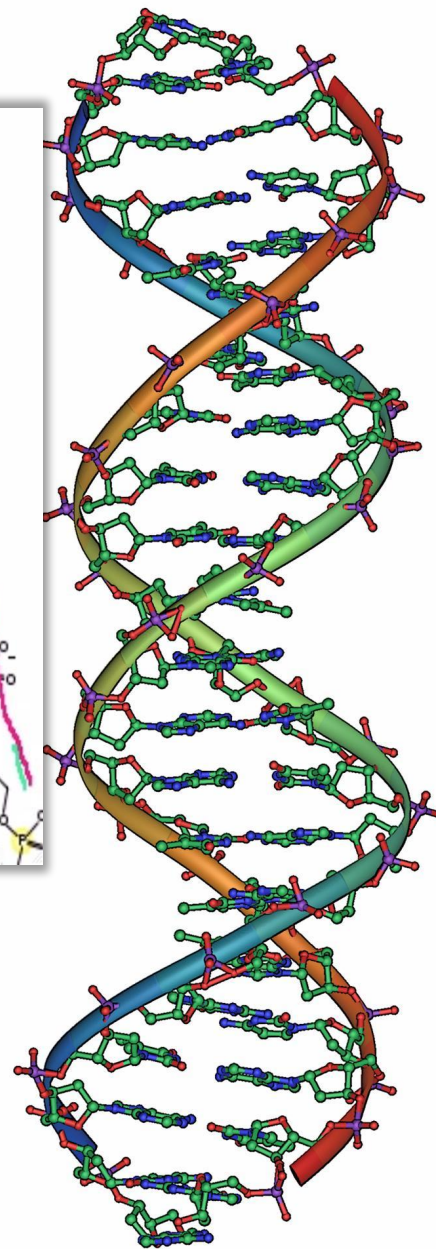
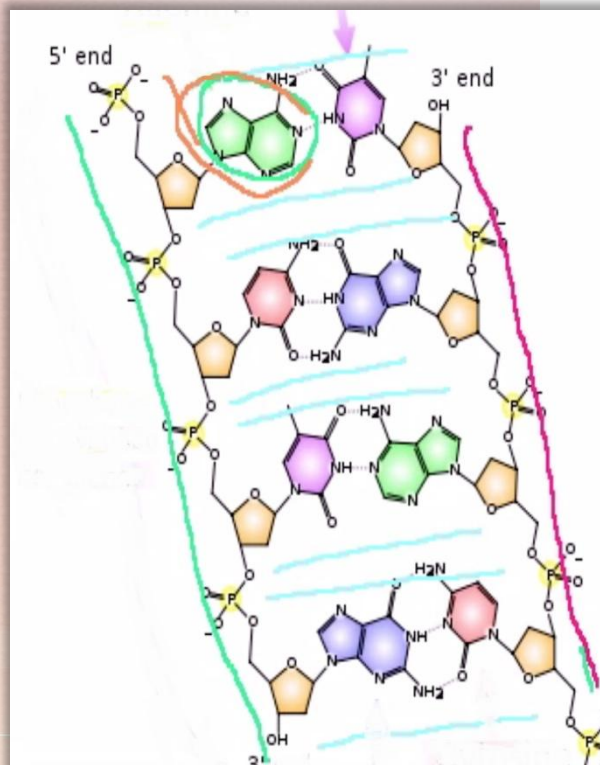
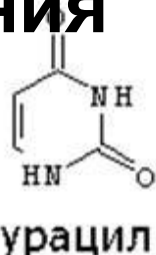
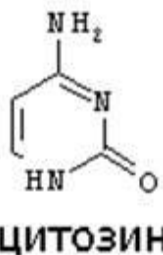
Моносахариды



