



Lecture 4:

DNA: Chemical composition

Readings (chapter 2)

Course 281

Lessons for life



Jim Rohn Official

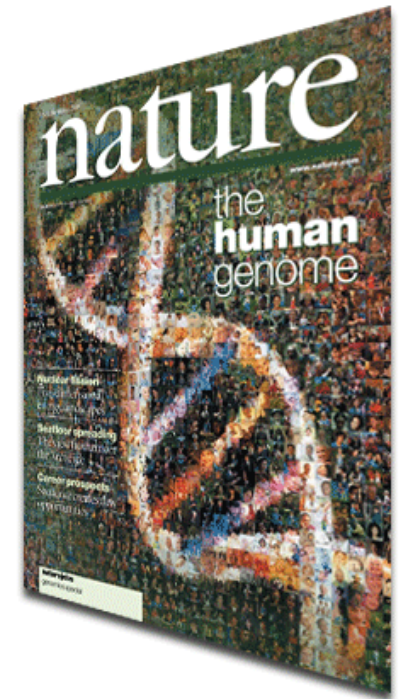
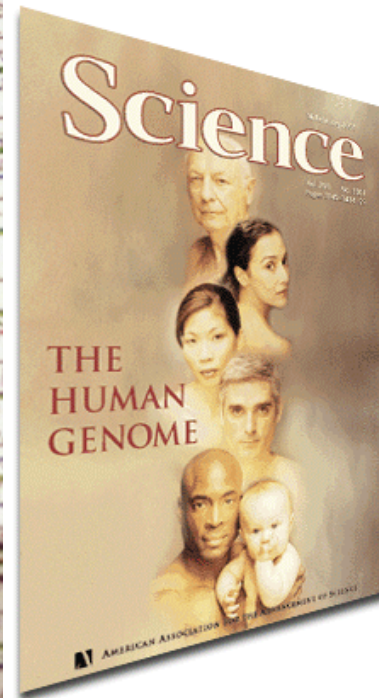
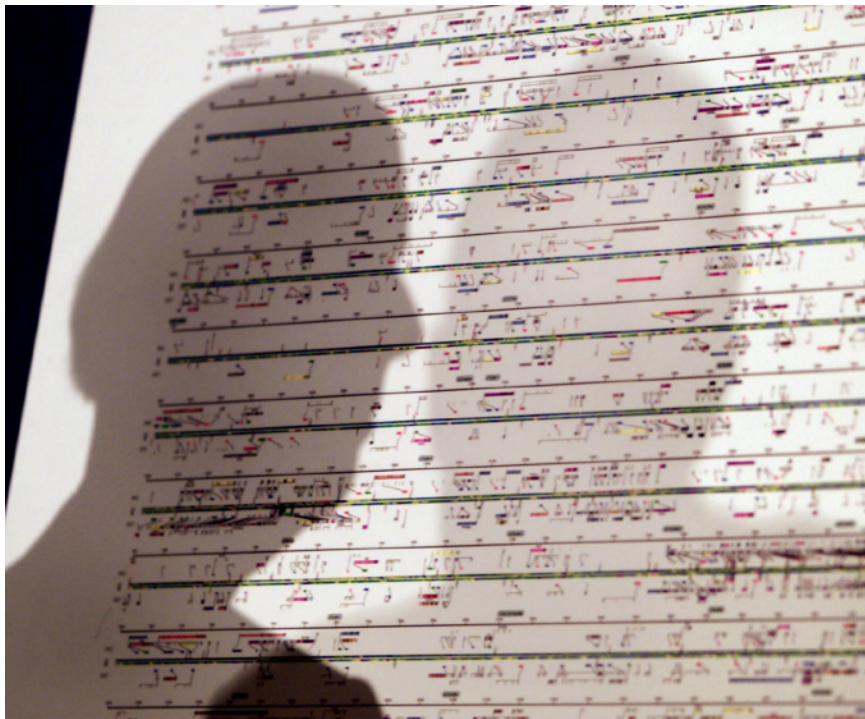
@OfficialJimRohn

"Success is nothing more than a few simple disciplines, practiced every day." -- Jim Rohn

AIMS

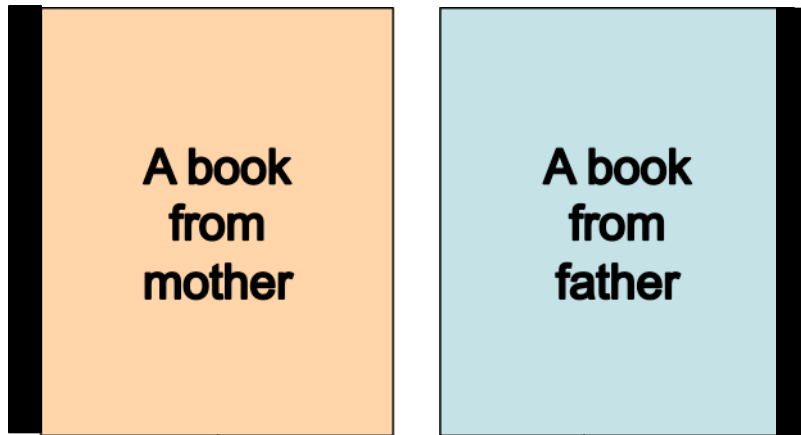
- Learn the chemical language of life.
- Understand the chemical composition of DNA and RNA (similarities and differences).
- Understand the chemical bond that links the units of DNA and RNA.

What is the genome?

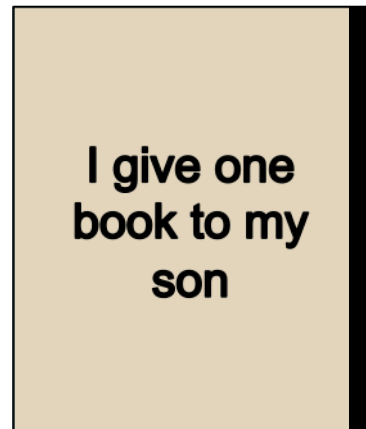
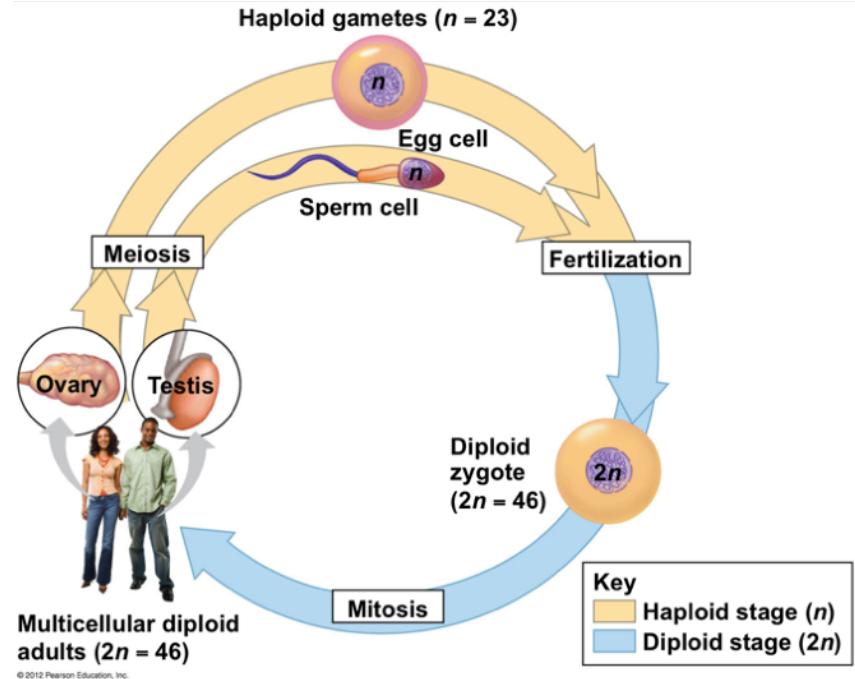


The book of life
The code to our existence
The instructions to make who we are
The map to how we look, feel, think, and behave
The genome is ourselves in a chemical language

The human book of life – an analogy



THE GENOME



The human book of life – an analogy

Can you define the genome?

