Experimental evidences for nucleic acid (DNA & RNA) as carrier of genetic information

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Introduction

- *Life depends on the ability of the cells to **store** , **retrieve** & **translate** the **genetic information** required to make & maintain a living organism.*
- *This hereditary information is passed from one cell to it's daughter cells at cell division , & from **one generation to the next** the organ's reproductive cells.*
- *The genetic information are stored within every living cell as it's **genes**.*
- *A gene is a **basic unit of hereditary** & a **functional segment of DNA** (genetic material) that yield a product which is either a RNA or a protein.*

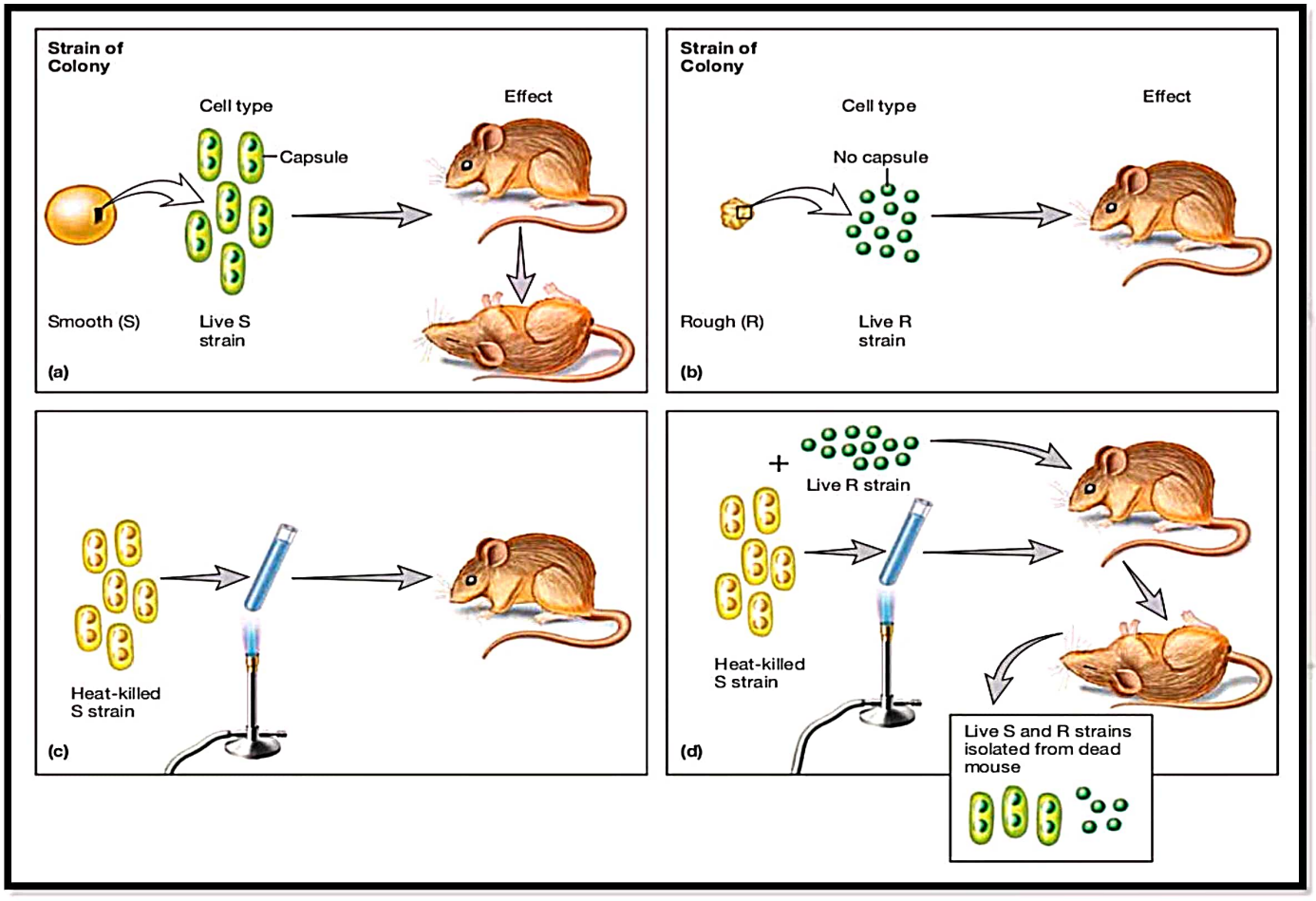
Nucleic acid as carrier of genetic information.

