MONDAY 11/26

PROBLEM OF THE DAY

How do humans look so similar – 2 arms, 2 legs – to each other while also having clear differences – brown hair, red hair?

EXTRA CREDIT POSTERS

- Make sure that your name is on your poster AND the packet
- Turn your poster in to the pile
  - Place your poster down first
  - Set your packet down on your poster

Unit 4 Makeup Tests

- For the Unit 4 Vocabulary Test, Practical Test, or Unit Exam
  - If you
    - Missed the original test date
      - Your score will not be capped
    - Scored LESS THAN 75%
      - Your score will be capped at 80% (your grade will not be higher than 80%)
- Come to the class right after school ends on
  - **Monday December 3rd**

Unit 4 Makeup Tests

- The slides for Unit 4 are posted on the website
- Answer the study guide questions on the handout you got on the first day of the unit
- Review the vocabulary for the unit
- Ask Ms. Van or Mr. Williamson questions about what you don't understand or want some clarification on

- Come to the class right after school ends on
  - **Monday December 3rd**

Taxonomy Pages 1-3

- Taxonomy quiz for page 3 (and review for pages 1 & 2) is on Wednesday 11/28

TRANSCRIPTION

&

TRANSLATION

aka…

DNA & Protein Synthesis

The Road So Far…

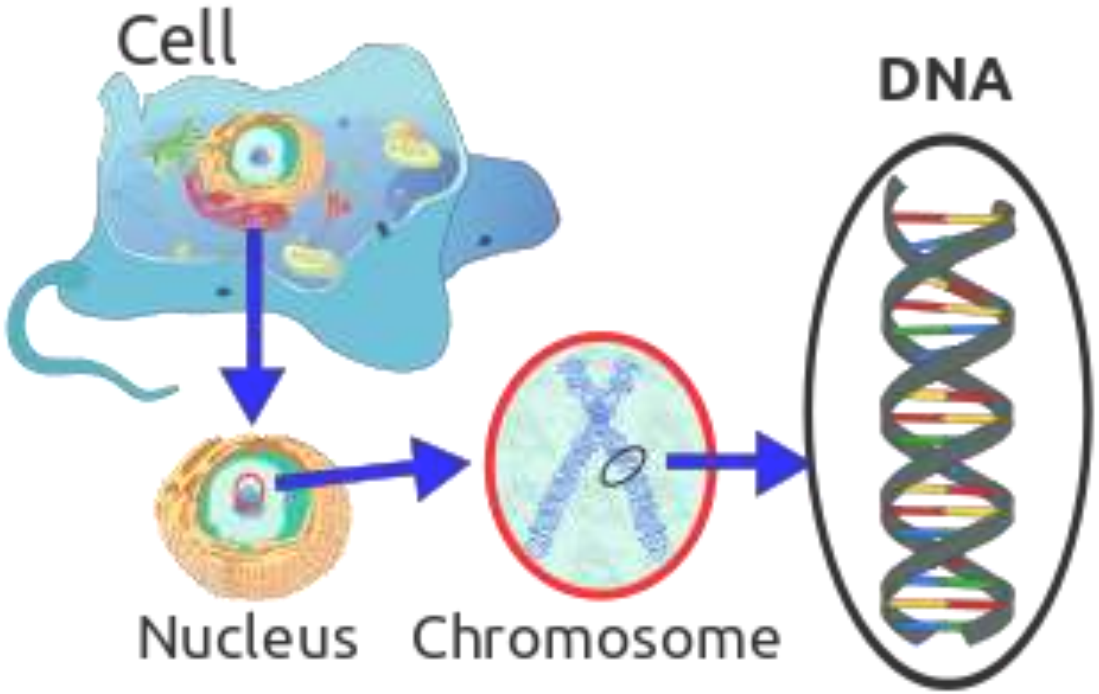
- We have covered many things in this first semester so far…
  - Photosynthesis
  - Respiration
  - Cells and Organelles
  - Biomolecules – lipids, proteins, etc.
  - Homeostasis and Cellular Transport

But how do cells 'know' how to do all of these things?

- How do cells
  - Make the chlorophyll they need for photosynthesis?
  - Make the proteins that create the electron gradient needed to produce 34 ATP during cellular respiration?
  - Make sure there is enough endoplasmic reticulum to function?
  - Make sure there are enough lipids to maintain the plasma membrane?
  - Know what homoestasis is and what is normal or healthy?

Instructions!

- Every cell has a set of instructions that includes *everything* that all of the cells of that organism needs to be successful
  - We call these instructions DNA



DNA as Instructions for Life

- For humans, it gives our cells instructions on what they need to do
  - They define the same basic body plan that all humans have
    - 10 fingers, 10 toes, 2 ears, 2 eyeballs, 2 arms, 2 legs, 1 head, etc.
      - Though there are differences within that basic body plan

What do the instructions look like?

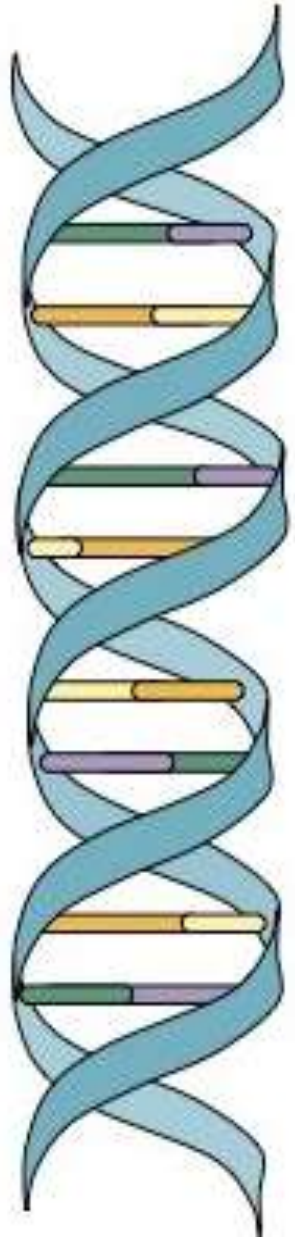
How do our cells "read" those instructions"?

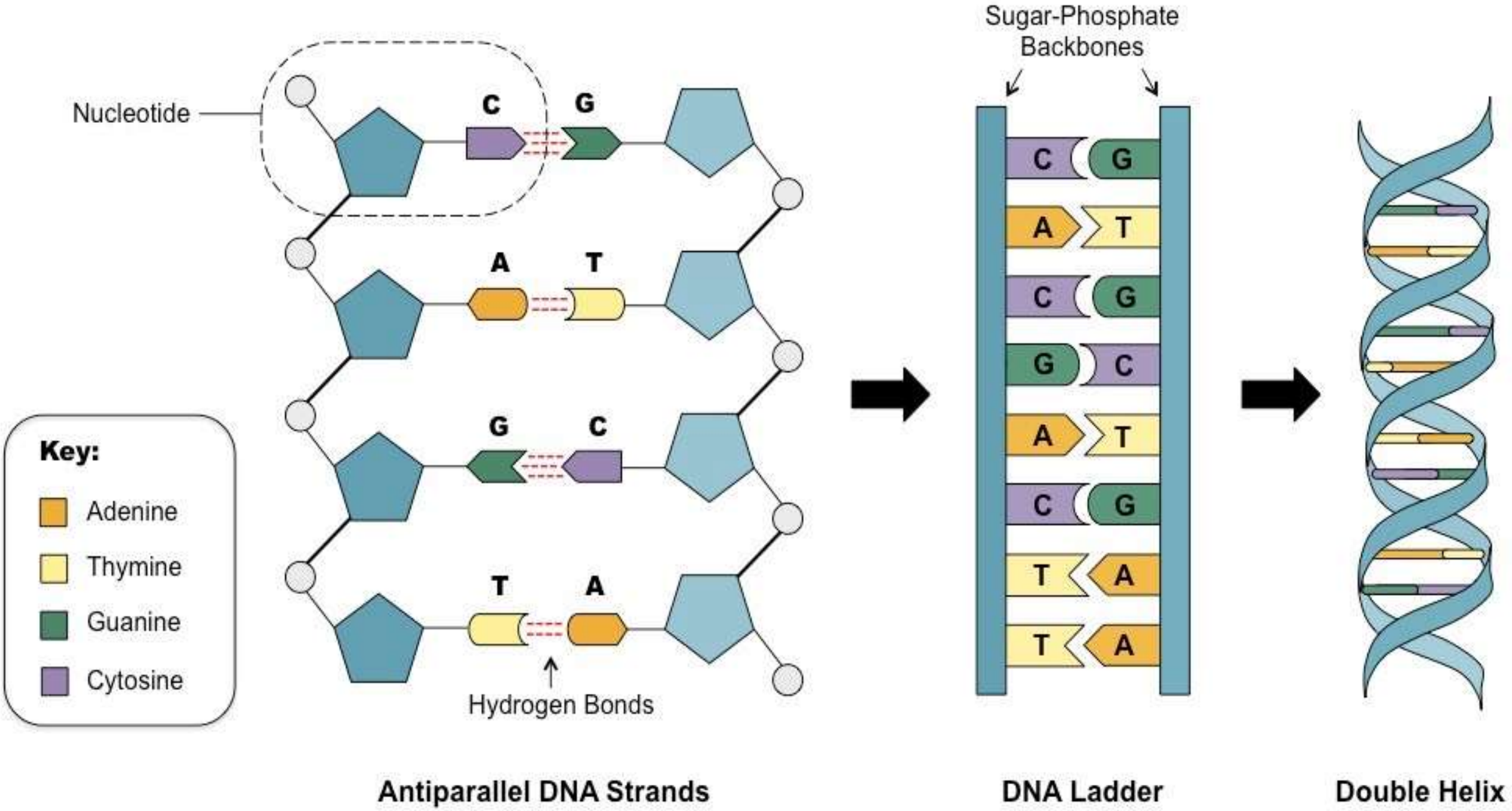
How do our cells follow those instructions?

