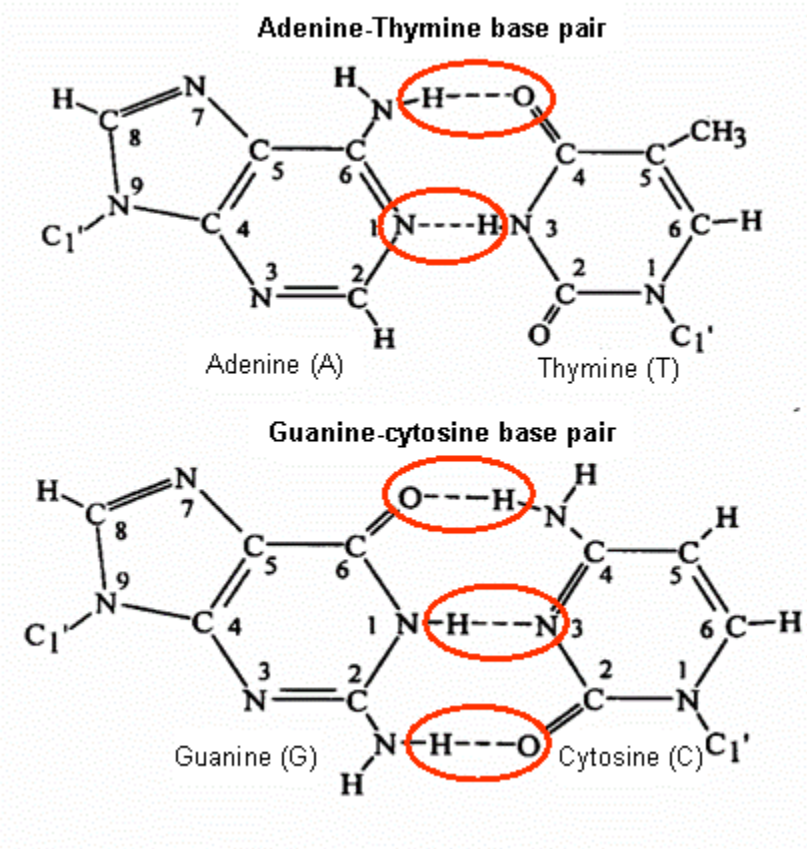
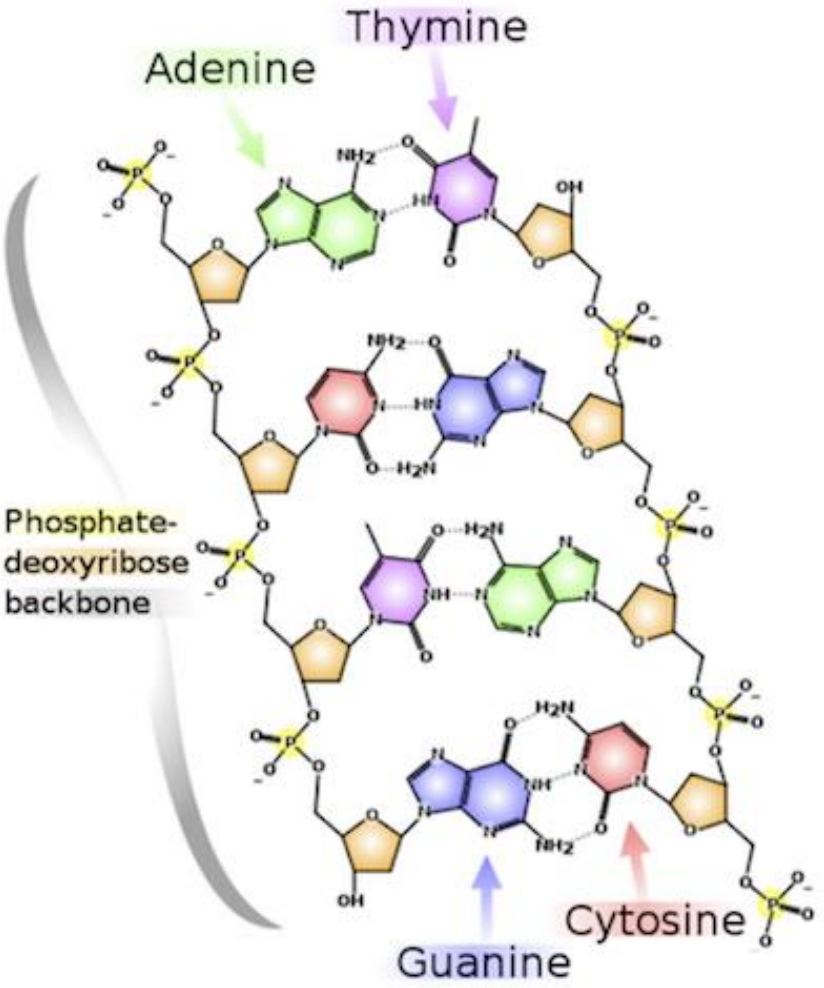
Nucleic Acids
secondary structure