What cells in your body have one copy of the genome and what cells have two?

Some details on the human book of life

- Humans are diploid organisms - two books (genomes) in most of their cells.
- Each book (genome) is composed of 23 chapters (chromosomes).
- The total number of chapters (chromosomes) in a humans is 46.
- Approximately 3 billion letters in the book!
- Sex determination depends on chapter 23 (the sex chromosomes).
- XX → female.
- XY → male.

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23 - X

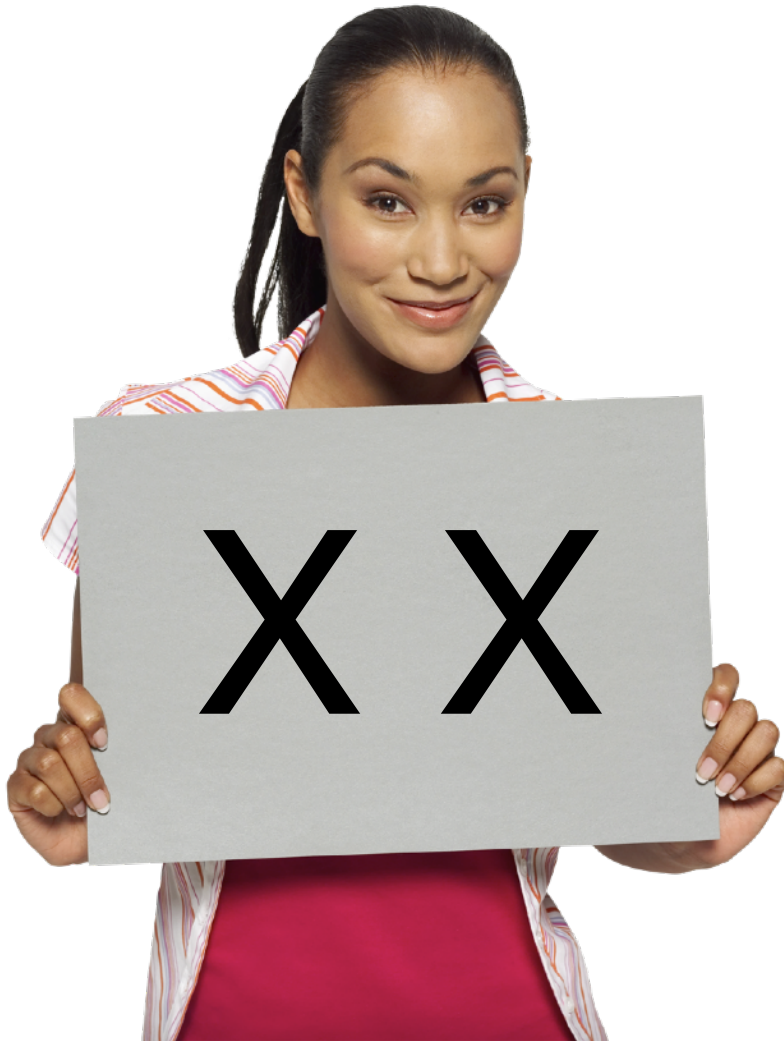
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23 - Y

Autosomal chromosomes

Sex chromosomes

Sex determination (mostly)

What are the 23rd chapters of your books of life?



More details about the book

- The number of pages, word, and letters differ in each chapter (chromosome).
- **Chapters (chromosomes) are numbered based on their size. (chr 1 is the largest).**
- The instructions/readable sections (genes) are not equally distributed over the chromosomes.

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23 - X

- Many sections of the book (genome) are not readable.
- **Many sections of the book are of repeated letter, words, or sentences.**
- The book is written in a chemical language composed of four letters (A,T,G,C).
- **Sentences are made of words made of three letters (AAC, ATG, etc.).**

What is written and how to read it?

1

ATGCCATC**ACAAATGCGGC**
TATG**CCATGACA****AAATGCGG**
CTAATGCCATGACAAATGC
GGCTAATGCCATGACAAATG
CGGCTAATGCCATGACAAAT
GCGGCTACATGACAAATGC
GGCTAATGCCATGACAAATG
CGGCTAATCATGACAAATGC
GGCTACATGACCATGACAAA
TGCGGCTACATG**CAACAA**
CAACAACAACAACAAC
AACAACATATATATATATAT
ATATATATATATATATATATAT
ATATATATATATATATATATAT
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ATATATATATATATATATATAT
ATATATAT

Met-Pro-Ser-Met-Arg-Lue-Cys-
His-Asp-Lys-Cys-Gly-**stop**

Make brown eyes and **stop**

Bla bla bla bla bla

More bla bla bla bla

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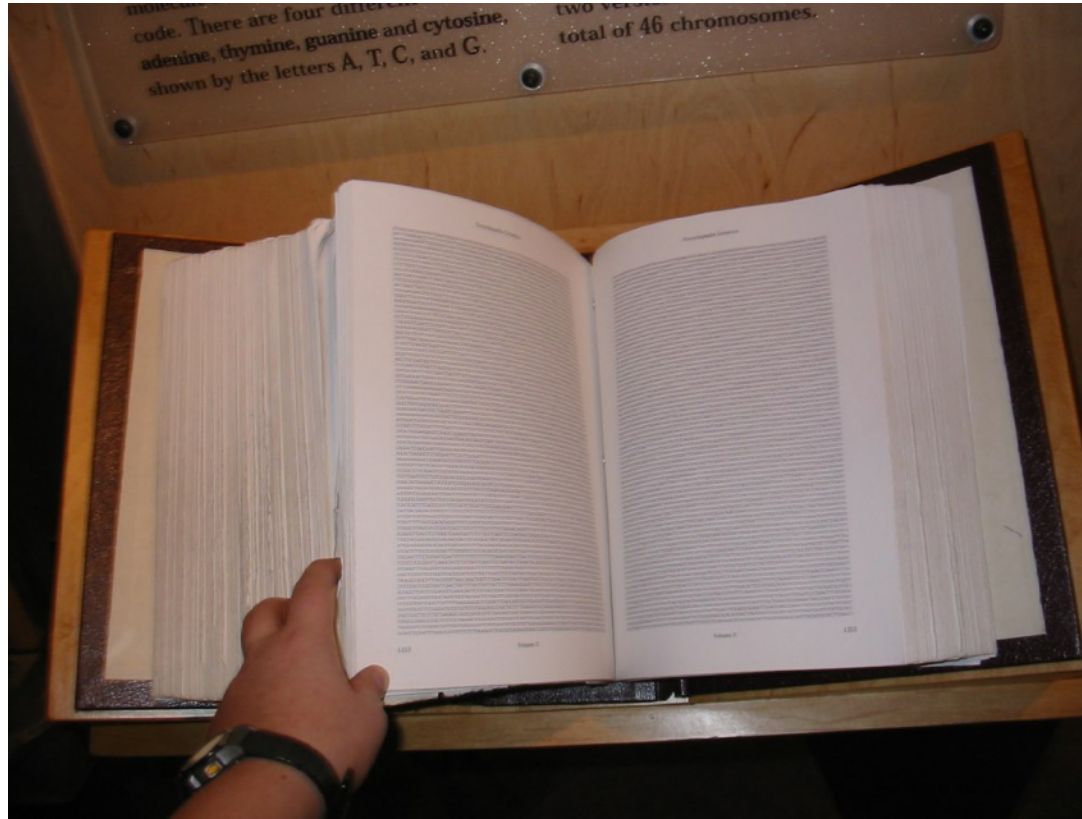
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23 - X

The genome in a cell?



The Wellcome collection in London.
The human genome printed using font size (5)!

The genome in a cell?



- If we print the genome using font size 12 and stretch the letter, it would go ~ from Kuwait to Spain!
- A lot of information. How is it packaged in a 100 trillion tiny little human cells (1-100 μm)?

Lost?

Are you lost with these analogy?

If yes, do not worry.

**You will learn all the details during this
course 😊**

Nucleic acids



We have established that DNA is the genetic material.