What happens when something happens and the instructions are misread or are wrong?

DNA

- Deoxyribonucleic acid
  - Structure is like a twisted ladder
    - Backbone
      - Phosphate
      - Sugar – deoxyribose
    - Rungs / Steps
      - Nitrogenous bases
        - Adenine *(where have we seen this one before?)*
        - Cytosine
        - Guanine
        - Thymine




Nucleotide
C
G
A
T
G
C
T
A
Hydrogen Bonds
Key:
Adenine
Thymine
Guanine
Cytosine
Antiparallel DNA Strands
Sugar-Phosphate Backbones
C G
A T
C G
G C
A T
C G
T A
T A
DNA Ladder
Double Helix

Historical Models for DNA

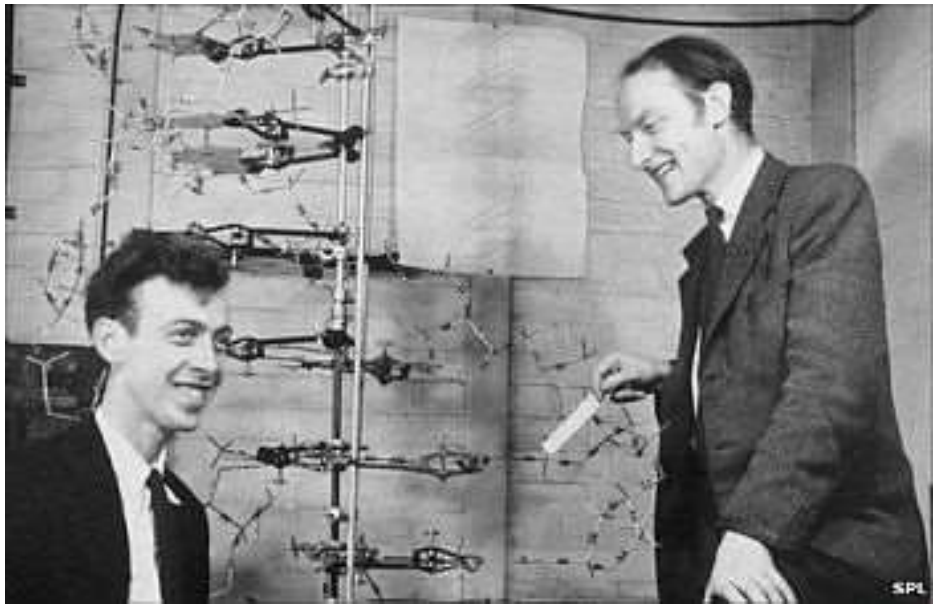
- Scientists have long been aware of a molecule that controlled what a cell was, how it behaved, and how it interacted with other cells around it
  - Many believed it to be a protein
    - In the 1870s, scientists discovered that this molecule resided in the nuclei of cells
    - In the 1880s, scientists were able to identify a non-protein component as well as the bases that make the steps of the ladder

Historical Models for DNA

- In the early 1900s, scientists were able to identify that DNA had
  - A base (one of the 4 discovered earlier)
  - A sugar
  - A phosphate
- In the 1930s, scientists hypothesized that the instructions – inherited traits – were made up of two mirror strands that could serve as templates for their own replication
- But nobody could determine a specific structure that would allow for all of these things

Discovery of the Double Helix

- There is actually quite a bit of controversy over who really discovered the structure of DNA

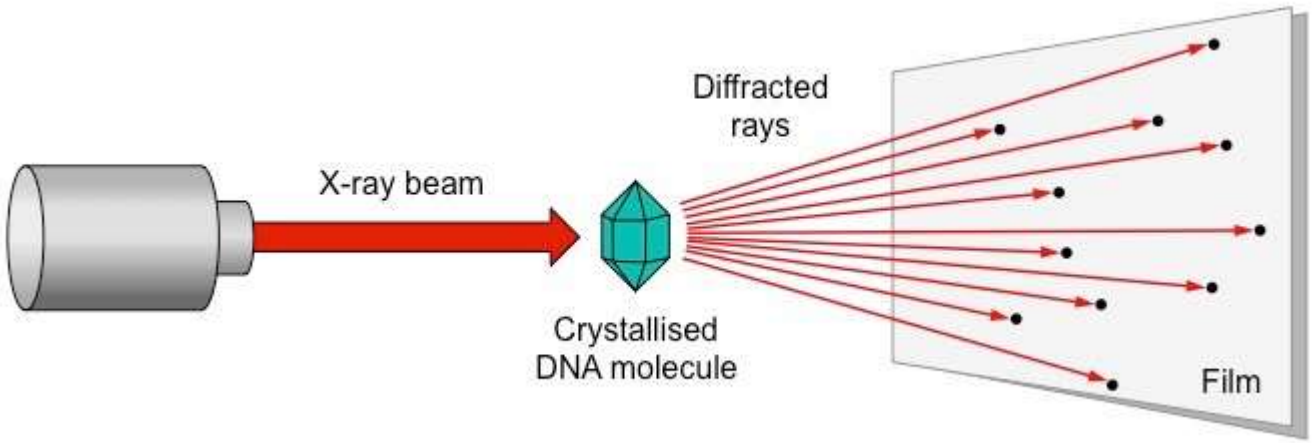


Discovery of the Double Helix

- In 1962, Francis Crick, James Watson, and Maurice Wilkins jointly received the Nobel Prize in Physiology or Medicine for the double-helix molecule model of DNA

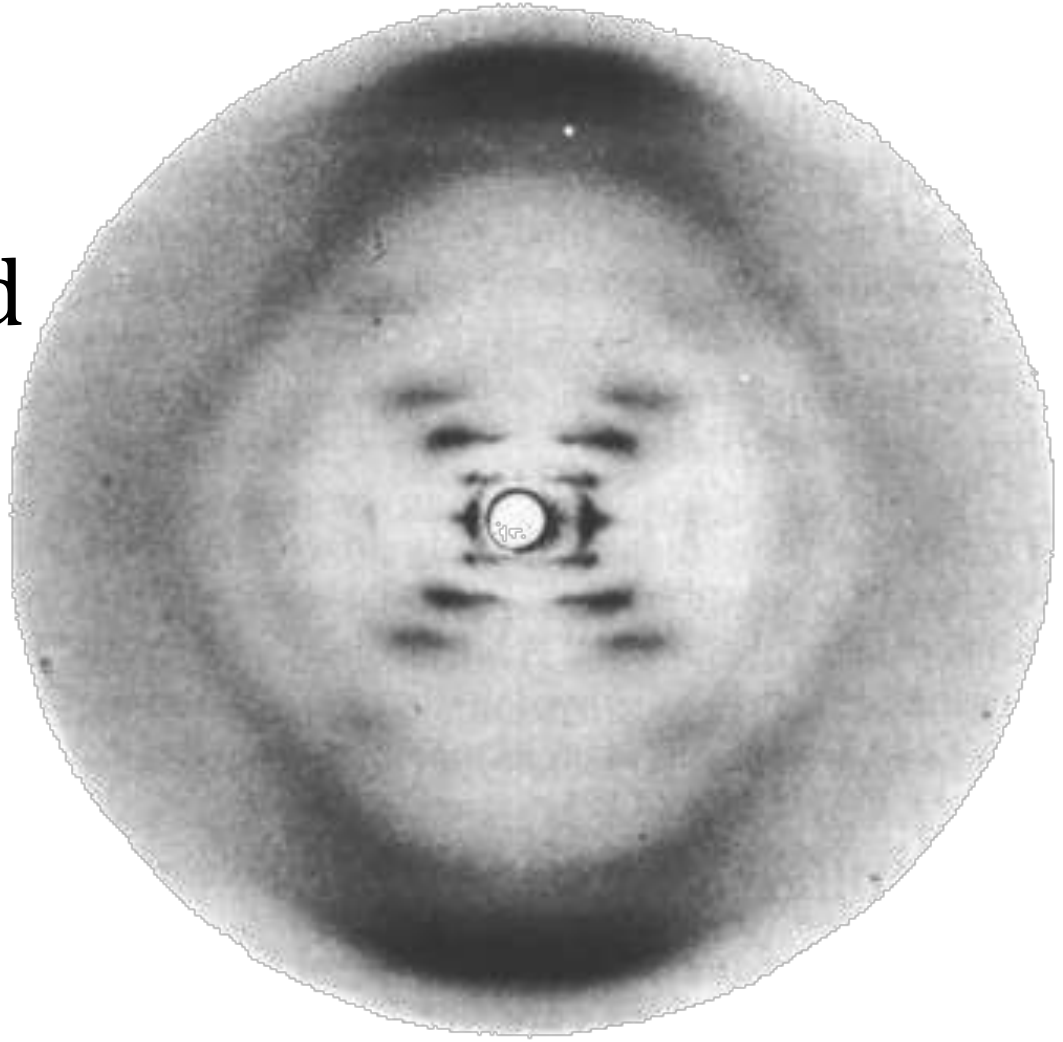
Discovery of the Double Helix

- The work Watson and Crick were able to complete was dependent upon the work of Rosalind Franklin
  - She was the first person to successfully make an image of the structure of DNA using a method called X-Ray Crystallography



Discovery of the Double Helix

- The work of Franklin and her partner Raymond Gosling was not recognized and Franklin died before her contribution was recognized
  - Nobel prizes are not given posthumously