Nitrogenous bases of nucleotides can form hydrogen bonds with each other:

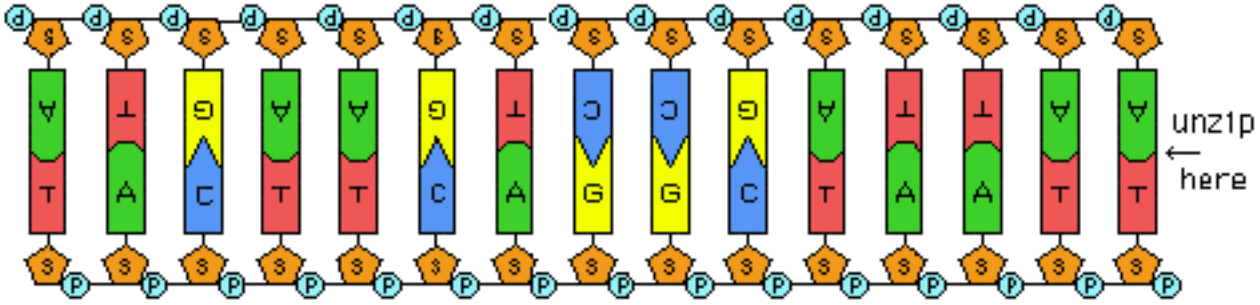


- Nucleic acids have **secondary structure**. They could be single stranded (ssDNA, ssRNA) or double stranded (dsDNA, dsRNA or DNA-RNA hybrid molecules). Double stranded nucleic acid forms when two single stranded molecules with **complementary sequences** meet and hydrogen bonds are formed between the bases of the two strands.