Пуриновые основания



Пиримидиновые основания

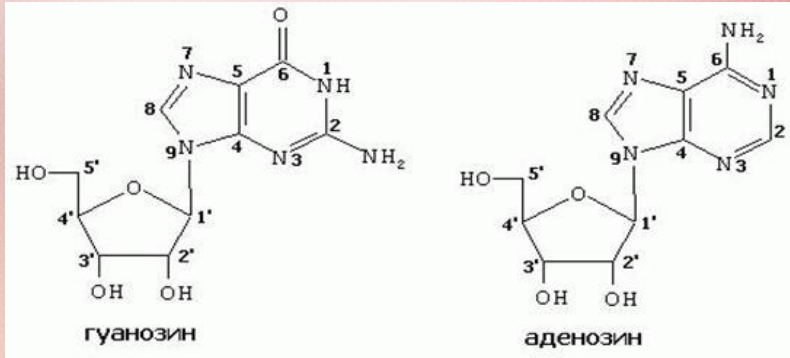


1 оборот спирали = 10 комплементарных пар = 3,4 нм

2 нм

Нуклеозиды

Пуриновые



Пиримидиновые

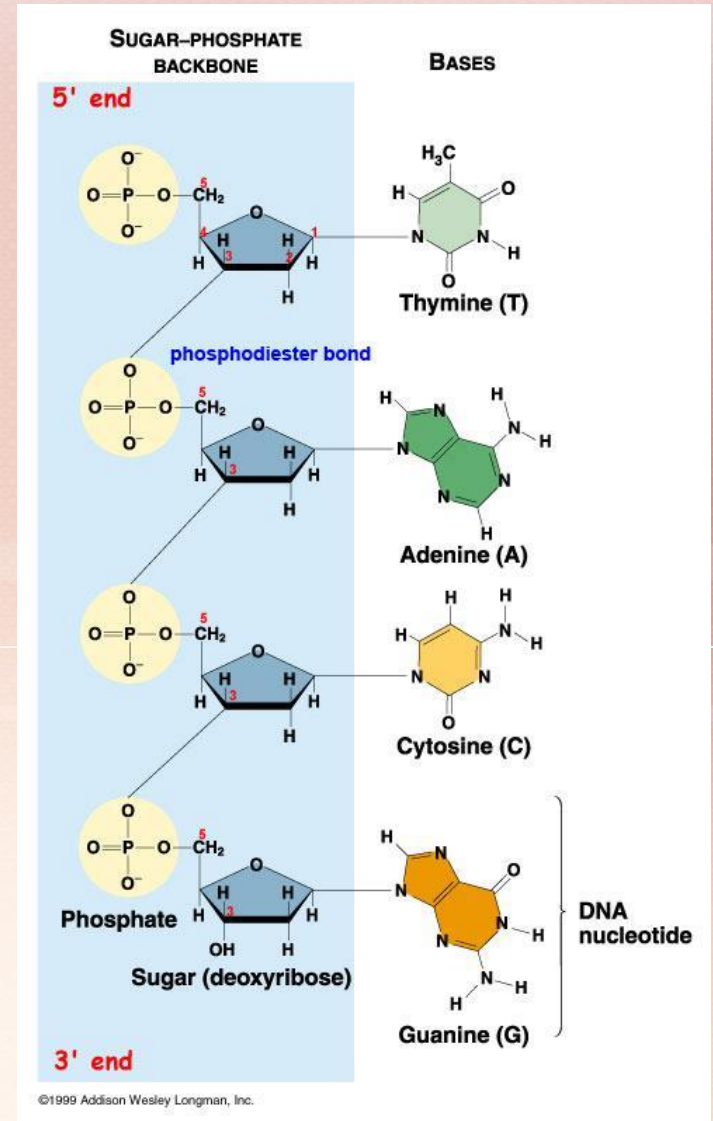
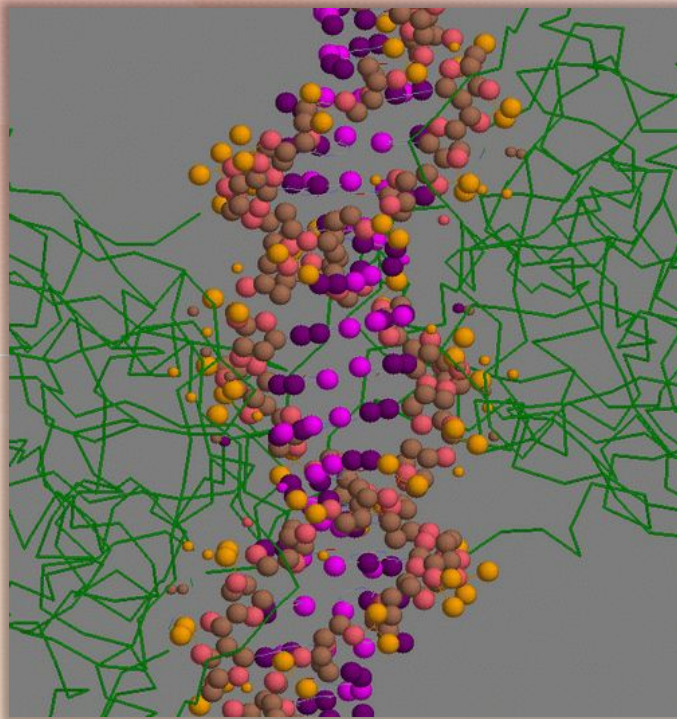


Азотистые основания	Нуклеозиды	Нуклеотиды	
Полное название	Сокращенное название		
Аденин	Аденозин	Аденозинмонофосфат	АМФ
Гуанин	Гуанозин	Гуанозинмонофосфат	ГМФ
Цитозин	Цитидин	Цитидинмонофосфат	ЦМФ
Урацил	Уридин	Уридинмонофосфат	УМФ
Тимин	Тимидин	тиминмонофосфат	ТМФ

ДНК и РНК обладают первичной, вторичной, третичной структурами.