- *Nucleic acid was first discovered by **Friedrich Miescher** from the nuclei of **pus cells** (Leukocytes) and called it **nuclein**.*
- *Later **Richard Altman** coined the term **nucleic acid.***
- *Nucleic acid are the **polymer of nucleotides** (therefore are also called polynucleotides).*
- *There are two types of nucleic acids : **RNA** (ribonucleic acid) & **DNA** (deoxyribonucleic acid).*
- ***DNA** acts as genetic material & used to store the genetic information of **all cellular** forms of life & **many viruses.***
- ***Some viruses** uses **RNA** as their genetic material.*

Experimental evidences

1. Griffith's transformation experiment

- *Fred Griffith experimented on the transfer of virulence in the pathogen **streptococcus pneumoniae** commonly called **pneumococcus**.*
- *He injected mice with **pathogenic strains** of pneumococcus which have a **capsule** & forms **smooth** colonies (**S – Strain**) . As a result the **mice died.***

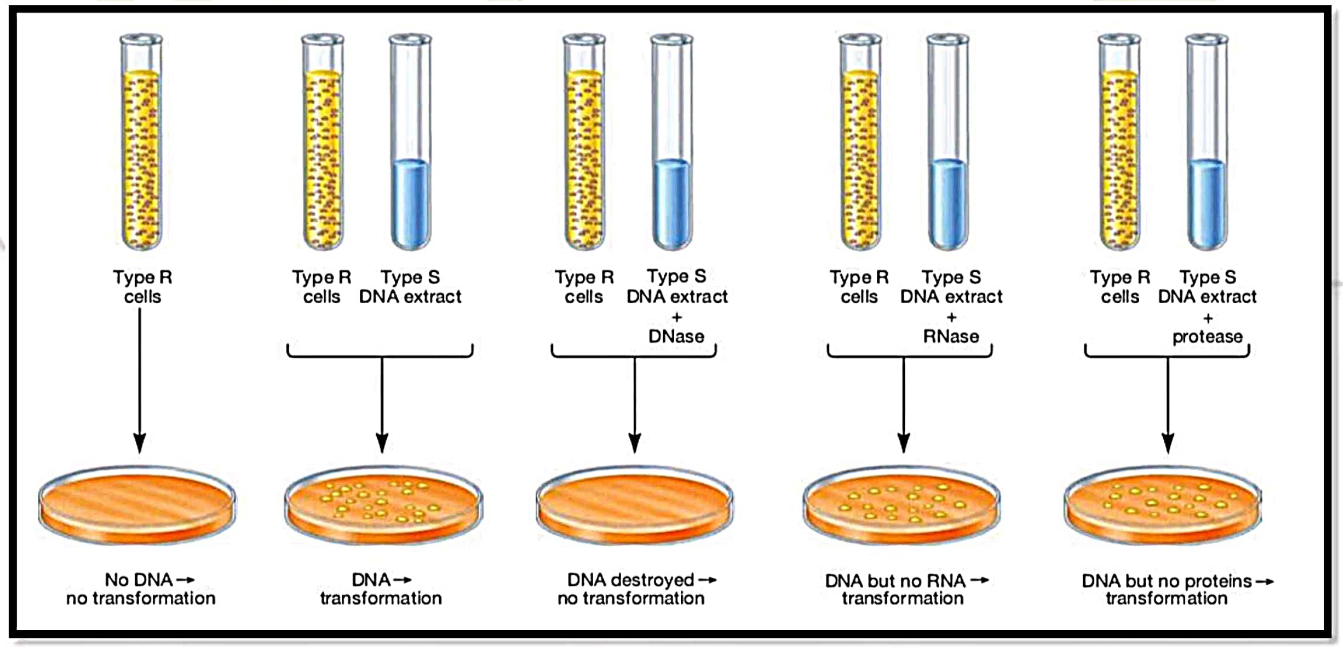


- ***Mice survived** when injected with a **non pathogenic strain** of pneumococcus which **lacks a capsule** & forms **rough** colonies (**R – strain**).*