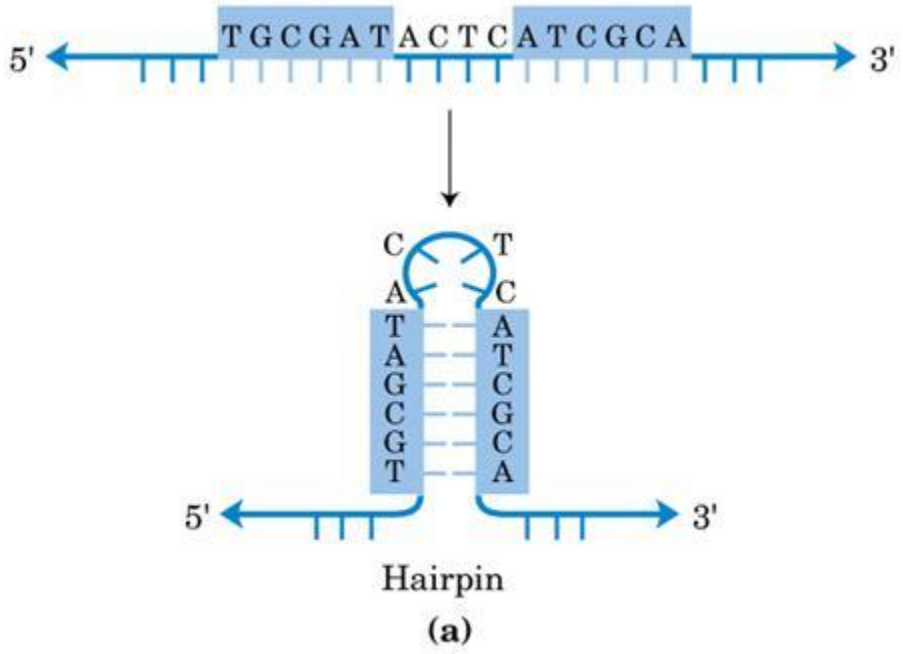
- Complementary nucleic acid strands



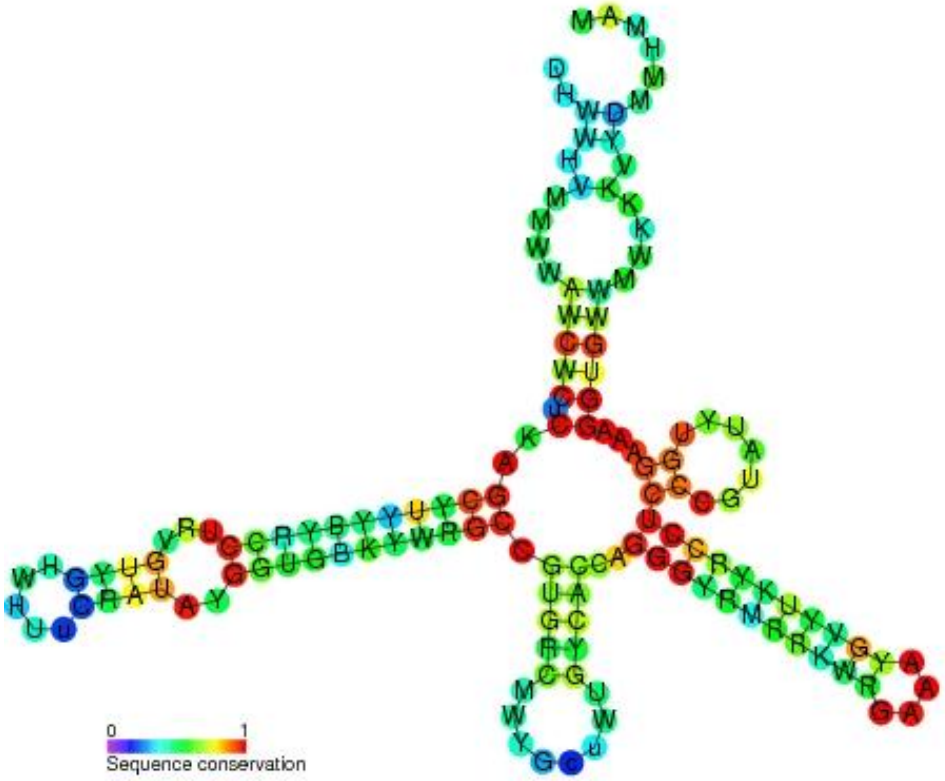
Complementary nucleic acid strands



Sometimes double stranded regions are formed within the same single stranded NA molecule