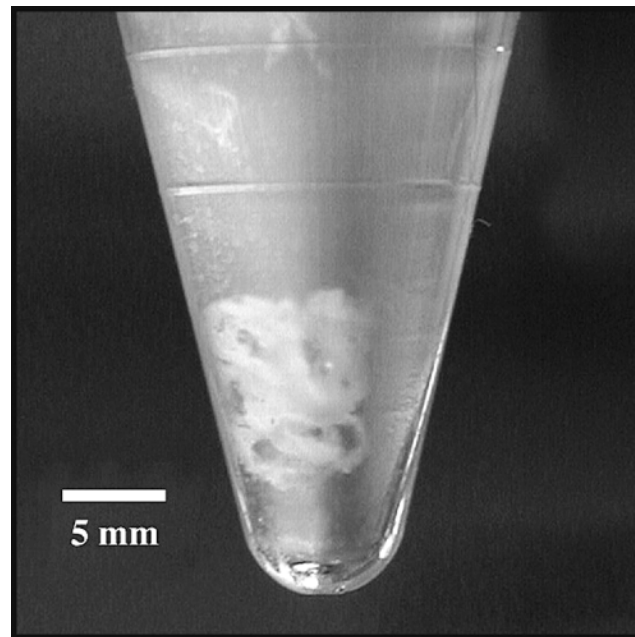
What is it composed of?

If DNA is the genetic material, what is RNA?

What's up with these weird names?

Nucleic acids

- DNA and RNA are organic compounds belong to a class called **Nucleic acids**.
- We will learn the similarities and differences between them.



2.1 THE STRUCTURE OF DNA

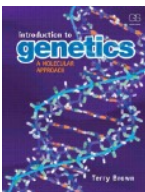
What is the basic unit of DNA?

- Nucleotides are the basic units of a DNA molecule.

What is the name of the bond that links DNA units?

What is the name of the molecule that is made of many DNA units?

- Nucleotides join together to make a polynucleotide



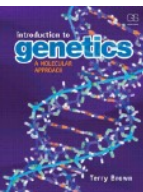
2.1 THE STRUCTURE OF DNA

What is the DNA structure inside living cells?

- In living cells, DNA is a double helix

How many forms of DNA structure exists in-vivo and in-vitro?

- The double helix exists in several different forms

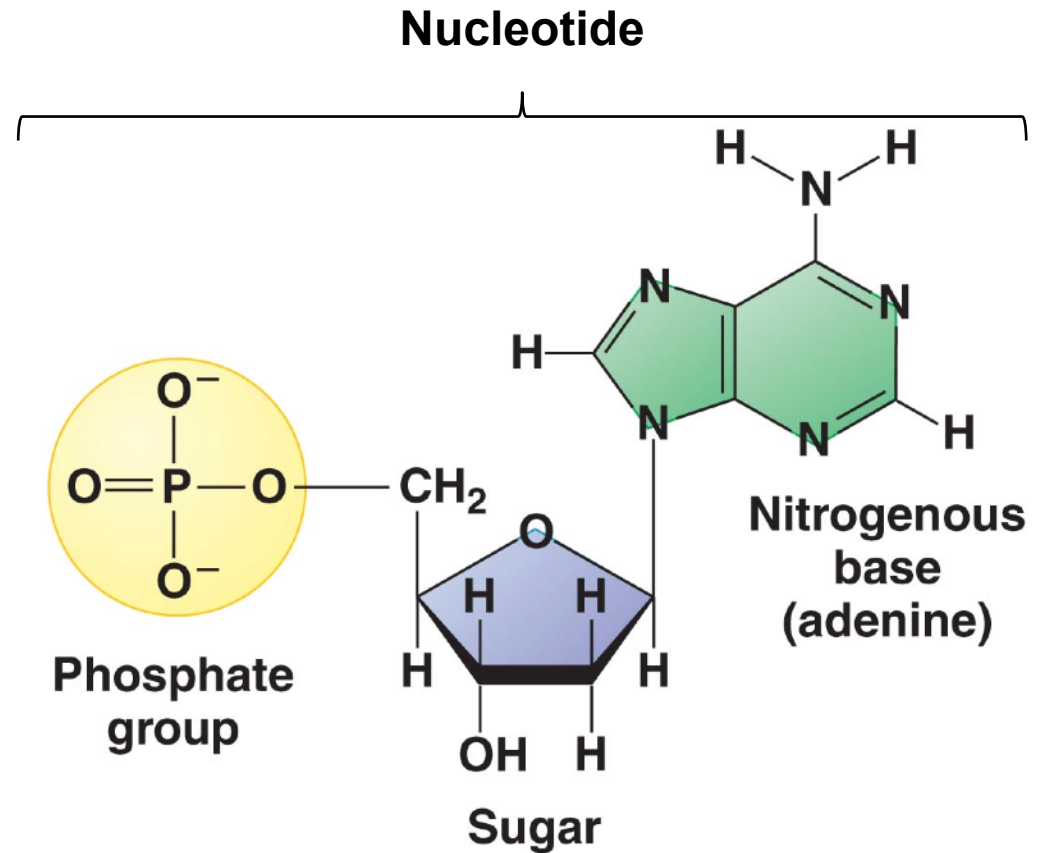


DNA and RNA chemical unit

- The chemical unit that makes nucleic acids (DNA and RNA) is called **Nucleotide**.

- A **nucleotide** is composed of:

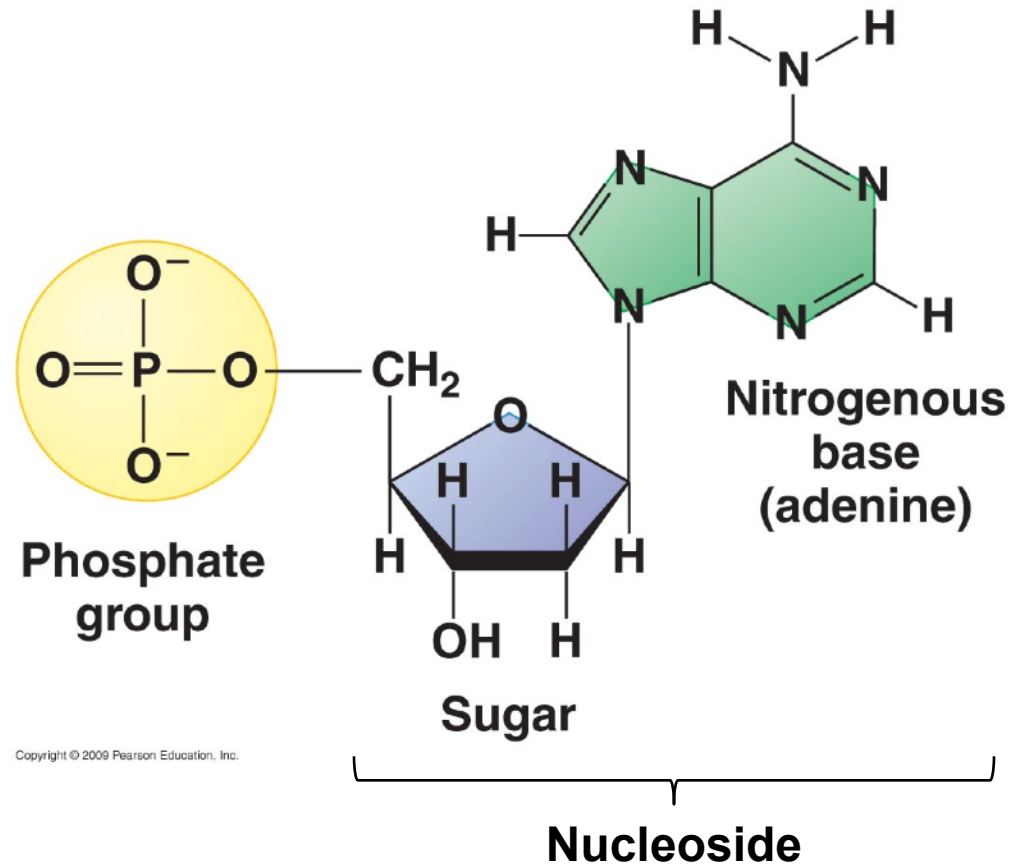
- Sugar
- Phosphate group
- Nitrogenous base