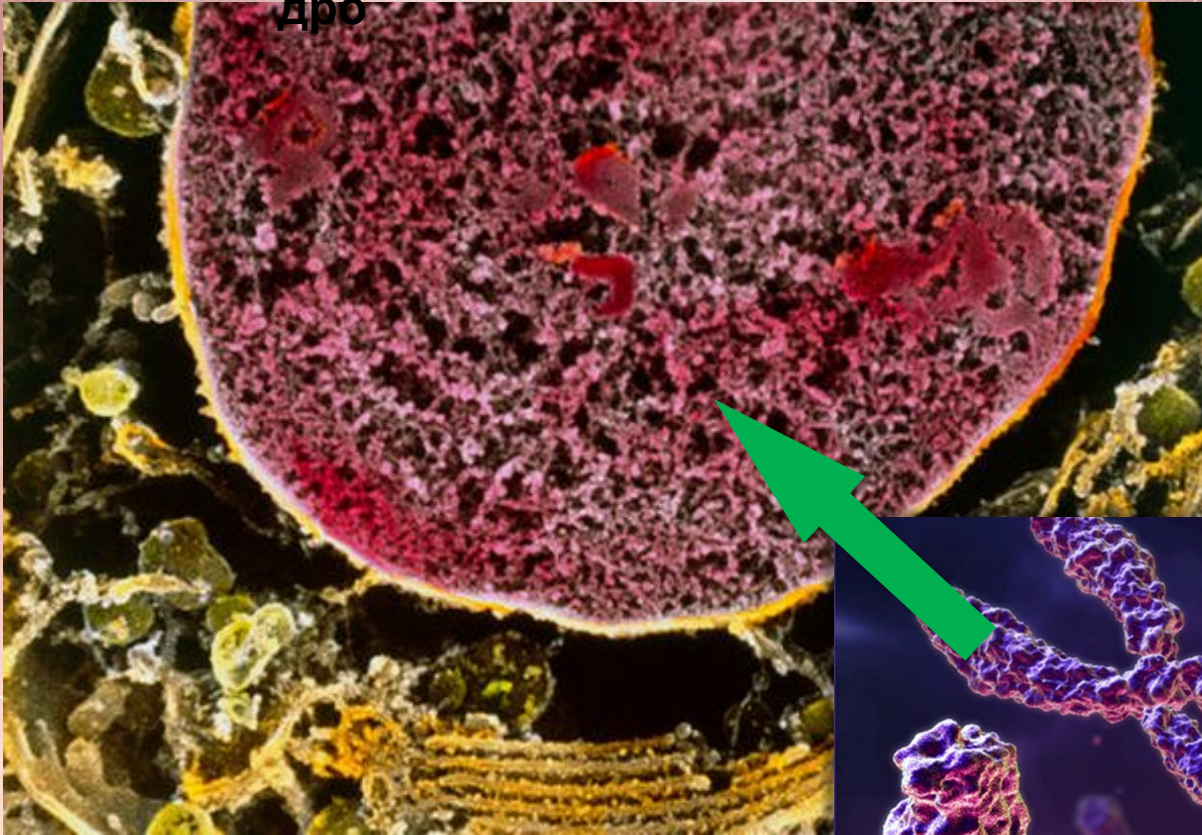
Первичная структура ДНК – последовательность нуклеотидов в молекуле ДНК.

5'-НО-Г-А-А-Т-Ц-Т-А-Ц-А-...3'



Срез клетки через клеточное ядро

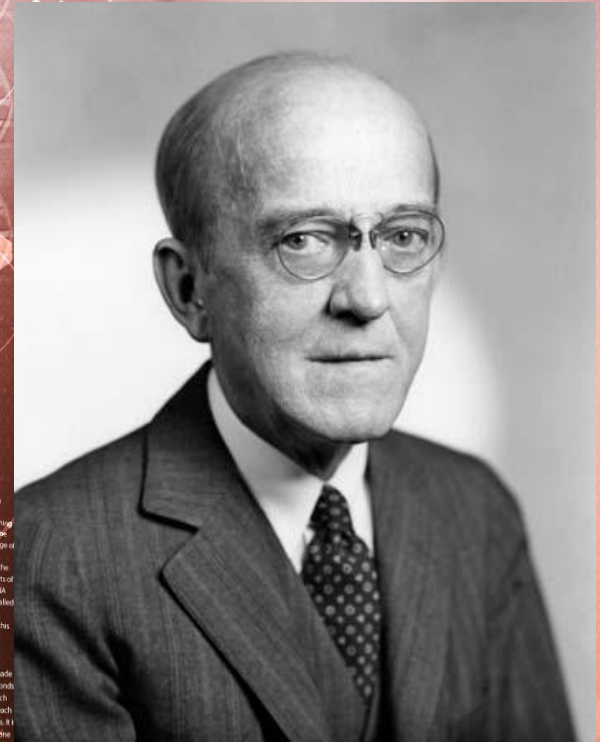
дро



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 four 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