Watson & Crick

- Watson & Crick had Franklin's X-ray crystallography image to aid them as well as previous knowledge that they needed to consider

Watson & Crick's DNA Model

- It was large, long, and thin
- It had 3 parts
  - Sugar (ribose)
  - Phosphate
  - Nitrogenous bases
- It had repeating units arranged in a helix
- The structure of DNA needed to follow 4 criteria

The Four Criteria

- In order for it to serve as the instructions for all life forms to follow, they also knew it had to meet four other criteria

1) The molecule must be able to store A LOT of information
2) The molecule must be able to copy itself with great precision
3) The molecule must be able to make mistakes when being copied
4) The molecule must be readable by cells

Unit 4 Test Review

- You have the rest of the class to review the Unit 4 Test
  - You may not leave the room with the tests

To retake the test, you must…

- Pick 5 questions that you got wrong – do not pick True and False questions or Question 1
  - Write out the questions and **all** of the possible answers; clearly mark the correct answer
    - Explain why the correct answer is correct
    - Explain why the incorrect answers are wrong
- You will turn it in with your exam when you make it up

1. Chemical bonds are forms of

(A) Kinetic energy – This is wrong because it is the kind of energy something has because it is moving

(B) Radiant energy – This is wrong because it is the kind of energy from the sun and electromagnetic waves

(C) Potential energy – This is correct because potential energy is the energy something has due to its position relative to another object; two atoms bonded together have potential energy relative to one another

(D) Mechanical energy – This is wrong because it represents the amount of kinetic and potential energy that something has to do work

(E) None of the above – This is wrong because (C) is correct

TUESDAY 11/28

Reminders

- Taxonomy Quiz #3 on Wednesday November 28th
  - On Page 3 with info from pages 1 and 2

Reminders

- If you got 75% or less on any Unit 4 test (Vocabulary, Practical, Exam) – makeup on Monday December 3rd

  - Required: Check with your teacher about the assignment that you need to do in order to be able to make up the test
    - Ms. Van – 5 questions with answer explanations
    - Mr. Williamson – Answer all study guide questions

Reminders

- Next week
  - Tuesday December 3rd – Unit 5 Exam
  - Wednesday December 4th – Prefix/Suffix Quiz #6
  - Thursday December 5th – Unit 5 Practical Test

Criteria 1

The molecule must be able to store A LOT of information

- Every cell has to have all of the information to make the complete organism
  - It needs the information for every type of cell in that organism
  - It needs the information for every protein in every type of cell

Criteria 1

- The human genome is five billion base pairs long
  - This is enough information to fill out 1000 books that are 600 pages long with 500 words per page
    - That is over 300,000,000 words!

Criteria 2

The molecule must be able to copy itself with great precision

- Every one of your over three trillion cells has a copy of all of your DNA
  - You started out as one single fertilized cell, but somehow, all of that DNA was copied exactly

Criteria 3

The molecule must be able to make mistakes when being copied

- While the main instructions need to be copied exactly, there does have to be room for some mistakes
  - Without those mistakes, there would be no evolution
    - The mechanism –how it works – of evolution is changes of DNA in cells
      - No change of DNA, no evolution!

Criteria 4

The molecule must be readable by cells

- Cells have to be able to access the instructions and information in the DNA
  - This would be like buying a car and getting all of the expensive packages available so that it was exactly what you wanted
    - And then never taking it out of the garage

Watson & Crick's DNA Model

- It was large, long, and thin
- It had 3 parts
  - Sugar (ribose)
  - Phosphate
  - Nitrogenous bases
- It had repeating units arranged in a helix

Watson & Crick's DNA Model

- Perhaps most important of that information relates to the size of the nitrogenous bases

What do you notice about the sizes?

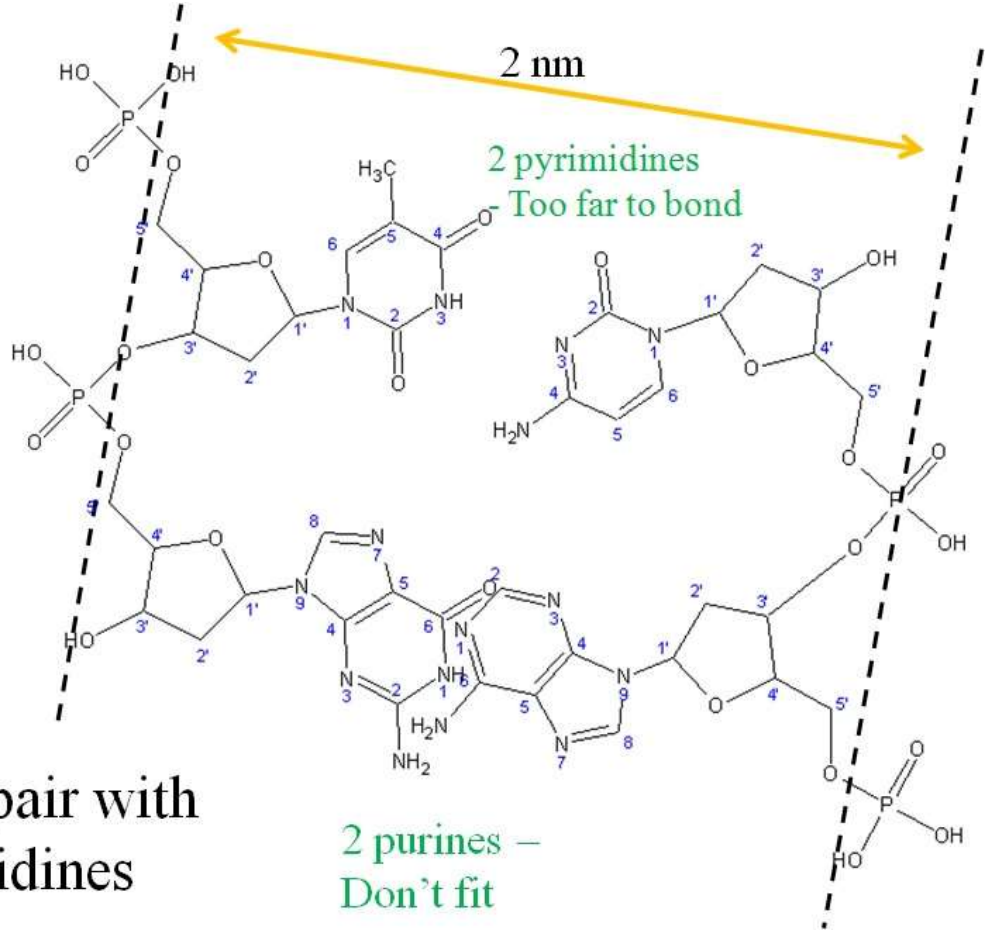
	Purines		Pyrimidines	
	Adenine	***Guanine***	***Cytosine***	***Thymine***
Human	30.4	19.6	19.9	30.1
Ox	29	21.2	21.2	28.7
Salmon	29.7	20.8	20.8	29.1
Wheat	28.1	21.8	21.8	27.4
E. Coli	26	24.9	24.9	23.9
Sheep	29.3	20.7	20.7	29.2

Don’t copy this down – it is in the Unit 5 handout you got yesterday

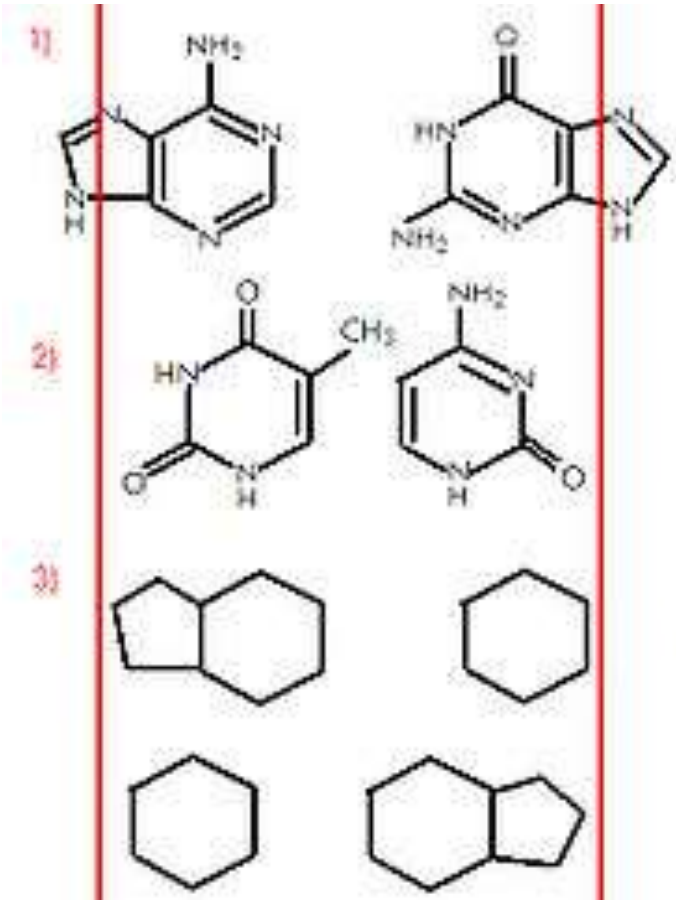
Nitrogenous Bases

- Watson & Crick also knew that DNA was 2 nm (nanometers) in diameter
  - Based on the sizes of the bases on the last size
    - If 2 purines were paired together, that would be much bigger than 2 nm
    - If 2 pyrimidines were paired together, that would be smaller than 2 nm