DNA and RNA chemical unit

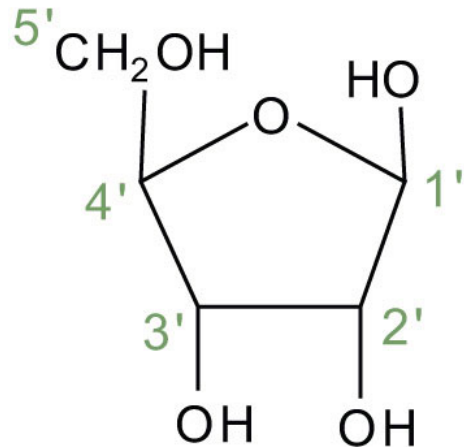
- A **nucleoside** is a part of the nucleotide and is composed of:

1. Sugar
2. Nitrogenous base

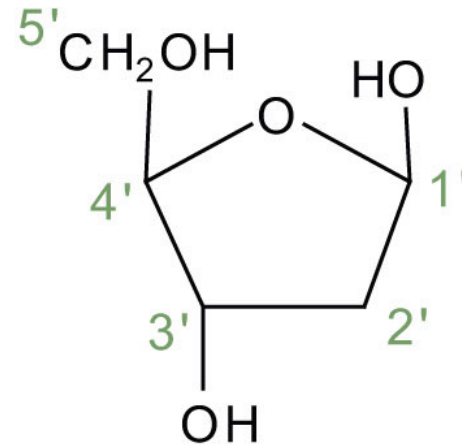


The sugar

- The sugar in DNA and RNA is **almost** the same.
- The sugar is a pentose (5 carbon sugar) – count them and know the carbon's numbers.

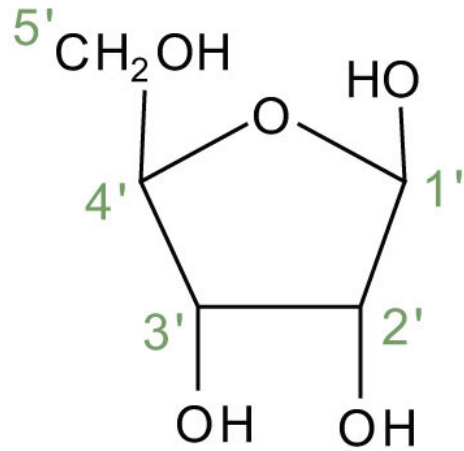


β -Ribose
(found in RNA)

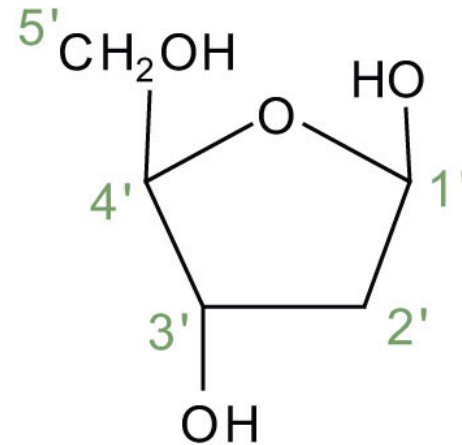


β -2-Deoxyribose
(found in DNA)

The sugar



β -Ribose
(found in RNA)

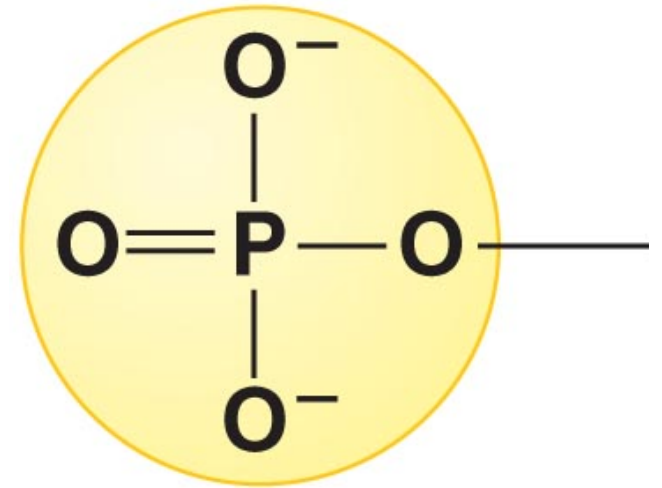


β -2-Deoxyribose
(found in DNA)

- RNA's sugar is **ribose**. Hydroxyl group (OH) on most carbons.
- DNA's is **deoxy ribos**. 2-deoxy-ribose (with out OH on carbon #2)

The phosphate group

- The phosphate group is attached to carbon #5 of the sugar.
- It is essential for the formation of DNA and RNA backbone and linking the nucleotides (we will see later).
- It is the reason for the negative charge of DNA and RNA.



The nucleotide bases

Nitrogenous bases

Small bases

Large bases

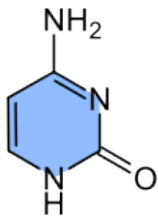
Pyrimidines
One ring

Purines
Two rings

Found in DNA and
RNA

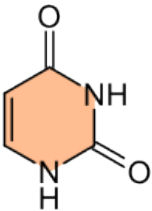
Cytosine

C



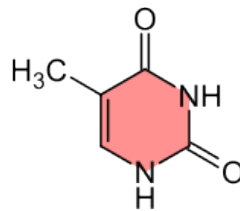
Uracil

U



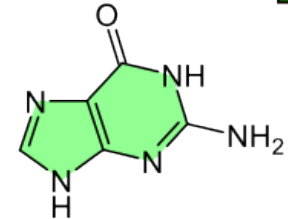
Thymine

T



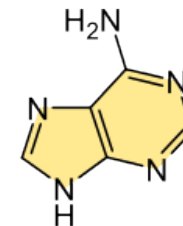
Guanine

G



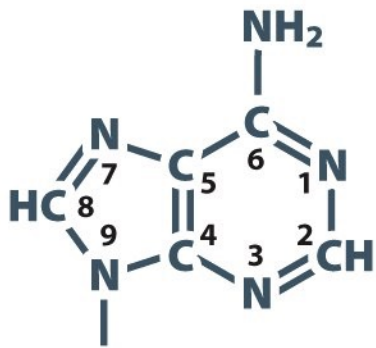
Adenine

A

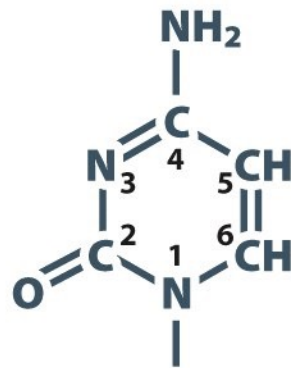


Found in RNA

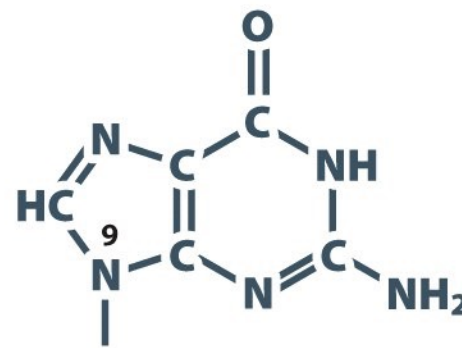
Found in DNA



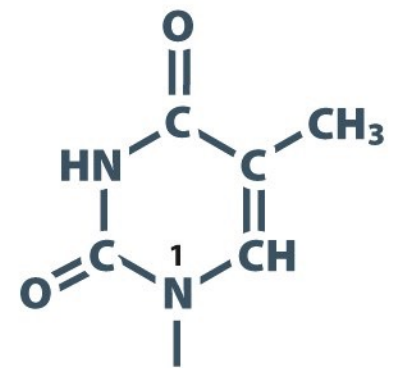
adenine (A)



cytosine (C)