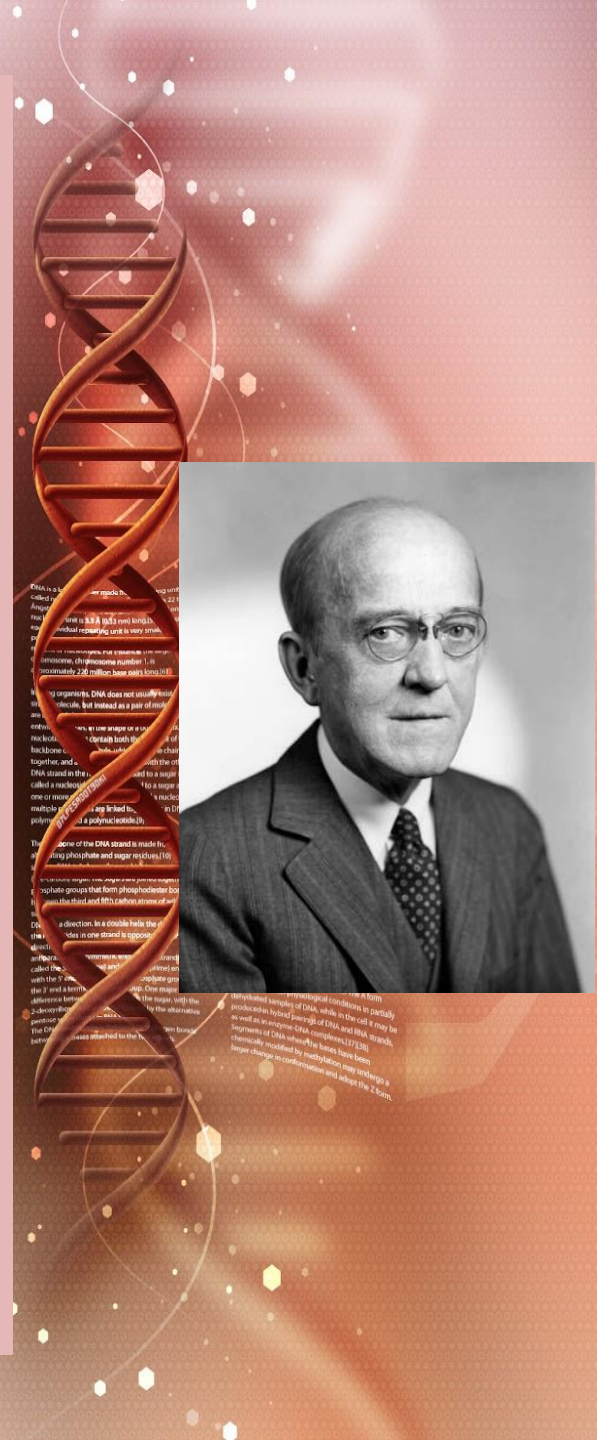


Было установлено, что:

- 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.



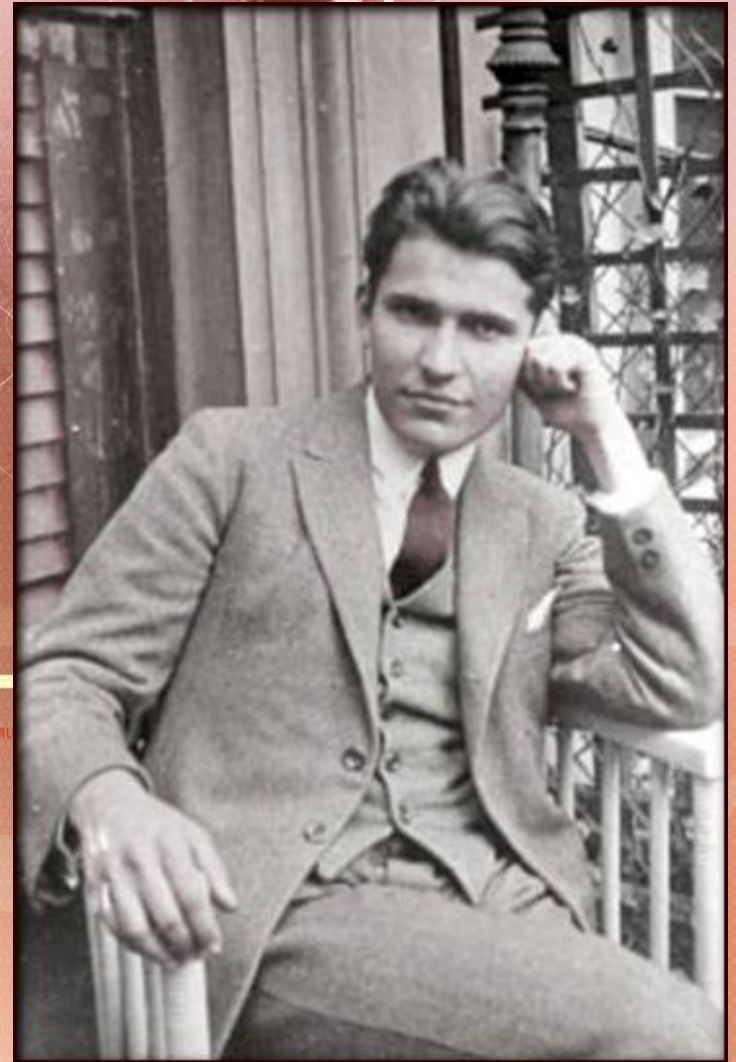
Правила Чаргаффа

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:

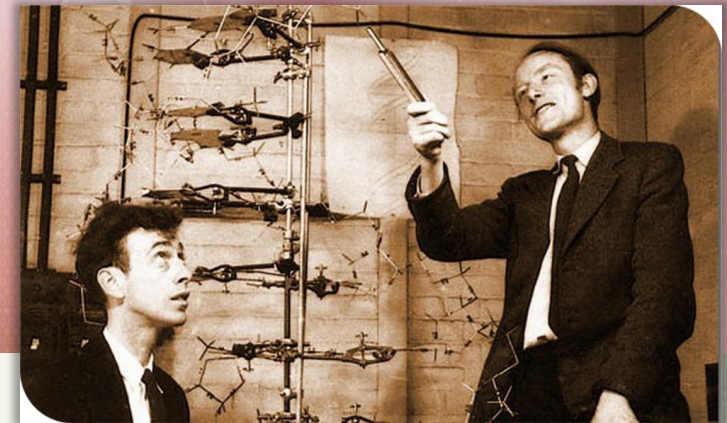
сумма пуриновых остатков равно сумме пиримидиновых, т.е. $A + G = T + C$

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:

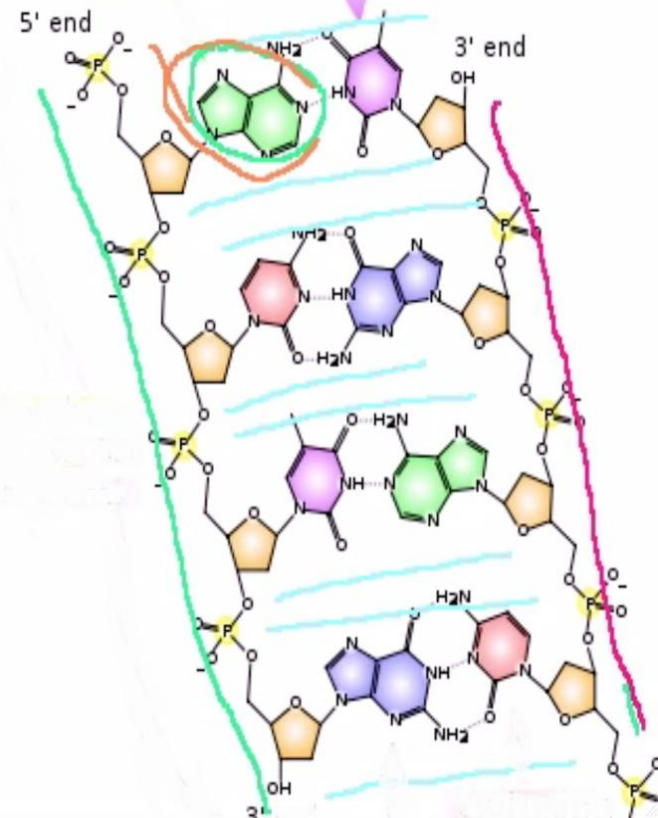
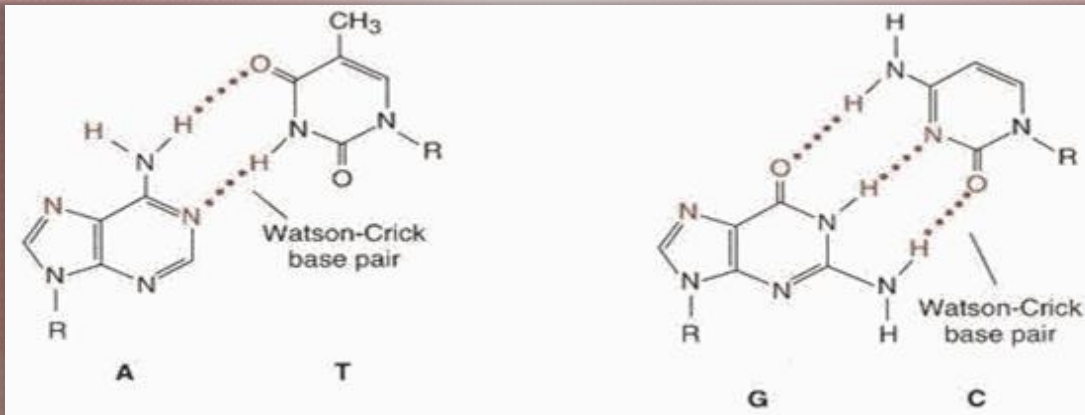
1. Молекула ДНК имеет постоянный диаметр 2 нм ($1 \text{ нм} = 10^{-9} \text{ м}$)
молекула пурина 1,2 нм
молекула пиримидина 0,8 нм
 $1,2 + 0,8 = 2 \text{ нм}$

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.