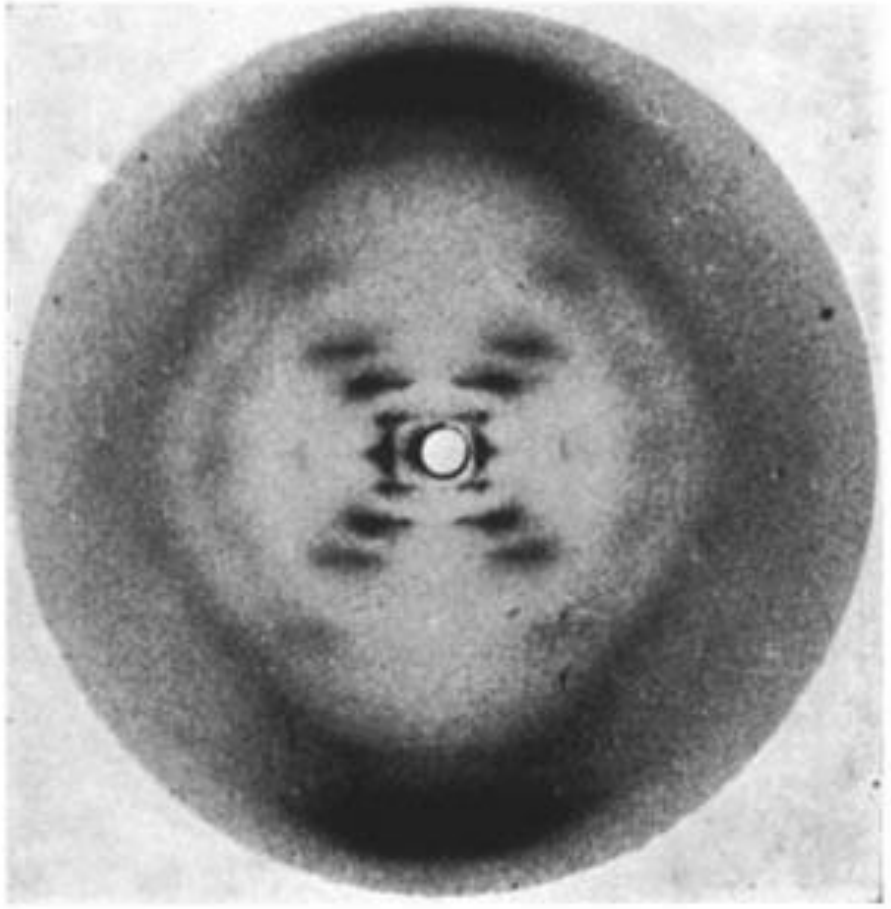


ssNA secondary structure



- DNA in living cell exists *mostly* in a double stranded form.
- It’s 3D-shape is a double helix.

Photograph 51



Photograph 51

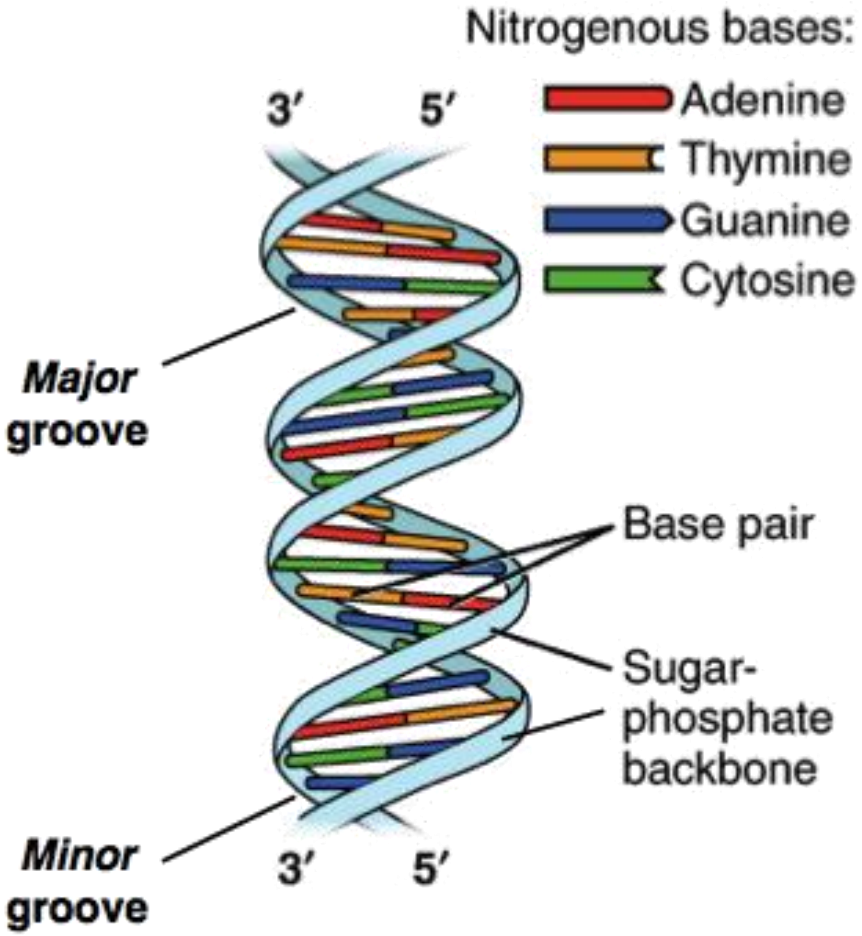
Photograph 51 is the nickname given to an X-ray diffraction image of crystallized DNA taken by Raymond Gosling in May 1952, working as a PhD student under the supervision of Rosalind Franklin, at King's College London in Sir John Randall's group. It was critical evidence in identifying the structure of DNA.

James Watson was shown the photo by his collaborator, Maurice Wilkins, without Rosalind Franklin's approval or knowledge. Wilkins did this, as by this time, Gosling had returned under his supervision, as Franklin was leaving King's and Randall has asked Gosling to share all his data with Wilkins. Along with Francis Crick, Watson used characteristics and features of Photo 51, together with evidence from multiple other sources, to develop the chemical model of the DNA molecule. Their model, and manuscripts by Wilkins and colleagues, and Gosling and Franklin, were first published, together, in 1953, in the same issue of Nature. In 1962, the Nobel Prize in Physiology or Medicine was awarded to Watson, Crick and Wilkins. The prize was not awarded to Franklin; she had died four years earlier, and although there was not yet a rule against posthumous awards, the Nobel Committee generally does not make posthumous nominations.