Nitrogenous Bases



Purines pair with pyrimidines



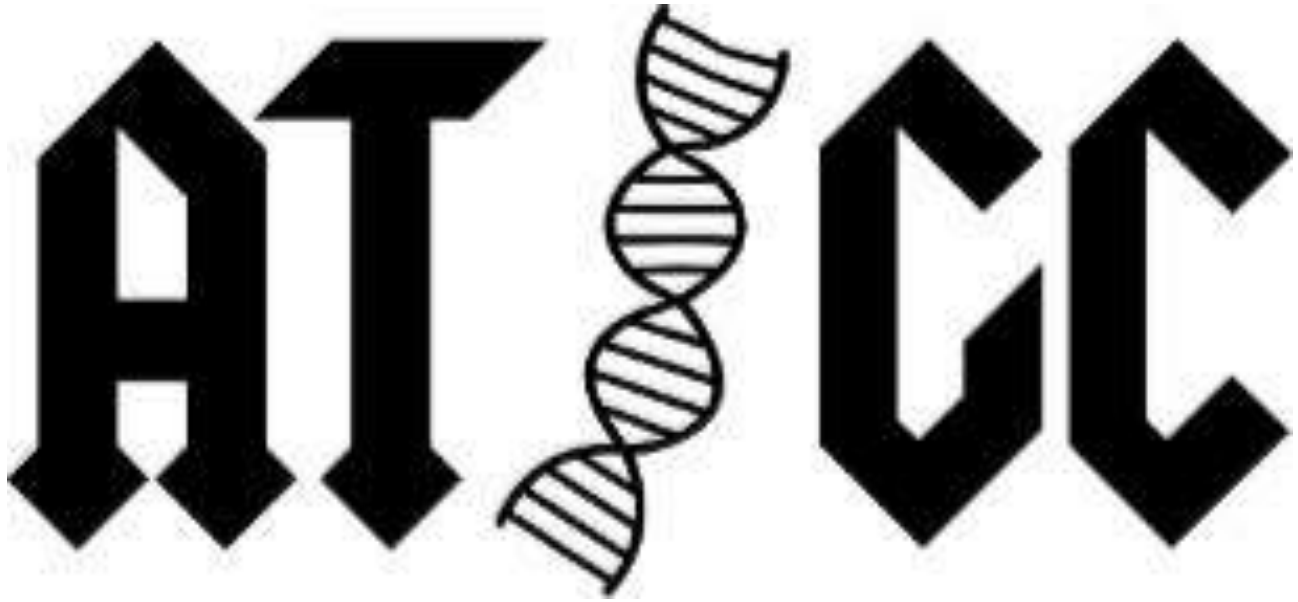
Pairing between two purines would result in a LARGER double helix width than was found in Watson and Crick's data.

Pairing between two pyrimidines would result in a SMALLER double helix width.

Pairing between a pyrimidine and a purine MATCHES the width Watson and Crick had in their data.

Nitrogenous Bases

- This means that
  - A purine will always be paired with a pyrimidine

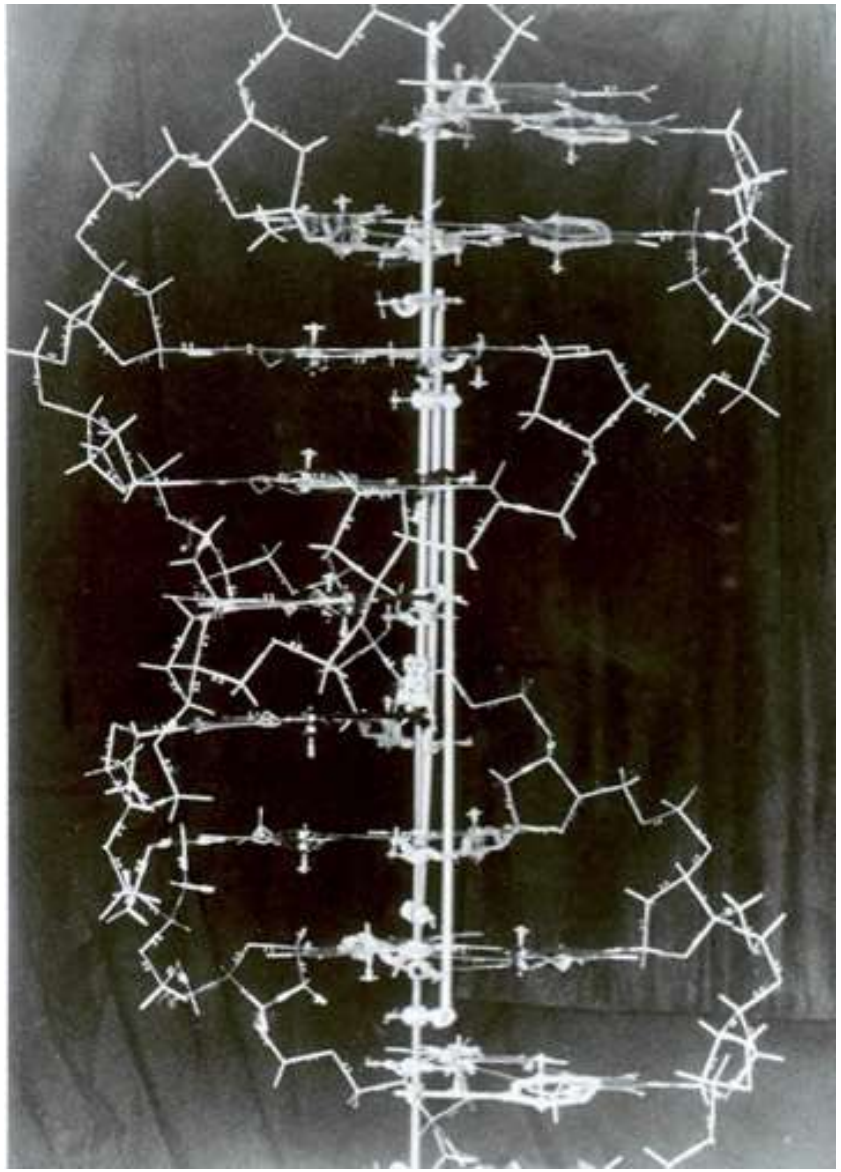


Nitrogenous Bases

- They also knew that the ratio of
  - Adenine to Thymine was 1:1
    - For every 1 adenine there was 1 thymine
  - Cytosine to Guanine was 1:1
    - For every 1 cytosine there was 1 guanine

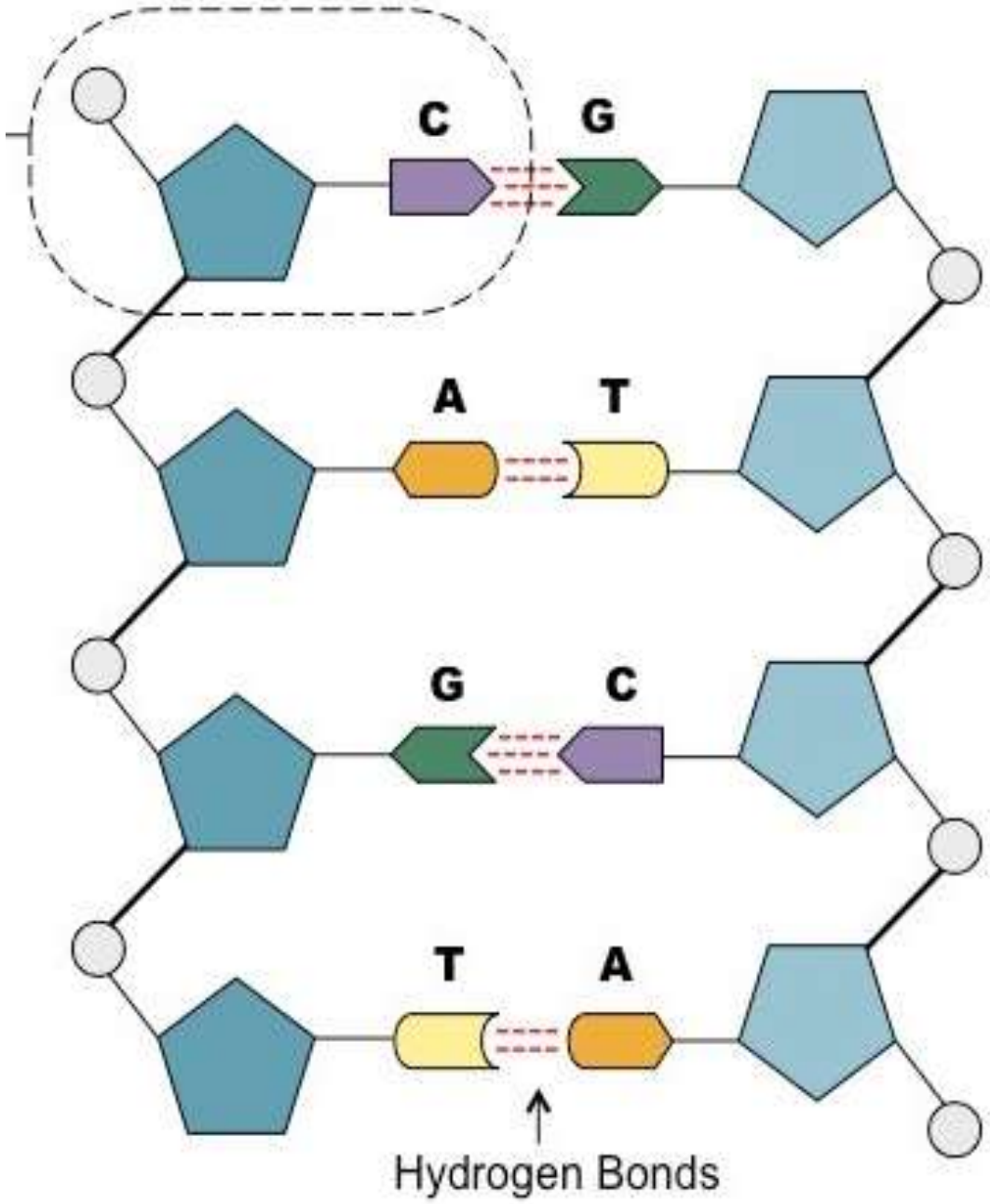
Double Helix Structure

- With all of those requirements, the only structure that worked, was that double helix
  - Twisted ladder