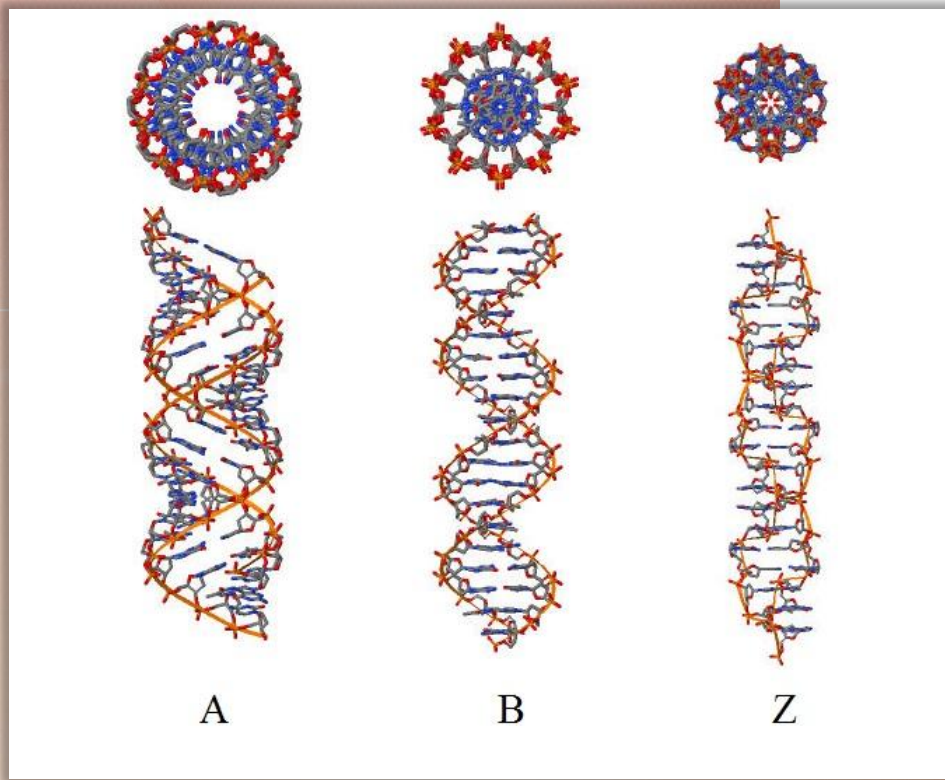
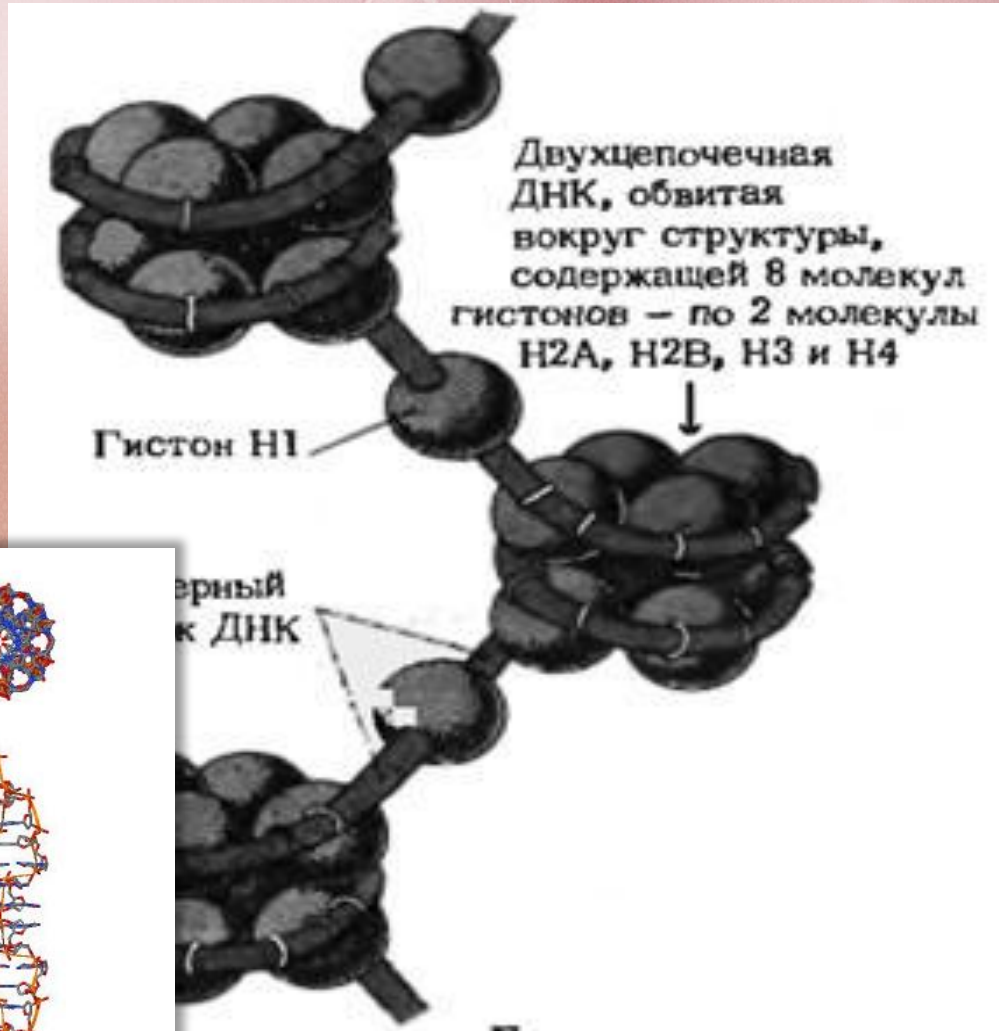
1. **Молекула ДНК** имеет постоянный **диаметр 2 нм** ($1 \text{ нм} = 10^{-9} \text{ м}$): молекула пурина 1,2 нм; молекула пиримидина 0,8 нм **$1,2 + 0,8 = 2 \text{ нм}$**
 Количество пуриновых оснований равно количеству пиримидиновых оснований.