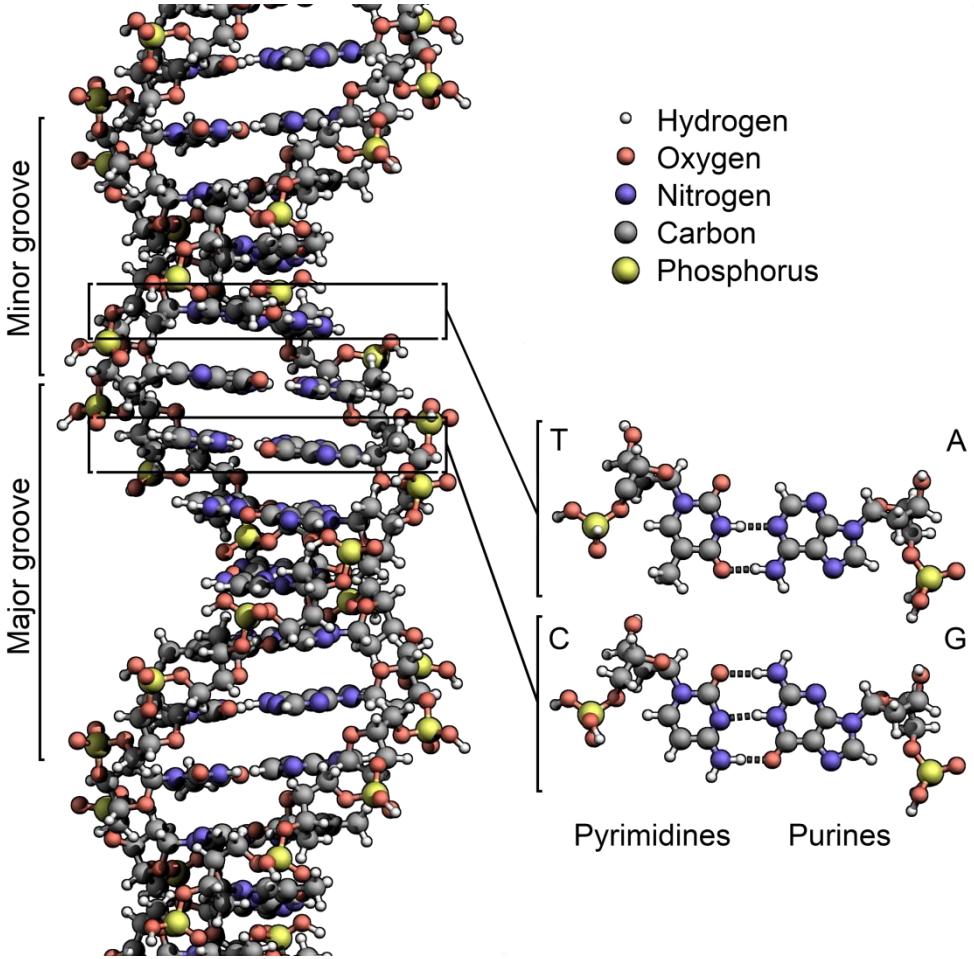
The prior model was triple-stranded DNA.