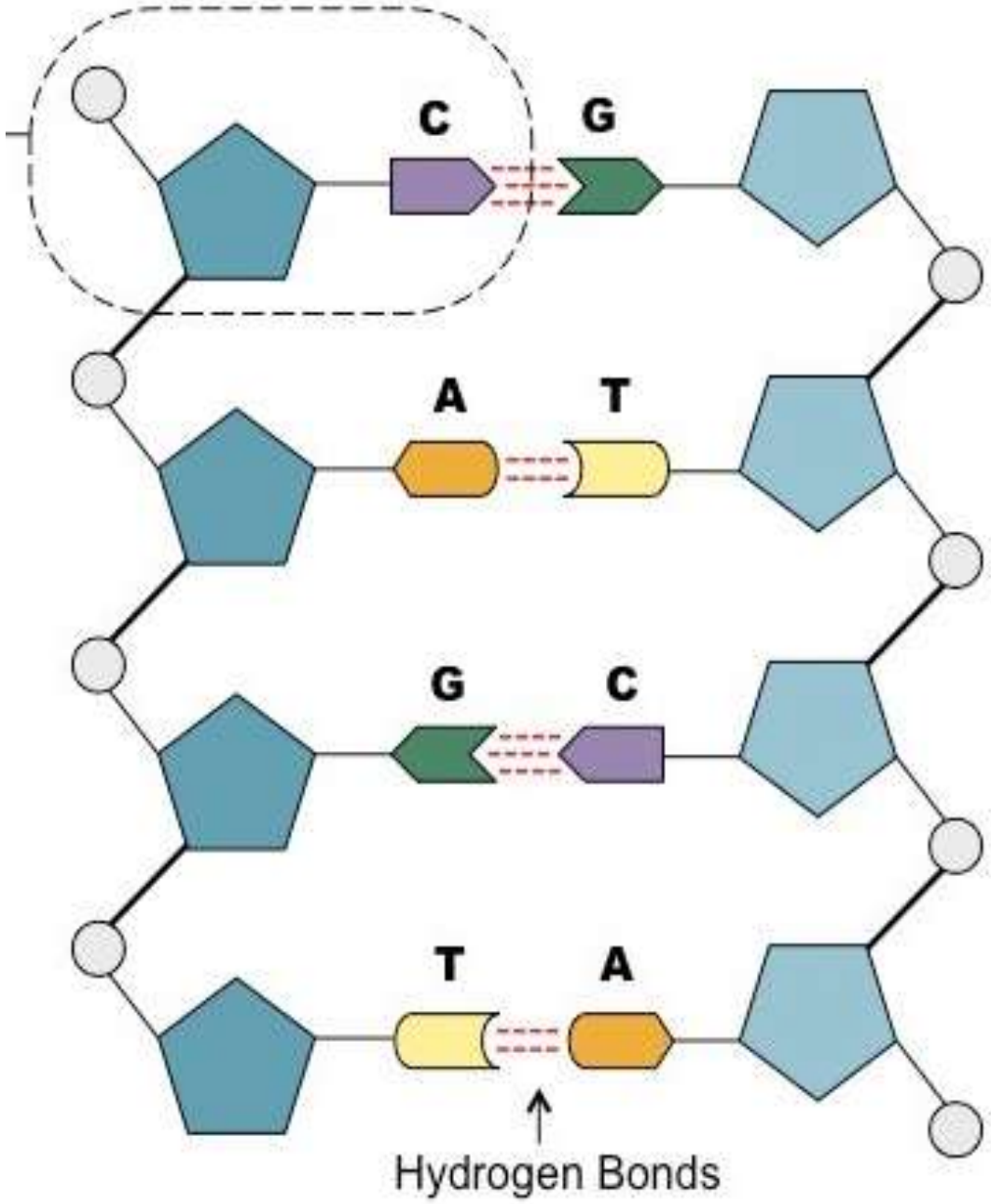
Double Helix

- Each molecule of DNA consists of a double strand of **alternating phosphate and ribose sugar** that make up the "backbone" of the molecule



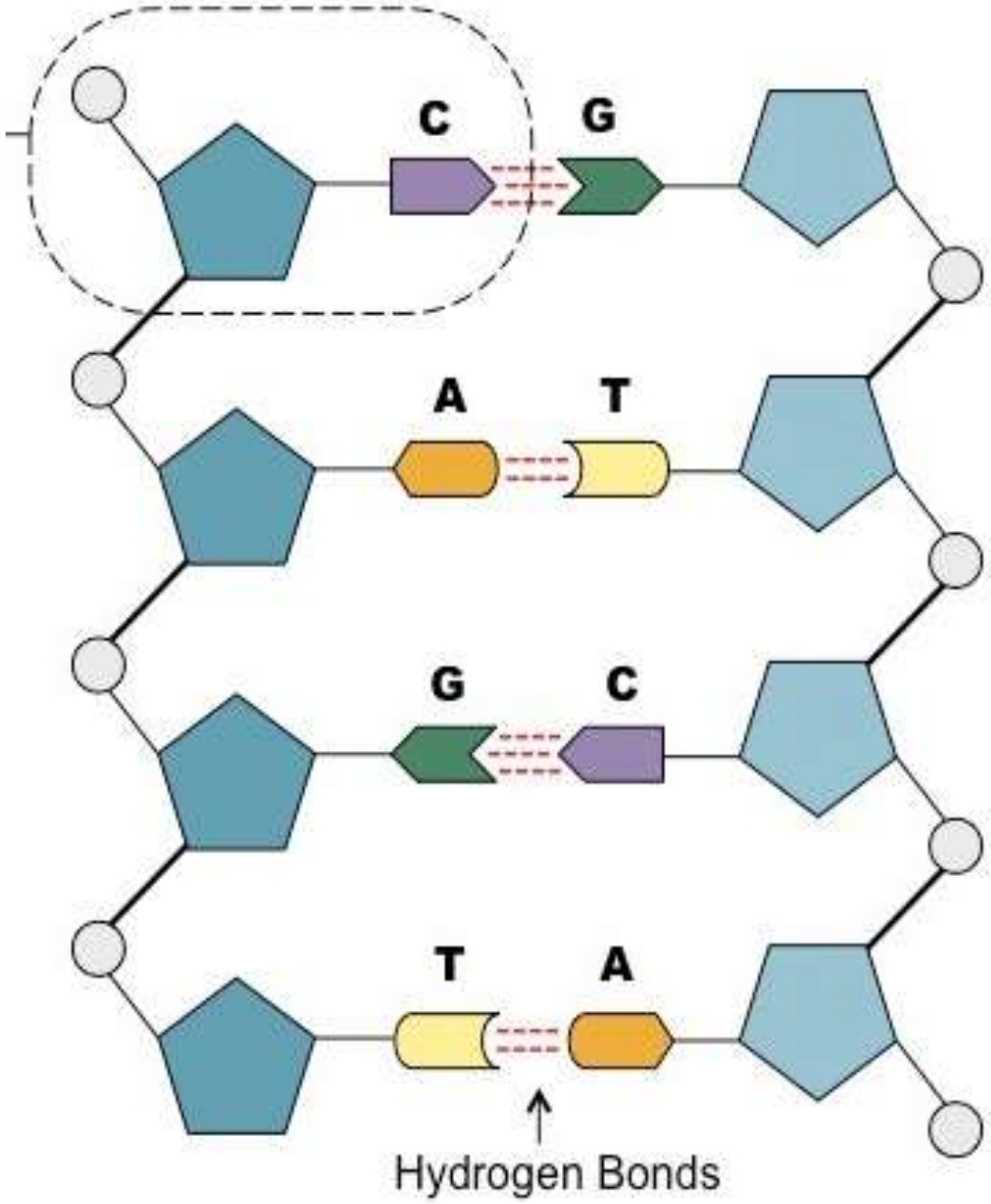
Double Helix

- The strands of one side of the DNA molecule run in opposite directions
  - This is called
    - Antiparallel
    - Complementary



Double Helix

- Between the strands/backbones are the nitrogenous bases
  - Adenine
  - Thymine
  - Cytosine
  - Guanine