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

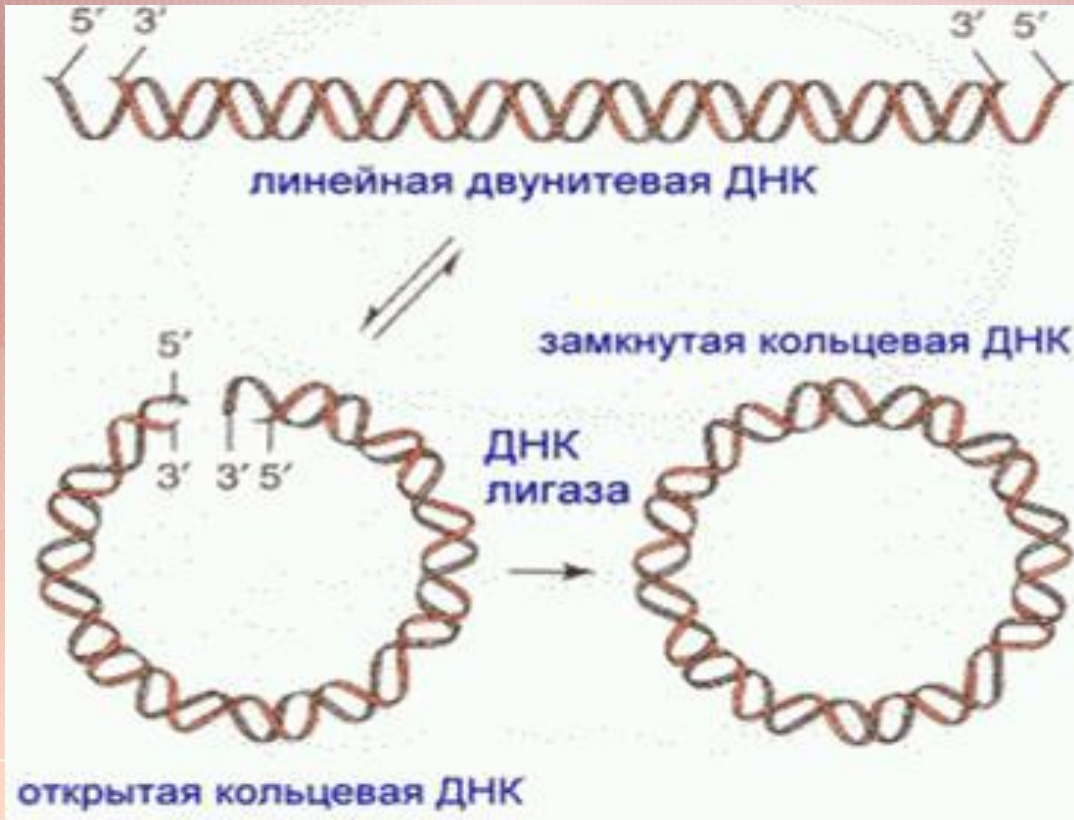
3. На каждый **полный оборот двойной спирали** приходится **10 пар оснований.** Следовательно, молекула ДНК имеет периодичность в структуре равную 3,4 нм.

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).

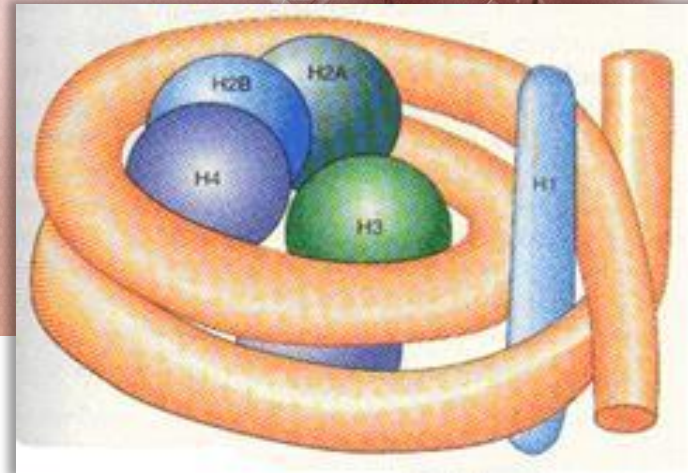


Срез клетки через

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 ...

... the DNA strand is made ...

... phosphate groups that form phosphodiester bonds ...

... a double helix ...

... the A-DNA form ...

... the B-DNA form ...

... the Z-DNA form ...

... the H-DNA form ...

... the G-DNA form ...

... the I-DNA form ...

... the J-DNA form ...

... the K-DNA form ...

... the L-DNA form ...

... the M-DNA form ...

... the N-DNA form ...

... the O-DNA form ...

... the P-DNA form ...

... the Q-DNA form ...

... the R-DNA form ...

... the S-DNA form ...

... the T-DNA form ...

... the U-DNA form ...

... the V-DNA form ...

... the W-DNA form ...

... the X-DNA form ...

... the Y-DNA form ...

... the Z-DNA form ...

... the AA-DNA form ...

... the BB-DNA form ...

... the CC-DNA form ...

... the DD-DNA form ...

... the EE-DNA form ...

... the FF-DNA form ...

... the GG-DNA form ...

... the HH-DNA form ...

... the II-DNA form ...

... the JJ-DNA form ...

... the KK-DNA form ...

... the LL-DNA form ...

... the MM-DNA form ...

... the NN-DNA form ...

... the OO-DNA form ...

... the PP-DNA form ...

... the QQ-DNA form ...

... the RR-DNA form ...

... the SS-DNA form ...

... the TT-DNA form ...

... the UU-DNA form ...

... the VV-DNA form ...

... the WW-DNA form ...

... the XX-DNA form ...

... the YY-DNA form ...

... the ZZ-DNA form ...

... the AAA-DNA form ...

... the BBB-DNA form ...

... the CCC-DNA form ...

... the DDD-DNA form ...

... the EEE-DNA form ...

... the FFF-DNA form ...

... the GGG-DNA form ...

... the HHH-DNA form ...

... the III-DNA form ...

... the JJJ-DNA form ...

... the KKK-DNA form ...

... the LLL-DNA form ...

... the MMM-DNA form ...

... the NNN-DNA form ...

... the OOO-DNA form ...

... the PPP-DNA form ...

... the QQQ-DNA form ...

... the RRR-DNA form ...

... the SSS-DNA form ...

... the TTT-DNA form ...

... the UUU-DNA form ...

... the VVV-DNA form ...

... the WWW-DNA form ...

... the XXX-DNA form ...

... the YYY-DNA form ...

... the ZZZ-DNA form ...