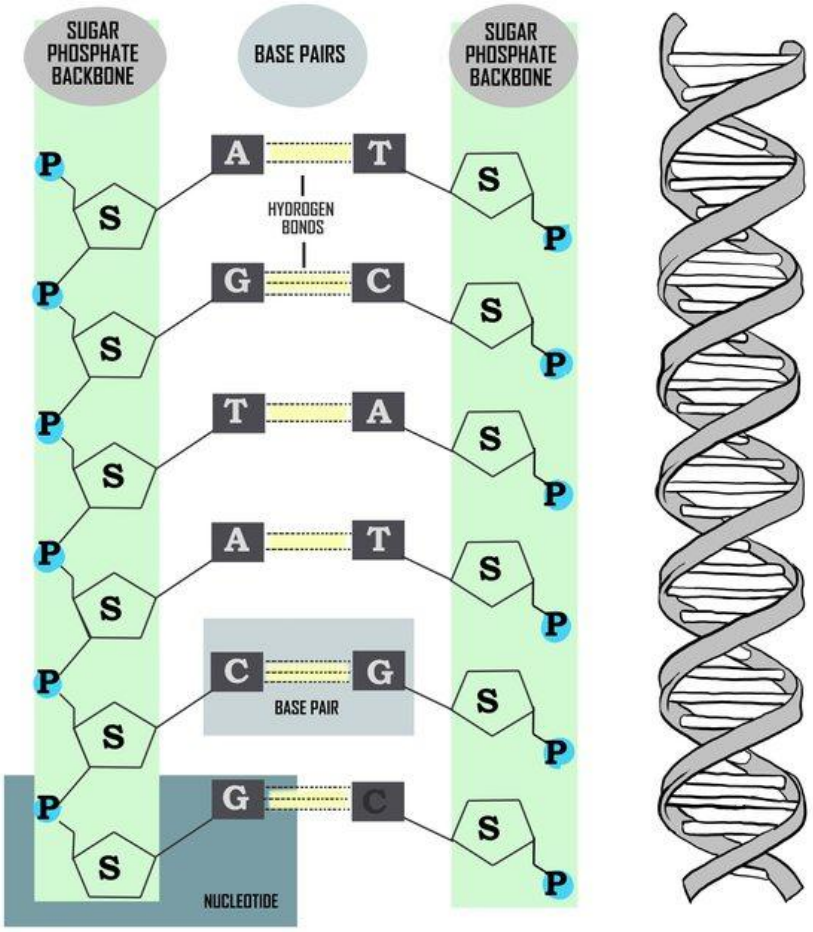
/Wikipedia/

DNA double helix



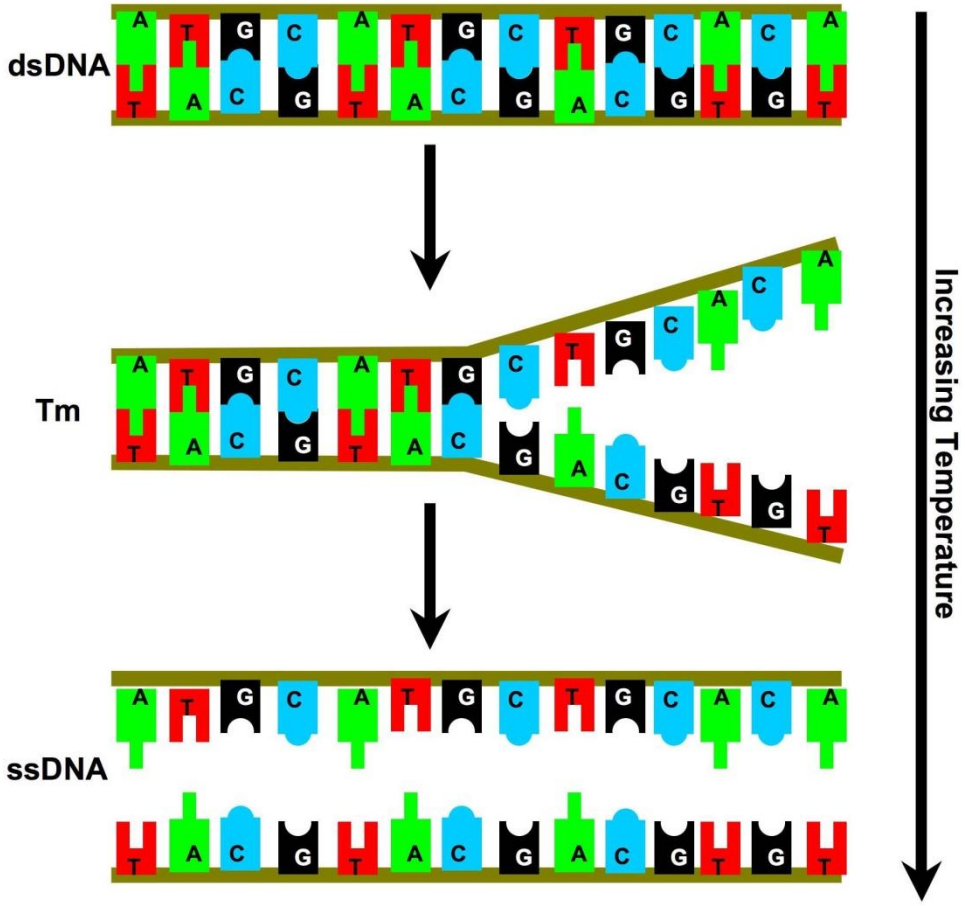
DNA double helix




SUGAR PHOSPHATE BACKBONE
BASE PAIRS
SUGAR PHOSPHATE BACKBONE
A
T
HYDROGEN BONDS
G
C
T
A
A
T
C
G
BASE PAIR
G
C
P
S
NUCLEOTIDE

