PROPERTIES OF GENETIC MATERIAL

Properties of Genetic Material (DNA versus RNA)

Hershey-Chase experiment unequivocally showed that DNA is the genetic material. After that, it became an established fact that it is DNA that acts as genetic material.

However, in some viruses, **RNA is the genetic material** (for example, Tobacco Mosaic viruses, QB bacteriophage, etc.).

DNA is the predominant genetic material, whereas RNA performs dynamic functions of messenger and adapter. A molecule that can act as a genetic material must fulfil the following criteria:

(i) It should be able to form its own copy (Replication).

(ii) It should be chemically as well as structurally stable.

(iii) It should undergo mutations that are required for evolution.

(iv) It should express itself as 'Mendelian Characters'.

(i) Replication:

Because of rule of base pairing and complementarity, both the nucleic acids (DNA and RNA) have the ability to direct their duplications. The other molecules in the living system, such as proteins fail to fulfill this criteria itself.

(ii) Chemical and structural stability:

The genetic material should not change with different stages of life cycle, age or with change in physiology of the organism.

Stability as one of the properties of genetic material was very evident in Griffith's 'transforming principle' .

That heat, which killed the bacteria, did not destroy some of the properties of genetic material. That the two strands of DNA are complementary and if separated by heating (denaturation) come together when appropriate conditions are provided (renaturation).

Hyroxyl (2'-OH) group present at every nucleotide in RNA is a reactive group and it makes RNA labile and easily degradable. RNA is also now known to be catalytic, hence reactive ribozyme, (hammer-headed RNA). Therefore, DNA is chemically less reactive and structurally more stable.

Therefore, among the two nucleic acids, the DNA is a better genetic material.

In fact, the presence of thymine at the place of uracil also confers additional stability to DNA.

(iii) Mutations

Both DNA and RNA are able to mutate. In fact, RNA mutate at a faster rate. Consequently, viruses having RNA genome and having shorter life span mutate and evolve faster. RNA can directly code for the synthesis of proteins, hence can easily express the characters.

DNA, however, is dependent on RNA for synthesis of proteins. The protein synthesising machinery has evolved around RNA.

From the foregoing account, it became clear that both RNA and DNA can function as genetic material, but **DNA being more stable is preferred for storage of genetic information**. For the transmission of genetic information, RNA is better.

RNA WORLD

RNA was the first genetic material. There is now enough evidence to suggest that essential life processes (such as metabolism, translation, splicing, etc.), evolved around RNA. RNA used to act as a genetic material as well as a catalyst. However, RNA being a catalyst was reactive and hence unstable. Therefore, DNA has evolved from RNA with chemical modifications that make it more stable. As DNA, double stranded and has complementary strand, resists changes by evolving a process of repair.