- *Infection with **heat killed S-strain** had **no effect.***
- *Injection with a **live R-strain** & a **heat killed S-strain** gave the mice pneumonia & live S-strains could be isolated from the **dead mice.***
- *Based on this information , Griffith concluded that Heat killed S-strains bacteria were responsible for converting live non virulent R-strain bacteria into virulent S-strain bacteria & called the phenomenon **transformation**.*

2. Avery – MacLeod – McCarty experiment

- ***Oswald Avery** , **Colin MacLeod** & **Maclyn McCarty** set out to discover which constitutent in the heat killed virulent pneumococcus was responsible for Griffith's transformation.*
- *They discovered **DNA is the transforming principle** which resulted in transformation of Rough strain cells to S-strain cells.*

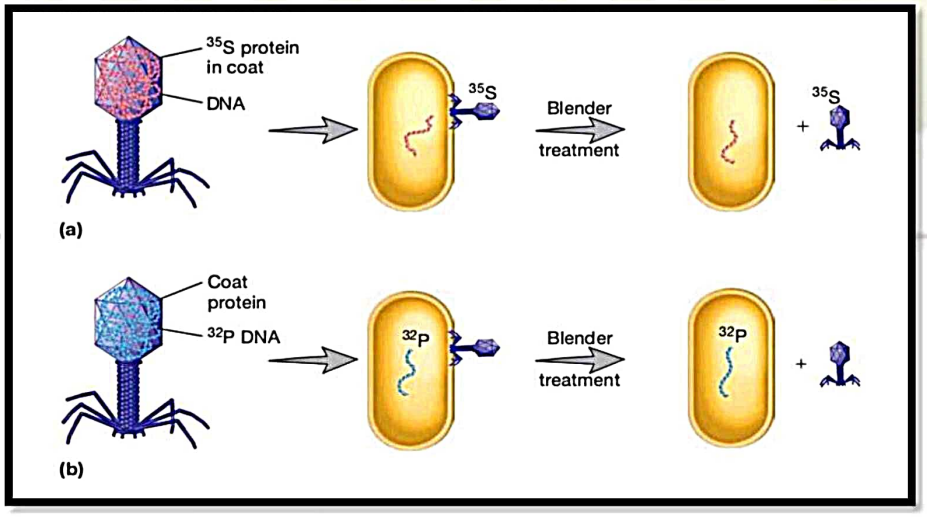


- *Extract from S-strain cells was treated with **RNase** , **DNase** & **protease**. They are then mixed with R-strain cells.*

- *Capsulated S-strain cell appeared in all cultures , except those in which heat killed S-strain cell extract has been treated with DNase , an enzyme that destroys DNA. These results suggested that* ***DNA was the molecule responsible for transformation.***

3. Hershey – Chase experiment

- *This experiment was conducted by* ***Alfred Hershey*** *&* ***Martha Chase*** *that identified* ***DNA as genetic material of phages***
- *They designed an experiment using* ***radioisotopes of sulfur*** *&* ***phosphorus*** *to keep separate track of* ***viral proteins*** *&* ***Nucleic acids*** *during the infection process.*
- ***Proteins contain sulfur*** *but DNA doesn't. Conversely* ***DNA contain phosphate*** *but Proteins do not. Thus radioactive forms of Phosphate (^{35}P) or Sulphur (^{35}S) can be selectively incorporated into either DNA or protein.*
- *They used the* ***T2 phage*** *(genetic material is* ***linear dsDNA*** *) & the bacterium* ***E.coli .***