Nitrogenous Bases

Purines

Double ring

- Adenine
- Guanine

Pyrimidines

Single ring

- Thymine
- Cytosine

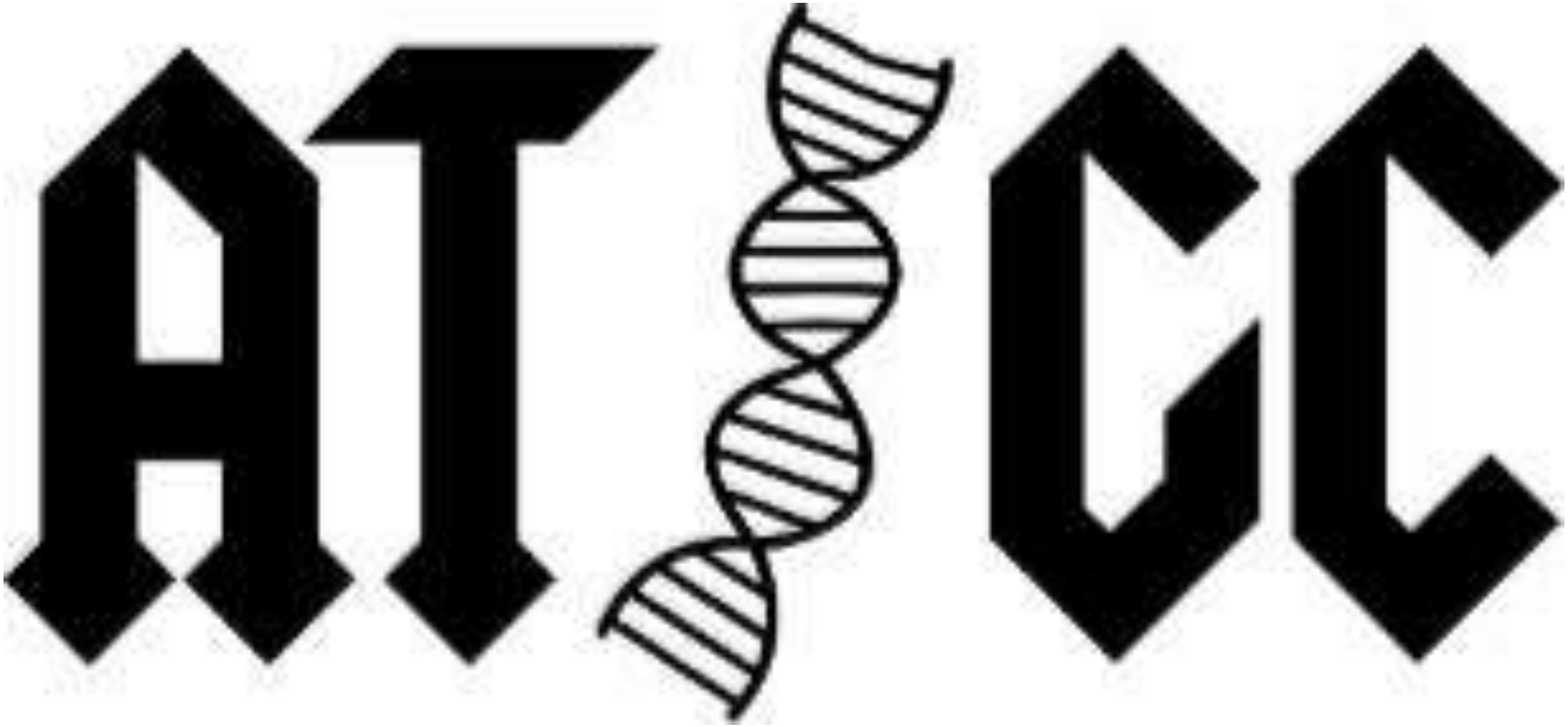
Mr. Stupid: Nitrogenous Bases

Straight lines w/ straight lines

- Adenine
- Thymine

Curved lines w/ curved lines

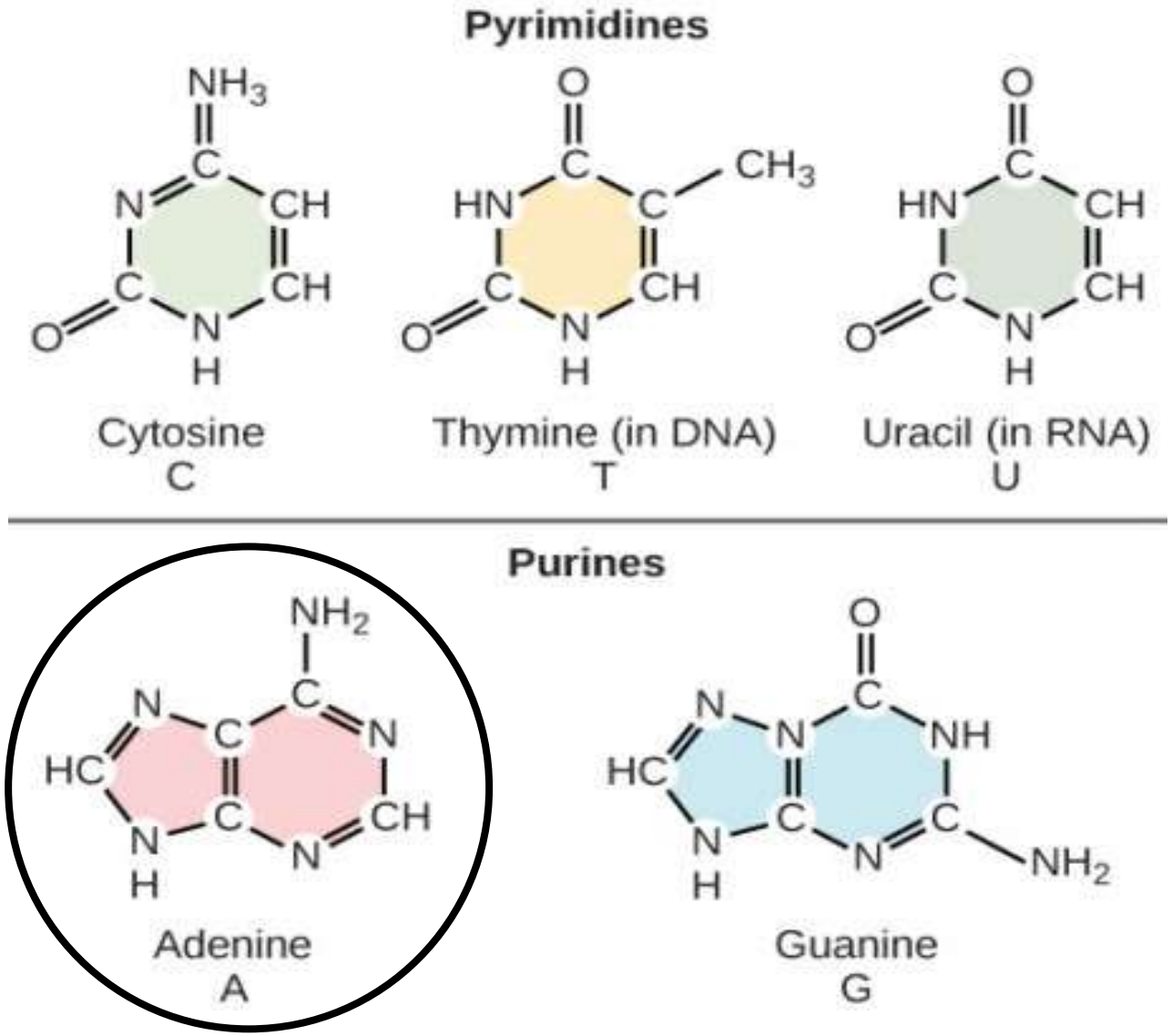
- Guanine
- Cytosine



Thunderstruck plays in the background

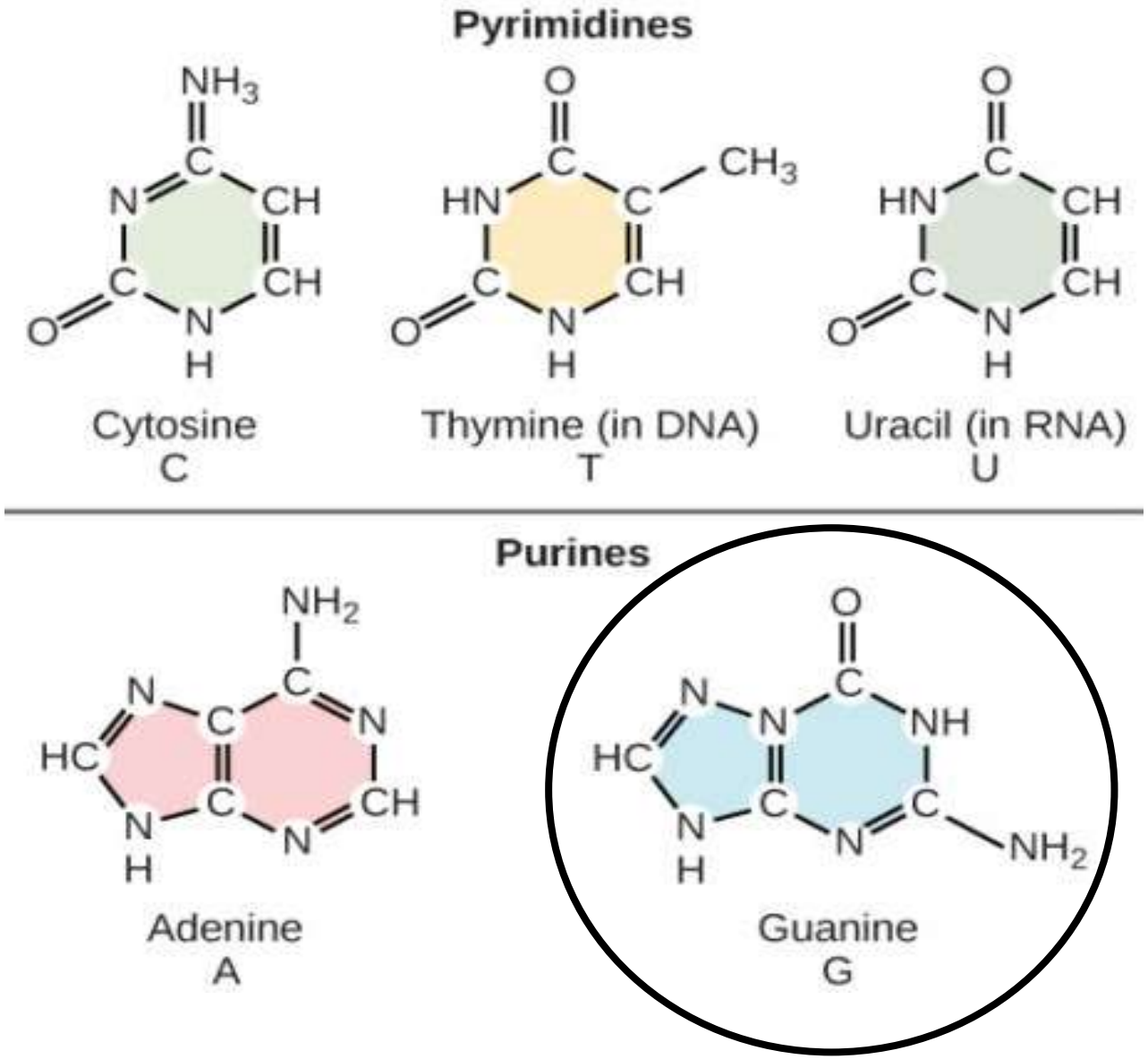
Adenine

- Purine
- Has a double ring
- Forms 2 hydrogen bonds with its base pair



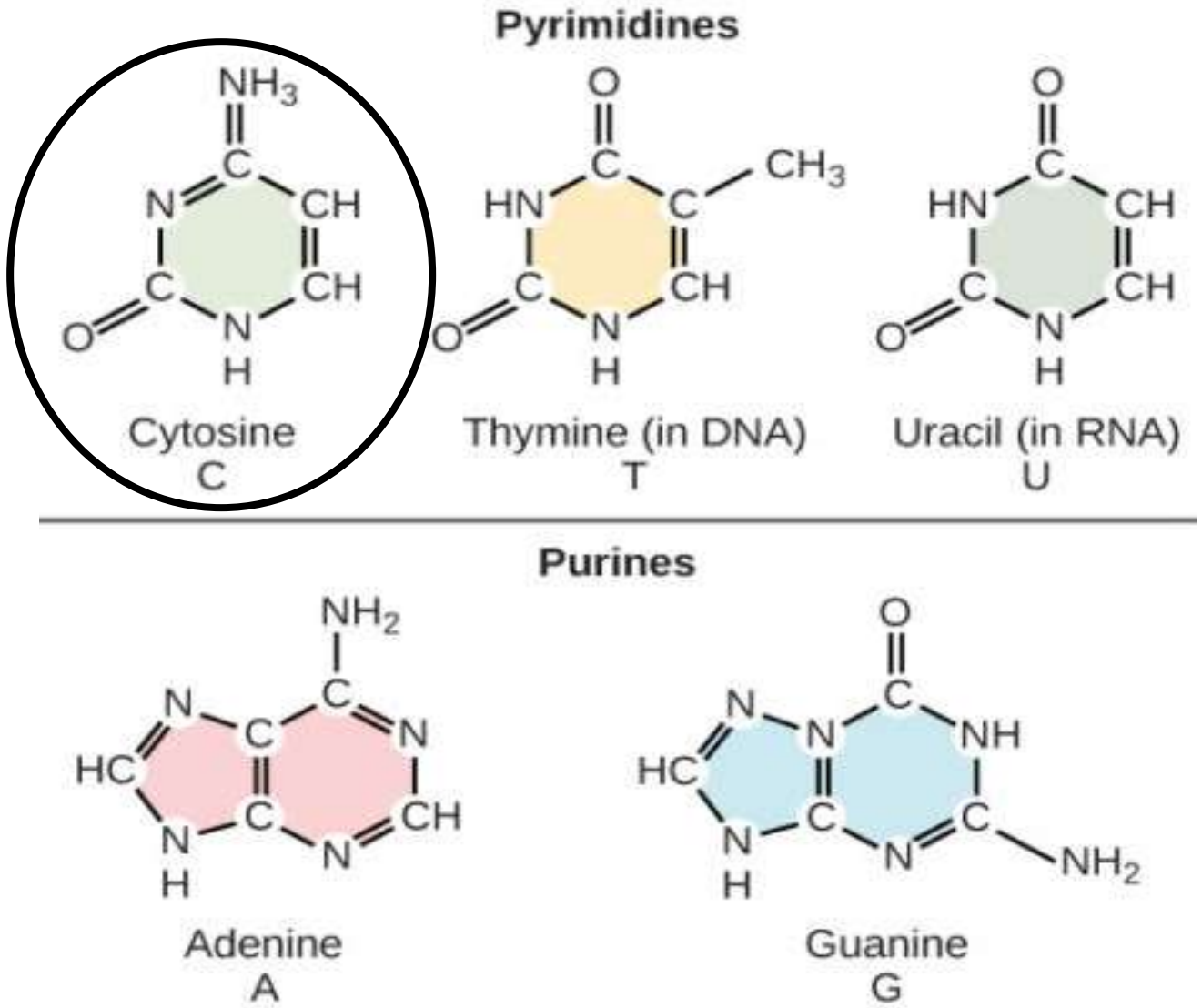
Guanine

- Purine
- Has a double ring
- Forms 3 hydrogen bonds with its base pair