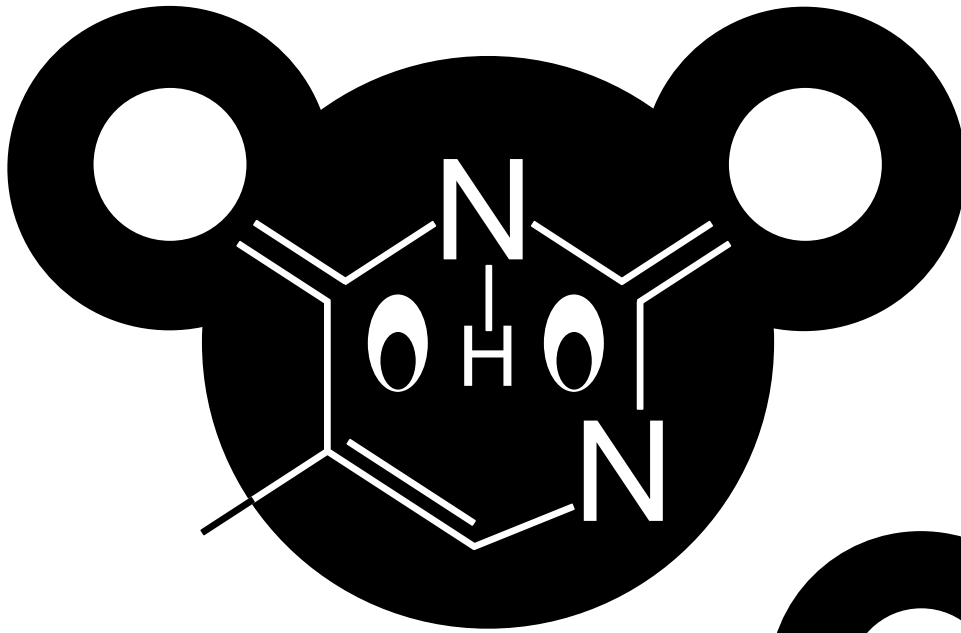
guanine (G)



thymine (T)

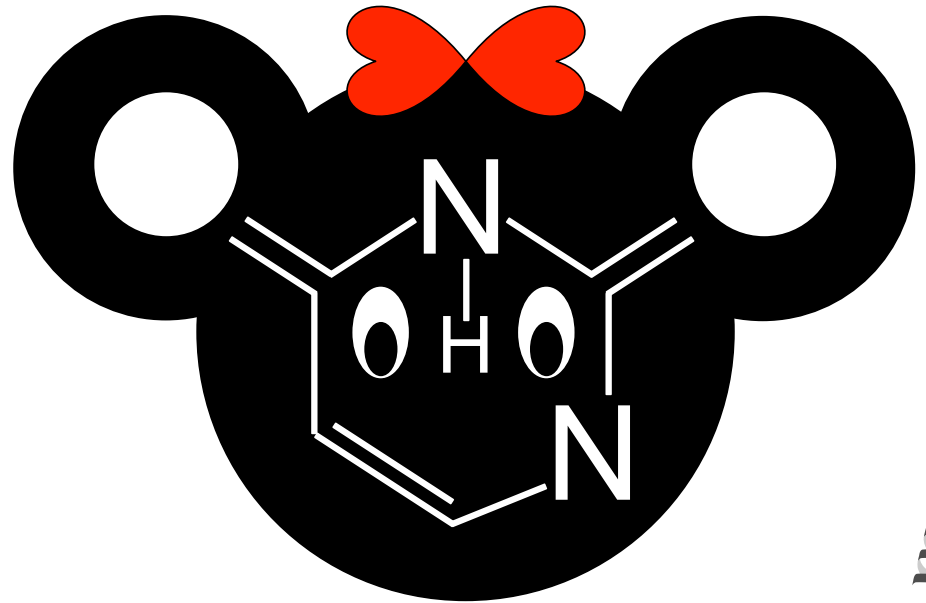
Figure 2.4 Introduction to Genetics (© Garland Science 2012)