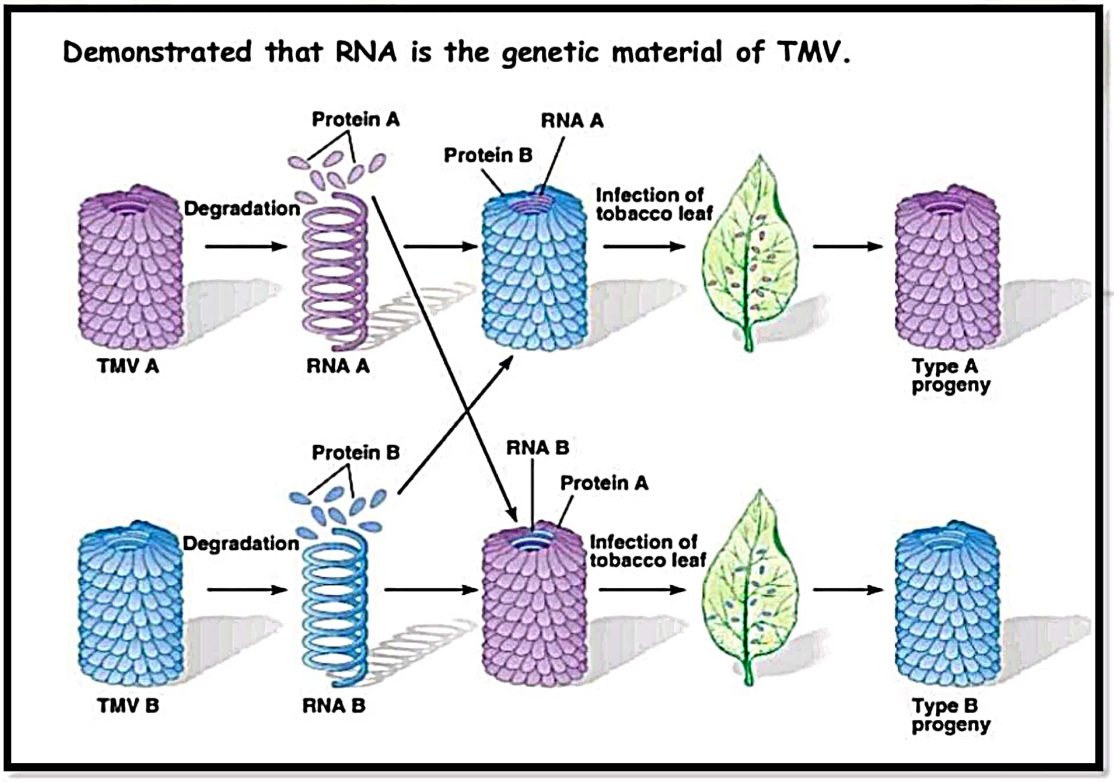


- *When* ***^{32}P labeled phages*** *are used to infect E.coli. They found that ^{32}P DNA entered the cell & the* ***next generation*** *of phages carried* ***32P labeled DNA.***

- *When* ***^{35}S labeled phages*** *are used to infect E.coli. They found that ^{35}S labelled protein stayed outside the bacterial cell and is not* ***^{35}S is absent*** *in* ***next generation*** *of phages.*
- *Since the DNA entered the bacterial cell & is responsible for the production of new phages during the infection process , the* ***DNA must be genetic material. not the protein***

4. Fraenkel-Conratt experiment

- *The genome of viruses may be DNA or RNA.* ***Most*** *of the* ***plant viruses*** *have* ***RNA*** *as their hereditary material.*
- ***Fraenkel-Conrat*** *(1957) conducted experiments on* ***tobacco mosaic virus (TMV)*** *to demonstrate that in some viruses* ***RNA acts as genetic material****.*
- *TMV is a small virus composed of a single molecule of* ***helical RNA*** *encapsulated in a* ***cylindrical protein coat.***



- *Fraenkel-Conrat and Singer took **two different strains of TMV** and **separated the RNAs from protein coats**, reconstituted **hybrid viruses** by mixing the proteins of one strain with the RNA of the second strain, and vice versa.*
- *When the **hybrid viruses** were **rubbed** into **live tobacco leaves**, the **progeny viruses** produced were always found to be phenotypically and genotypically **identical to the parental type** from where the **RNA** had been isolated.*
- *Thus the **genetic information** of TMV is **stored in the RNA** and not in the protein.*