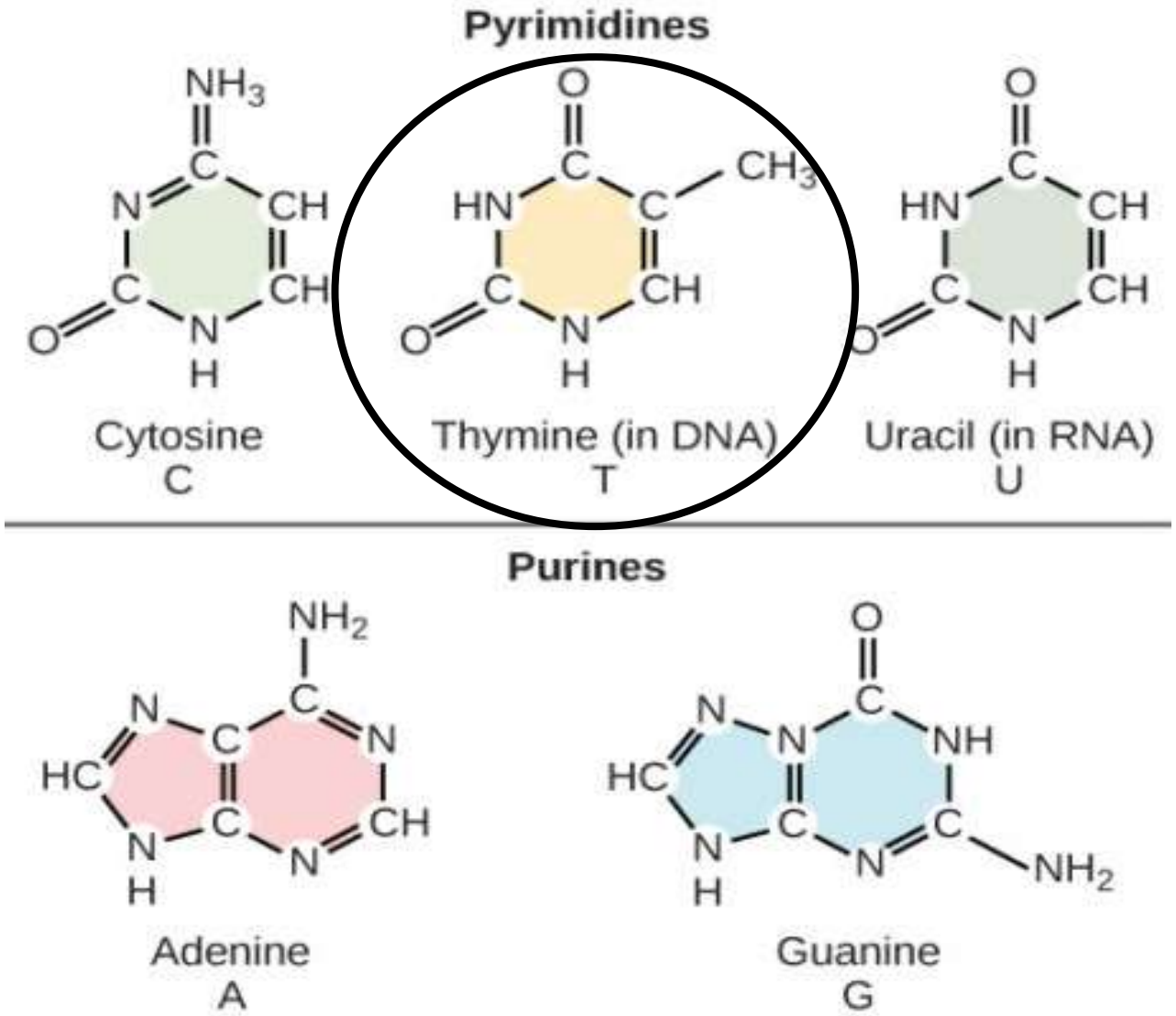
Cytosine

- Pyrimidine
- Has a single ring
- Forms 3 hydrogen bonds with its base pair



Thymine

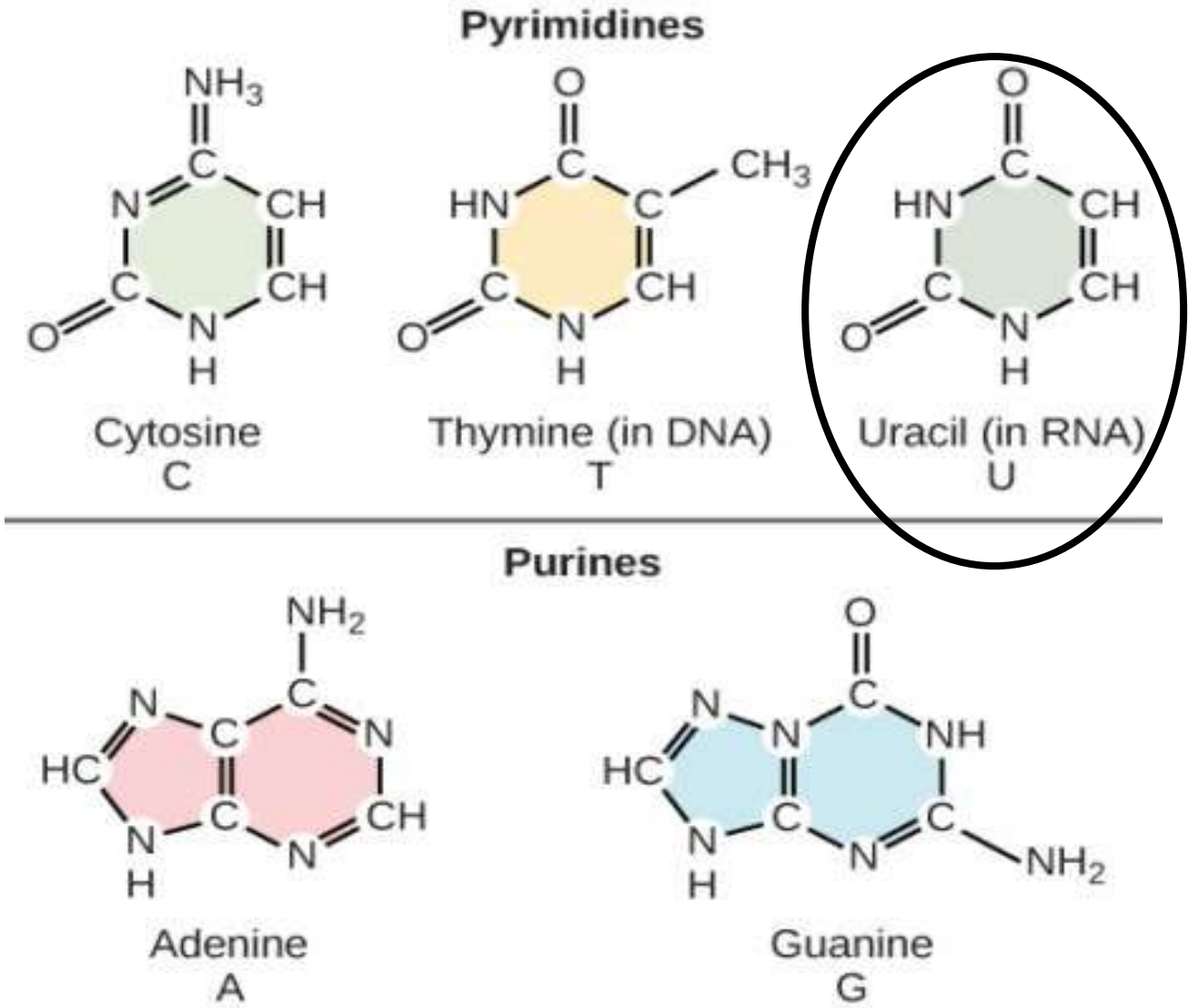
- Pyrimidine
- Has a single ring
- Forms 2 hydrogen bonds with its base pair
- Only in DNA



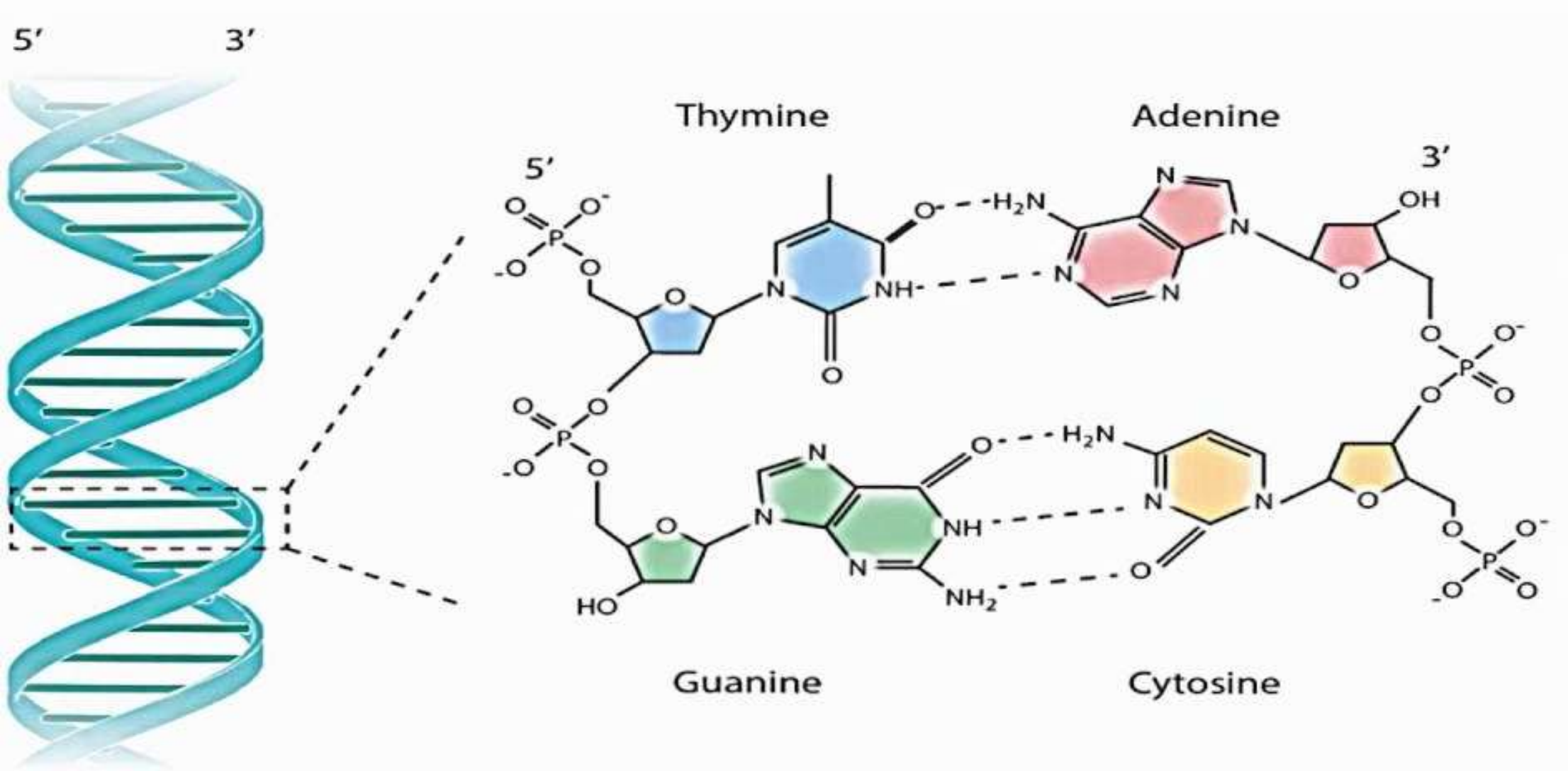
Uracil

- Pyrimidine
- Has a single ring
- Forms 2 hydrogen bonds with its base pair

- Only in RNA (takes place of thymine)



Nitrogenous Base Pairing



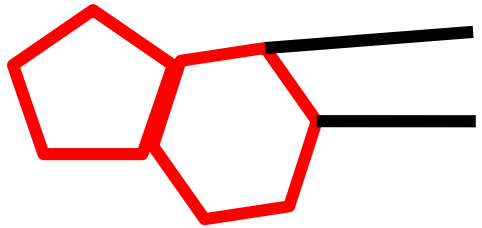
Mr. Williamson

A Pure Double Double

Mr. Williamson

A Pure Double Double

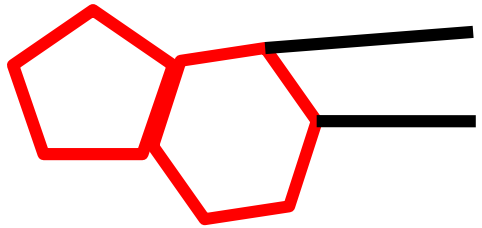
Adenine Purine Double Ring Double Bond