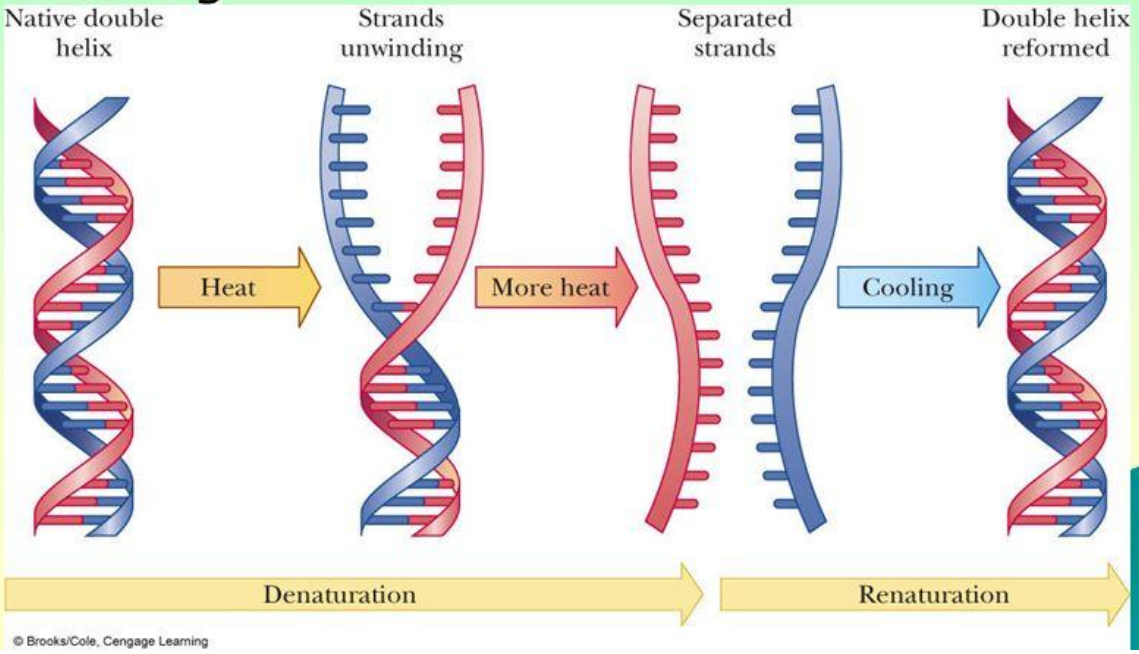
- Double helix secondary structure is not exclusively a feature of dsDNA. It is a feature of any ds nucleic acid with perfectly complementary sequences of its strands. Molecules of dsRNA and DNA/RNA hybrids can also assume the double helix shape.