Упаковка ДНК в хромосоме

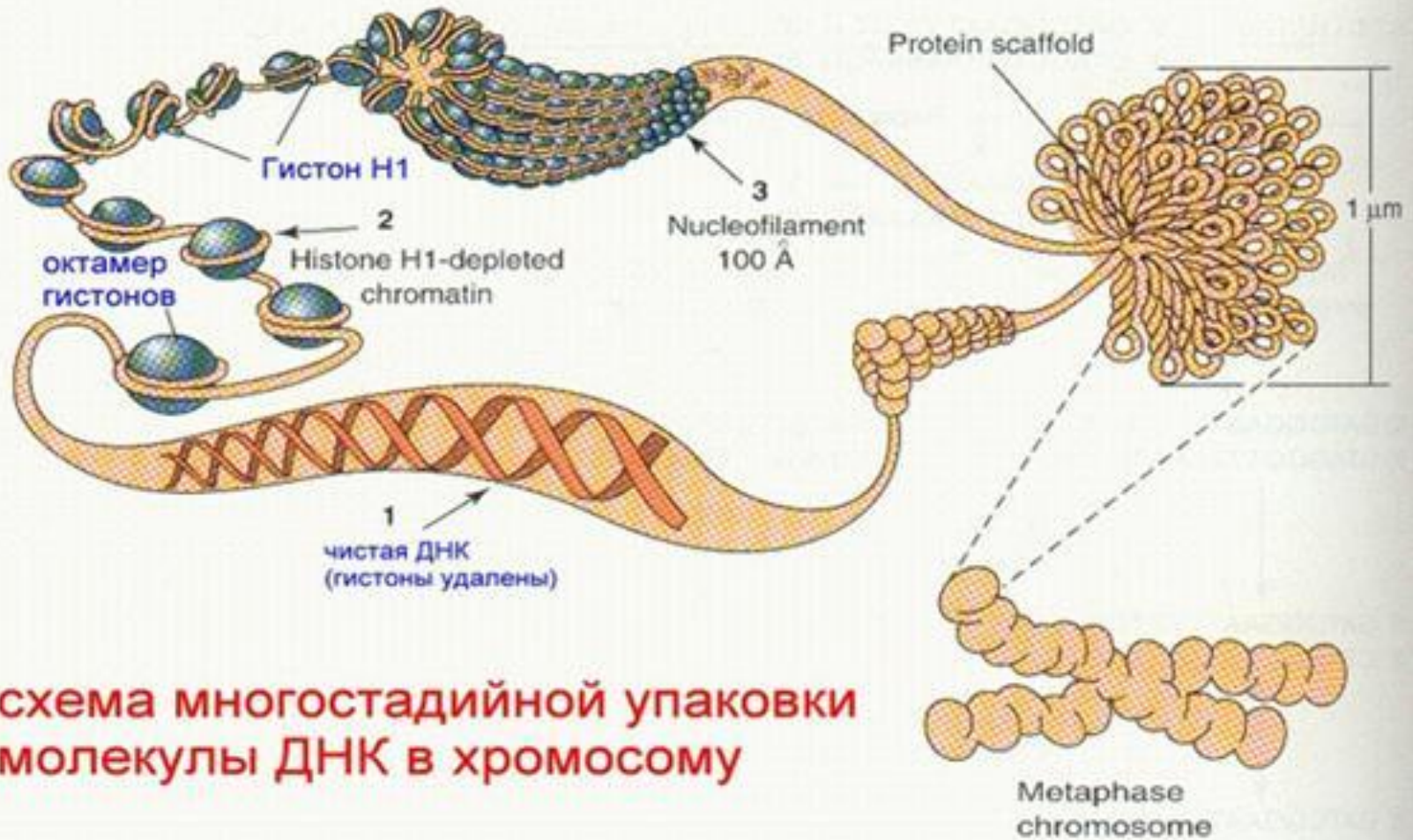
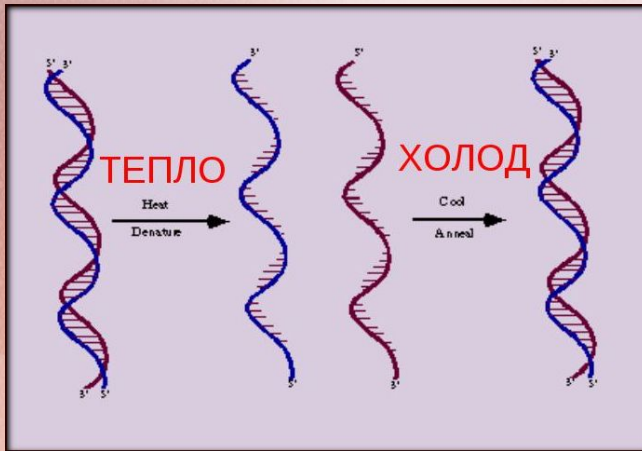


схема многостадийной упаковки молекулы ДНК в хромосому

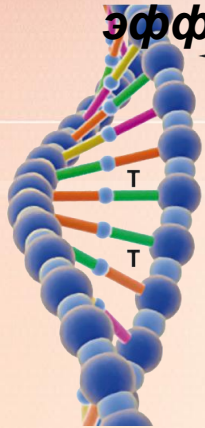
Физико-химические свойства ДНК



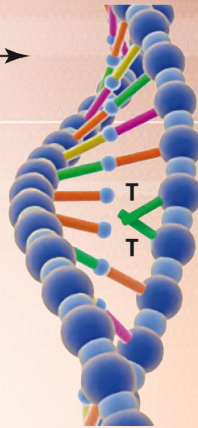
$t \geq 80^{\circ}\text{C}$ и выше

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
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Спасибо за внимание