Mr. Williamson

A Pure Double Double

Adenine Purine Double Ring Double Bond

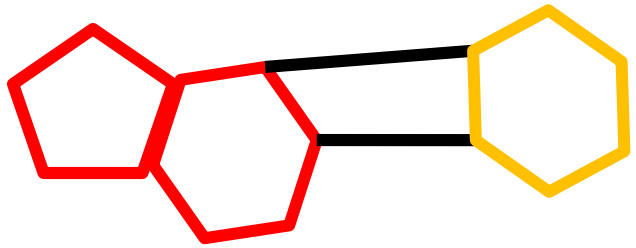


What does Adenine bond with?

Mr. Williamson

A Pure Double Double

Adenine Purine Double Ring Double Bond



How do you spell Thymine?

A purine always binds with a pyrimadine

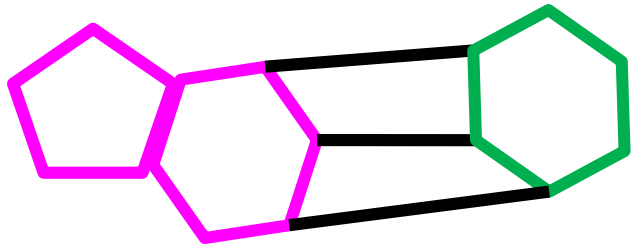
Mr. Williamson

How do you spell Thymine?

A purine always binds with a pyrimadine

What else has a y in it?

Cytosine



DNA

- The double helix of DNA must answer all four of the criteria

1. Store information
2. Be able to be copied
3. Be able to make mistakes
4. Be able to be read