Thy-Mickey and Mini-cil

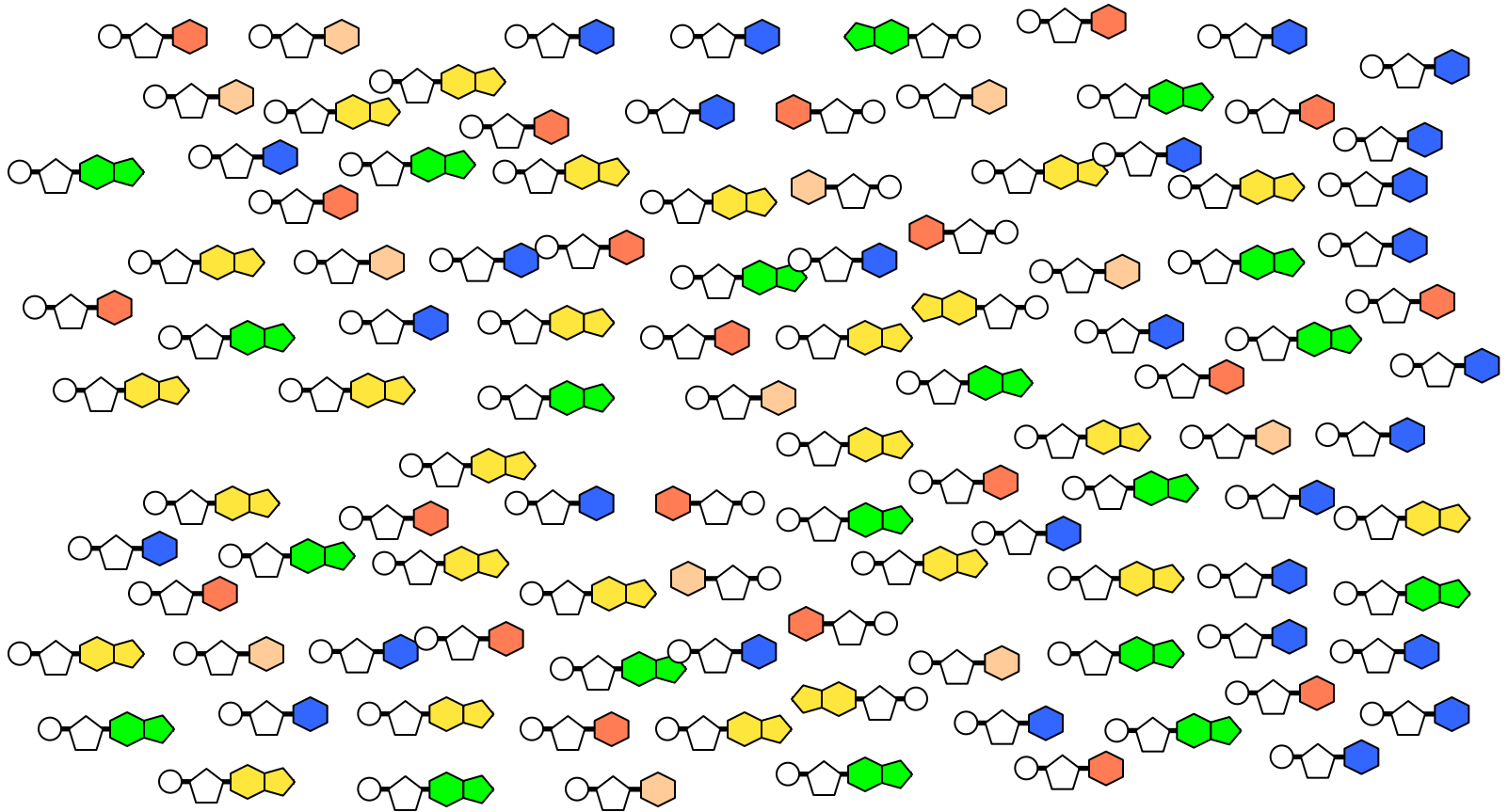


Uracil
Mini Mouse

Thymine
Mickey Mouse



Nucleotides

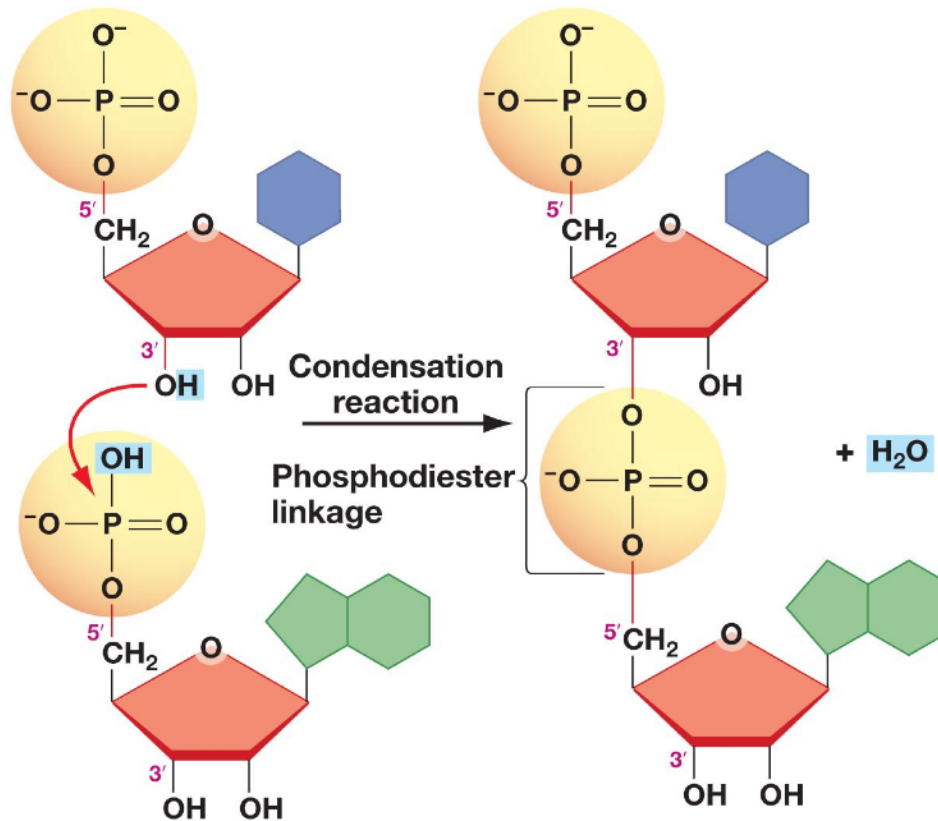


There are millions/billions of nucleotides in one genome.

How are they linked and connected?

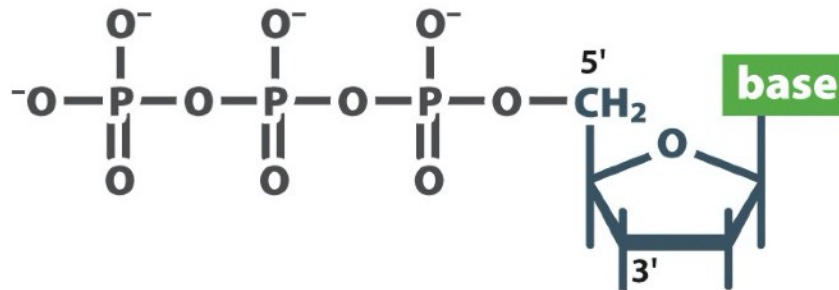
Nucleotide linking

- Nucleotides are linked via **phosphodiester bond**.
- A covalent bond links the phosphate group of one nucleotide to the 3' carbon of the sugar of another.

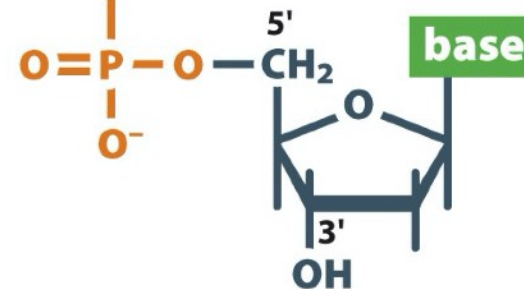
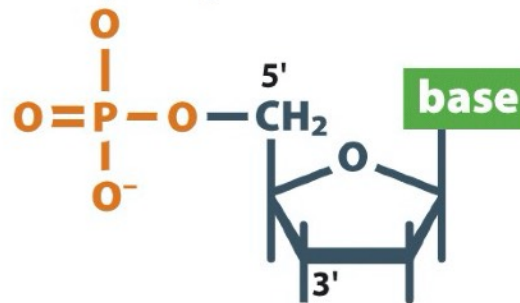


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5'-P terminus



a phosphodiester bond

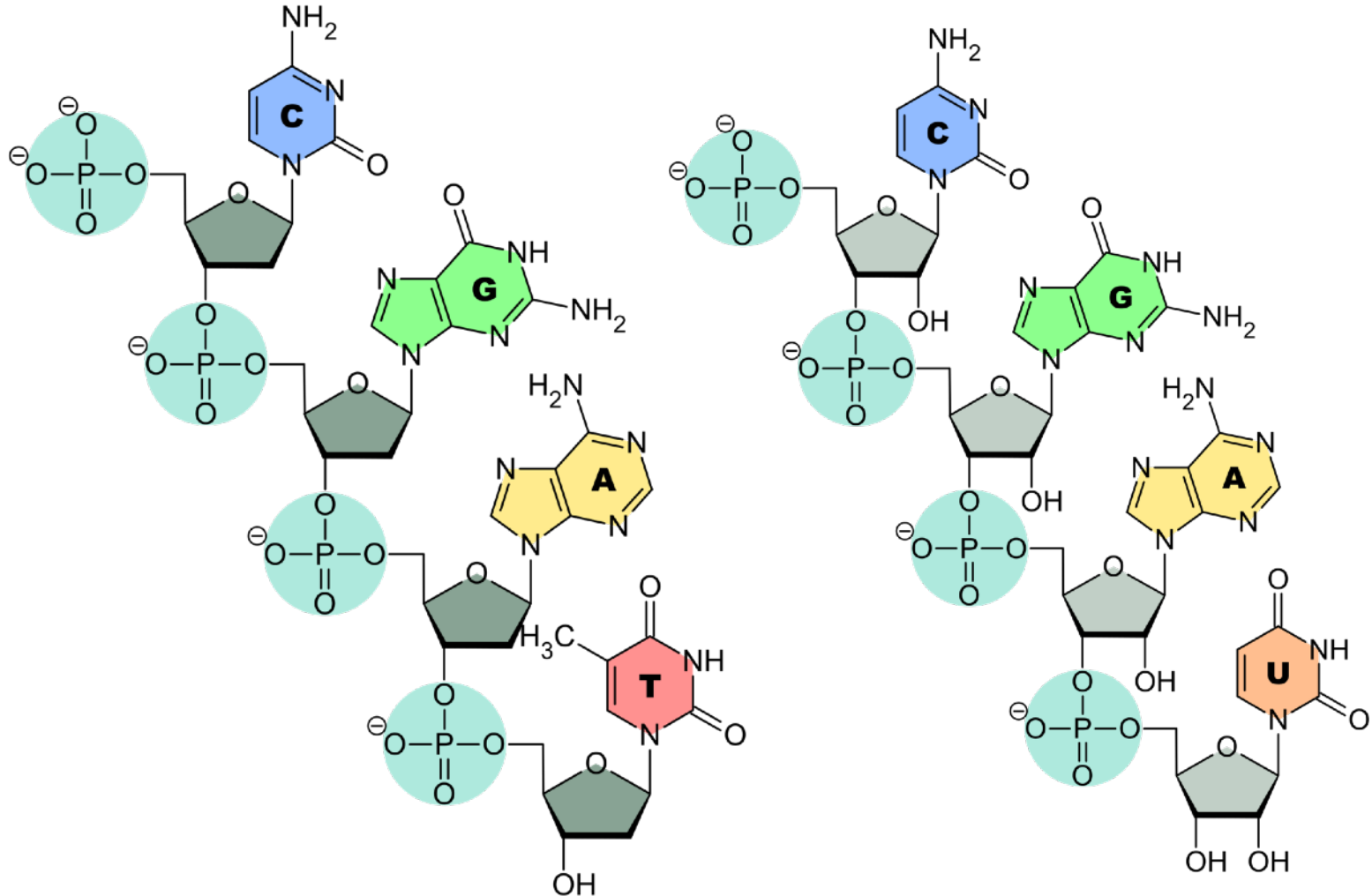


3'-OH terminus

Figure 2.5 Introduction to Genetics (© Garland Science 2012)

