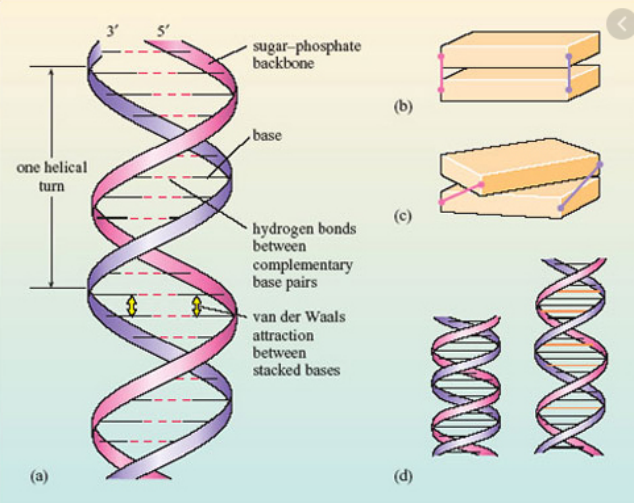
AUG
Faculty of Computer and Information Sciences
Ain Shams University

Session 5
Let's do bioinformatics

DNA Stability

There are two main factors are responsible for the stability of the DNA double helix:

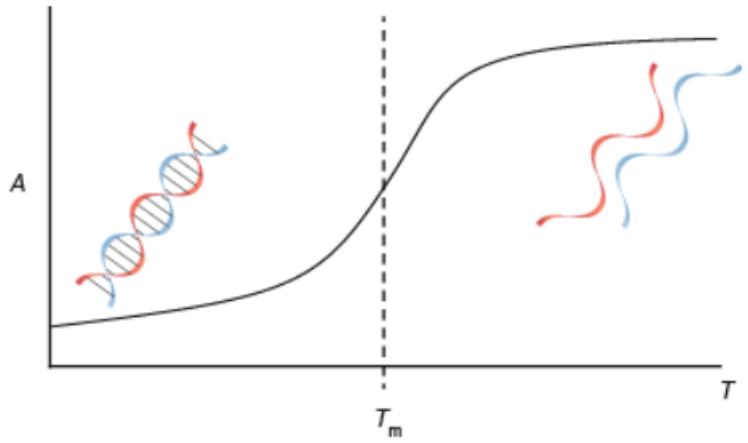
- base pairing between complementary strands
- stacking between adjacent bases.

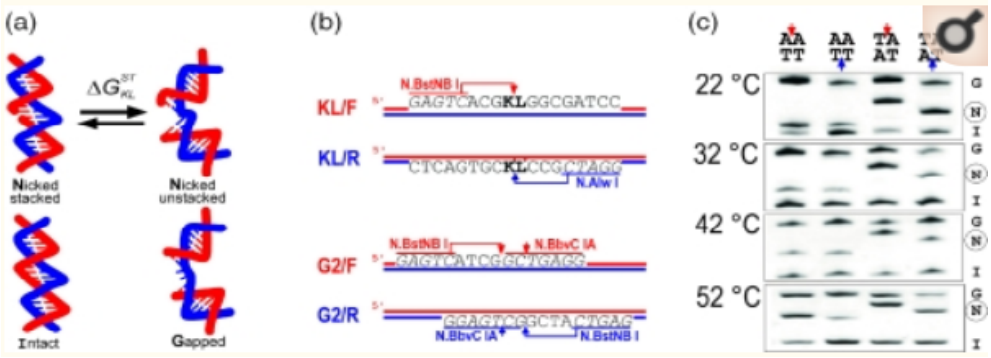


DNA instability factors

- DNA mutations
- Thermal denaturation of double-stranded DNA

  Heating double-stranded nucleic acids causes the strands to unwind (denature) by disrupting the ordered stacking of the bases and breaking hydrogen bonds.

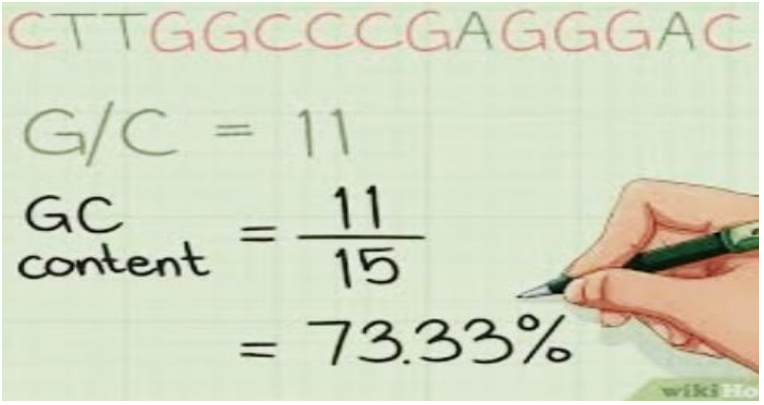




GC-content

is the percentage of nitrogenous bases that are either guanine (G) or cytosine in a DNA or RNA molecule.(the ratio between G and C bases out of four total bases).

$$\frac{G+C}{A+C+G+T} * 100$$



GC-content may be given for a certain fragment of DNA or RNA or for an entire genome.(fragment is an individual gene or section of a gene).
GC base pair is held together by three hydrogen bonds, while AT and AU base pairs are held together by two hydrogen bonds."G≡C" versus "A=T" or "A=U"

The GC-content of most species does tend to hover near 50%. However, coding regions of the genome have a tendency to contain a higher percentage of guanine and cytosine; these areas are called GC-rich, in contrast to areas of GC-content below 50%, which are called GC-poor.

GC content & DNA Stability

DNA with low GC-content is less stable than DNA with high GC-content however, the hydrogen bonds themselves do not have a particularly impact on molecular stability, which is caused by molecular interactions of base stacking.

it has been demonstrated that the most important factor contributing to the thermal stability of double-stranded nucleic acids is actually due to the base stackings of adjacent bases rather than the number of hydrogen bonds between the bases. There is more favorable stacking energy for GC pairs than for AT or AU pairs because of the relative positions of exocyclic groups. Additionally, there is a correlation between the order in which the bases stack and the thermal stability of the molecule as a whole.

Even so, it has been shown that there is a strong correlation between the optimal growth of prokaryotes at higher temperatures and the GC-content of structural RNAs. The AU base pairs are less stable than the GC base pairs, making high-GC-content RNA structures more resistant to the effects of high temperatures.

Applications

- GC-content can offer a preliminary test of the identity of unknown DNA:
  because the GC-content throughout the genome differs between species.

- testing the GC-content of a snippet of DNA from a known species can offer
  insight into whether that DNA may belong to a gene