Double stranded NA could be denatured by heat

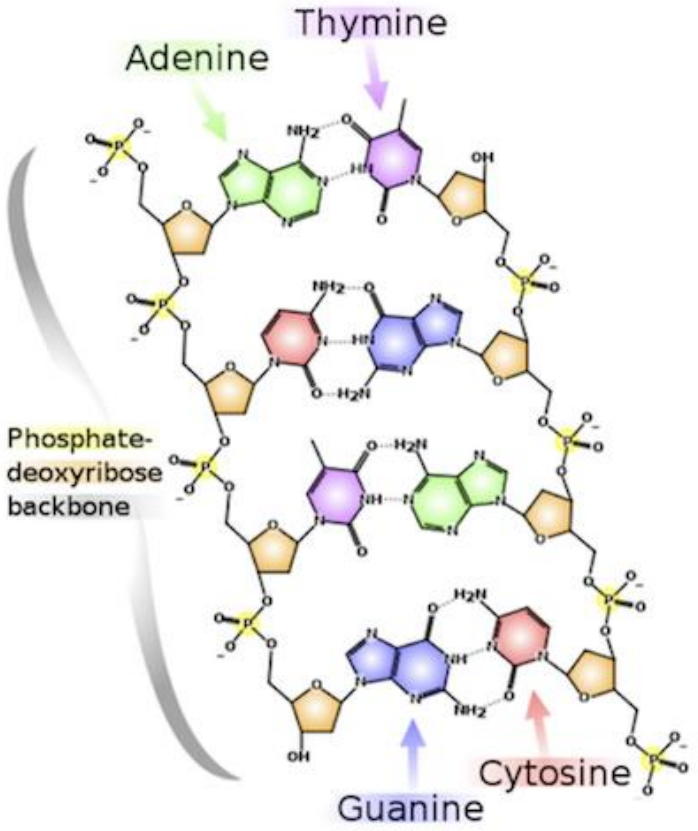


Denaturation of DNA

- Double helix unwinds when DNA is denatured
- Can be re-formed with slow cooling and annealing

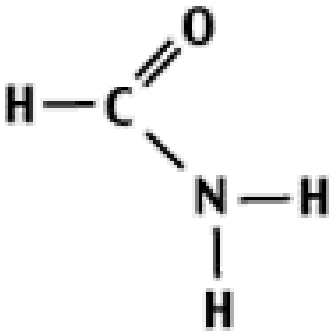


- **G-C pair forms 3 hydrogen bonds while A-T pair forms only 2. Therefore, GC-reach ds-nucleic acid has more heat resistant secondary structure than AT-reach one.**

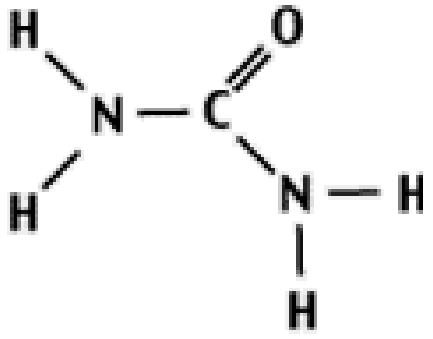


Denaturation of nucleic acids

- Heat
- Chemical agents. Urea or formamide are most commonly used

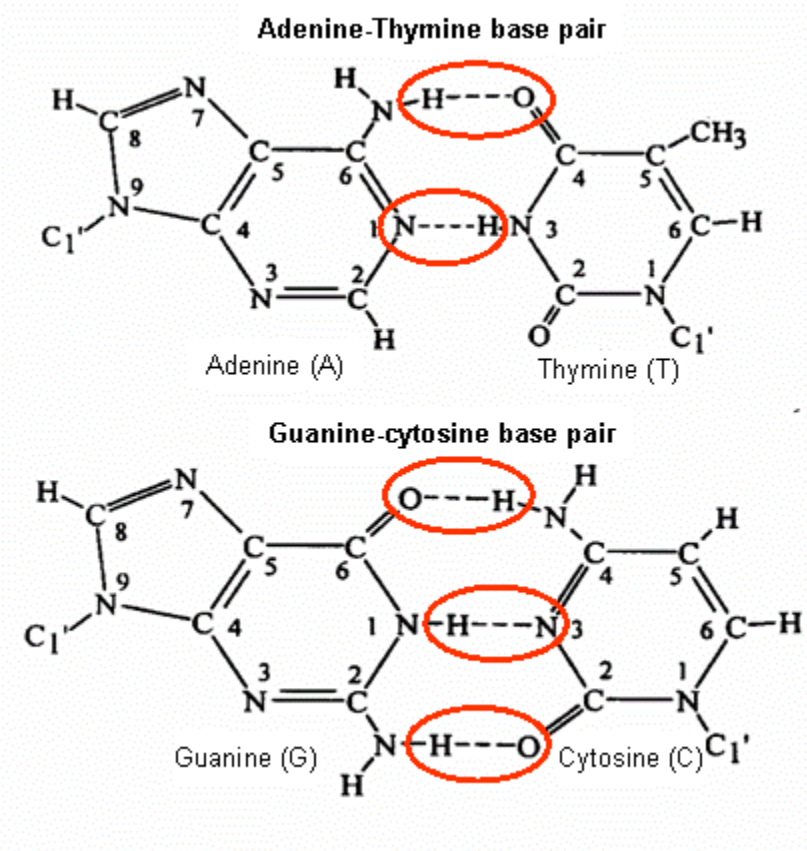


formamide



urea

Hydrogen bonds in ds-NA



Urea and formamide interaction with NA bases