Nucleotide linking

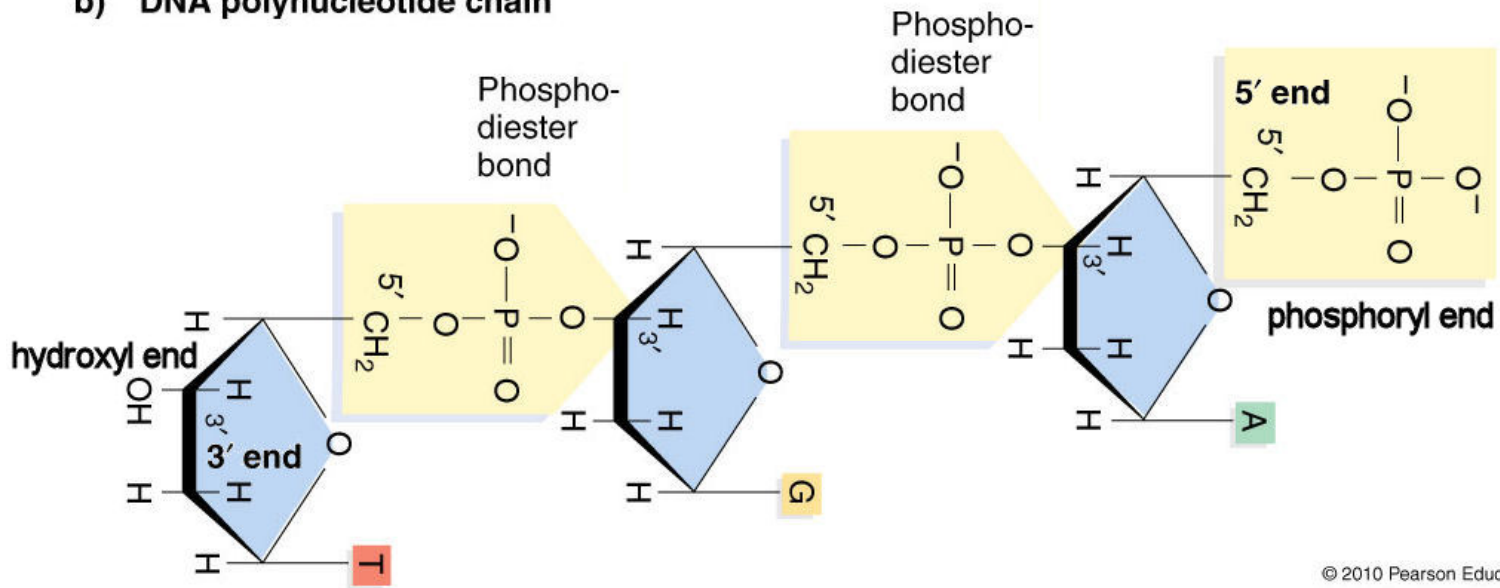
- The backbone of DNA/RNA is composed of sugar-phosphate-sugar-phosphate etc.



Polynucleotides

- Polynucleotides: (poly=many) a number of nucleotides linked together via phosphodiester bonds.

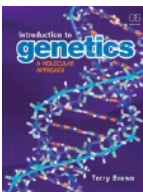
b) DNA polynucleotide chain



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Do you know the difference between monomers
and polymers?

Chapter2



monomers

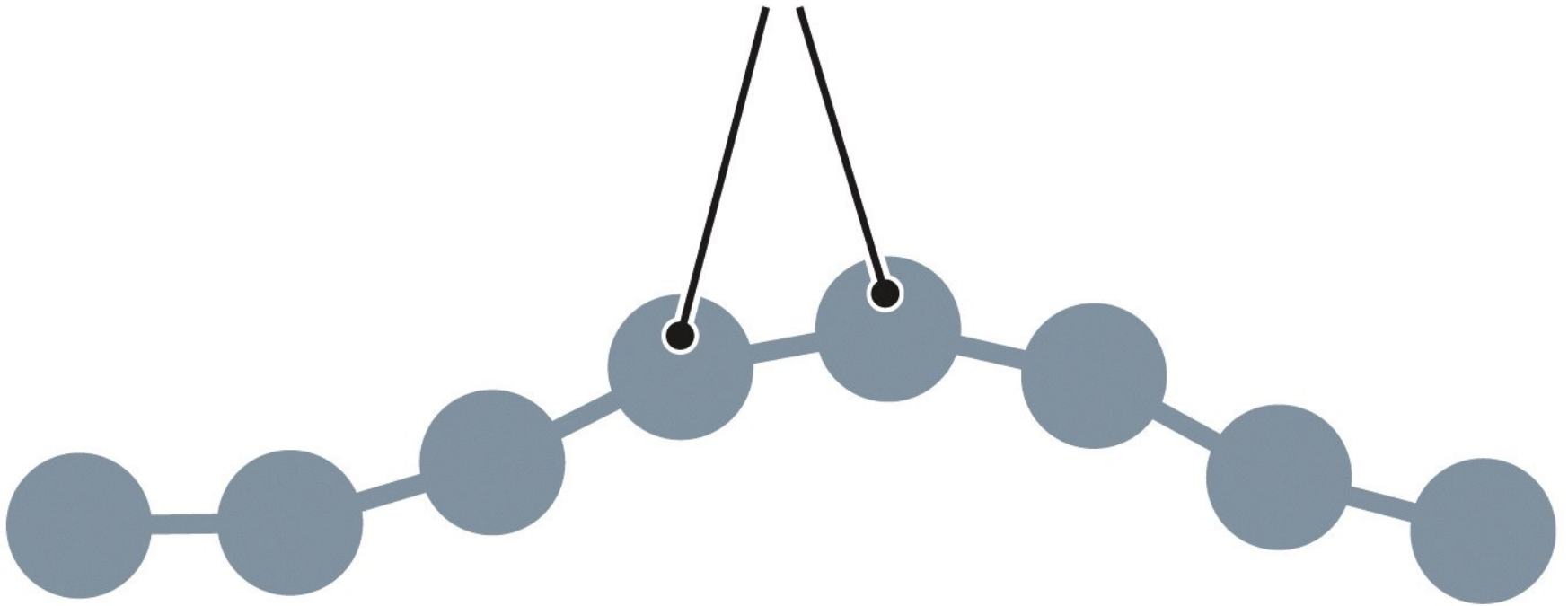
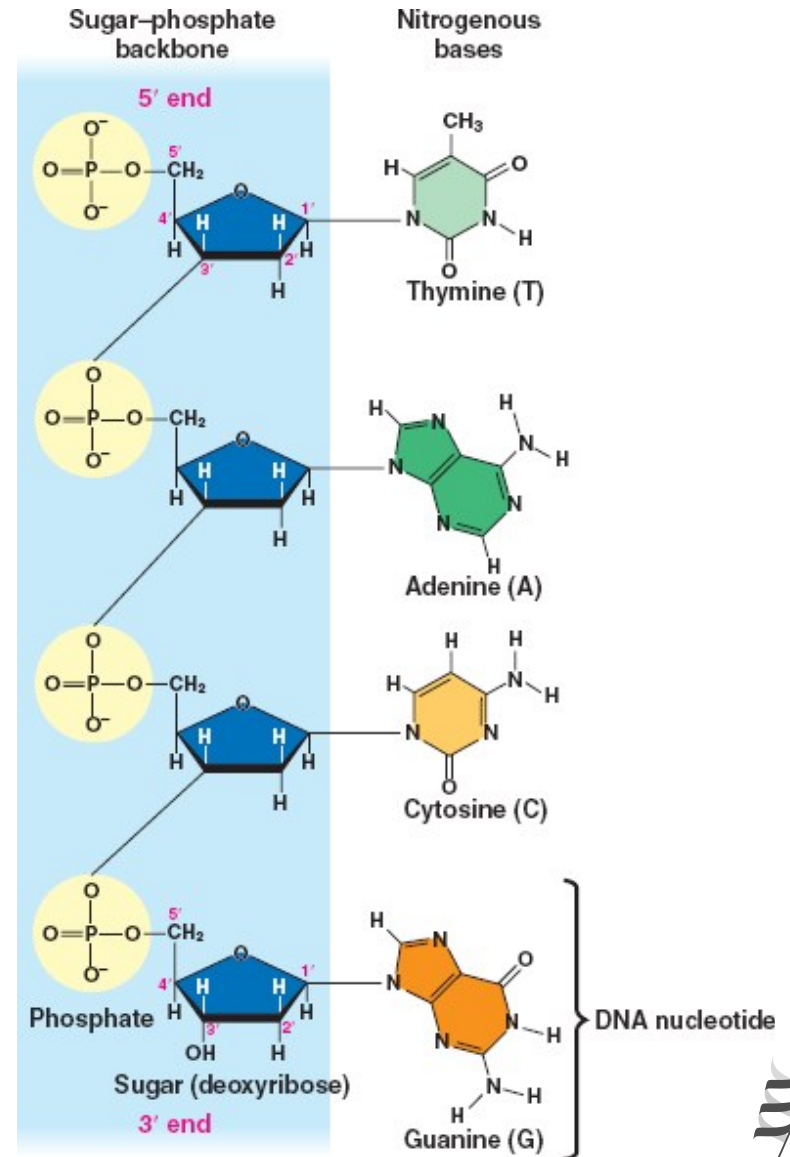


Figure 2.1 Introduction to Genetics (© Garland Science 2012)

Polynucleotides

- What is DNA polarity?
 - A number of polynucleotides have two **different** ends.
1. **5' end:** where the 5' carbon at one end of the molecule has a phosphate group.
 2. **3' end:** where the 3' carbon at the other end of the molecule has a hydroxyl group.



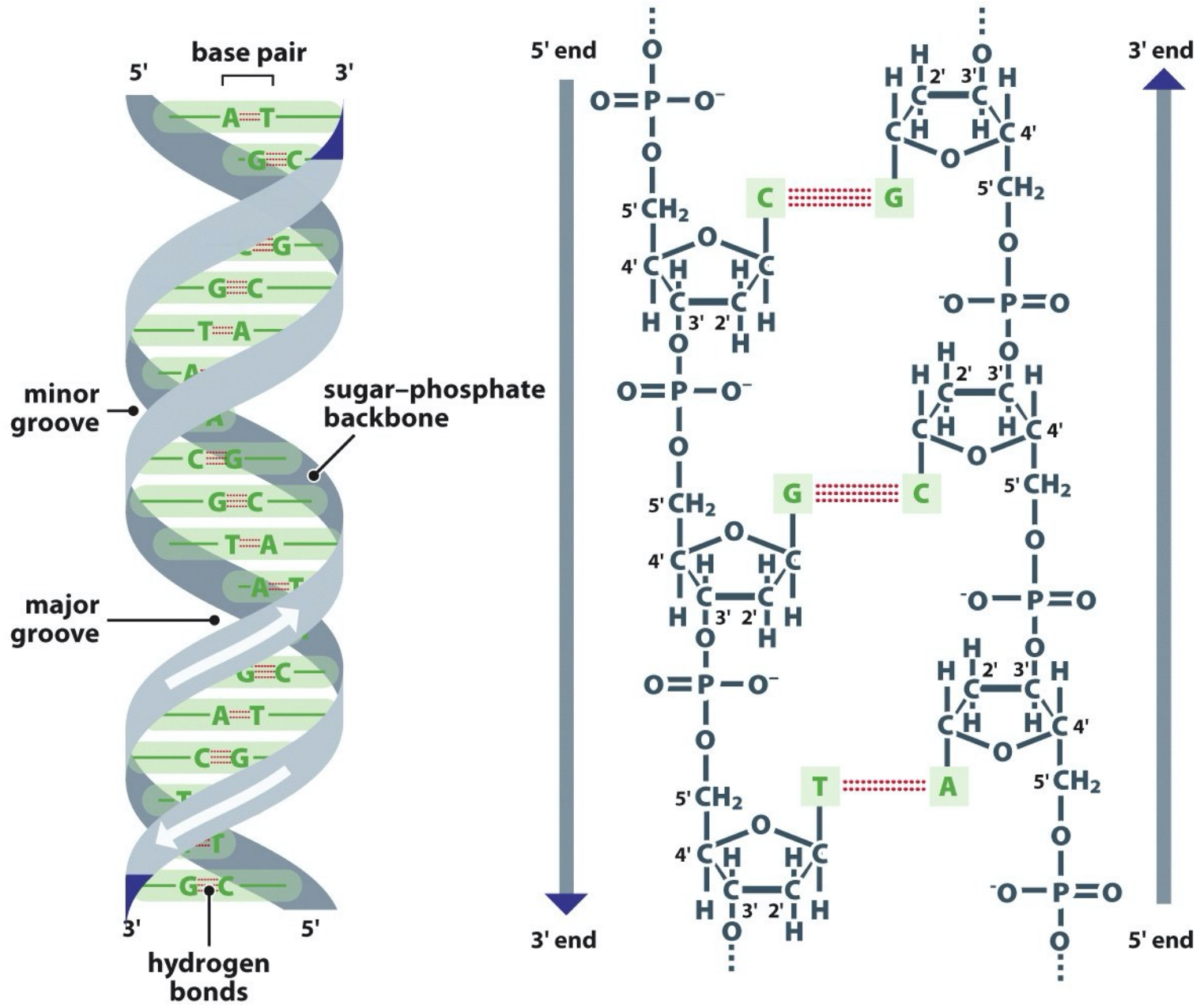


Figure 2.6 Introduction to Genetics (© Garland Science 2012)

To study

Thymine Purine **A**

Nucleotide DNA backbone Polynucleotide

Hydrogen bond 5' carbon Adenine pentose

ribose Phosphodiester bond Nucleoside

DNA Uracil **T** 2' carbon

ribose 3' carbon deoxyribose polymer

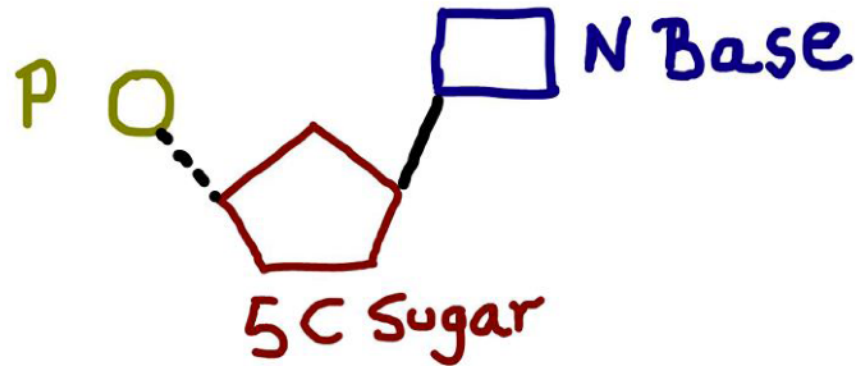
Guanine monomer **U** Cytosine RNA

2-deoxyribose RNA backbone Pyrimidine

Expectations

- You know the chemical composition of DNA and RNA.
- You know the two chemical differences between DNA and RNA.
- You know the names and terminology of the chemical units of DNA and RNA.
- You know the chemical differences between DNA and RNA.

For a smile



NUCLEO -

SIDE = SUGAR + BASE

TIDE = SIDE + PHOSPHATE