



FACULTY OF ENGINEERING & TECHNOLOGY  
DEPARTMENT OF BIOTECHNOLOGY

# DNA as genetic material

• Before we discuss the evidence gathered from experiments to prove that the genetic material of most living organisms and many viruses is double-stranded DNA, let's review what was known about genes and DNA at the time James Watson and Francis Crick elucidated the structure of DNA in 1953:

2. Genes—the hereditary “factors” described by Mendel

—were known to be associated with specific character traits, but their physical nature was not understood.

3. The one-gene–one-enzyme theory postulated that genes control the structure of proteins.

4. Genes were known to be carried on chromosomes.

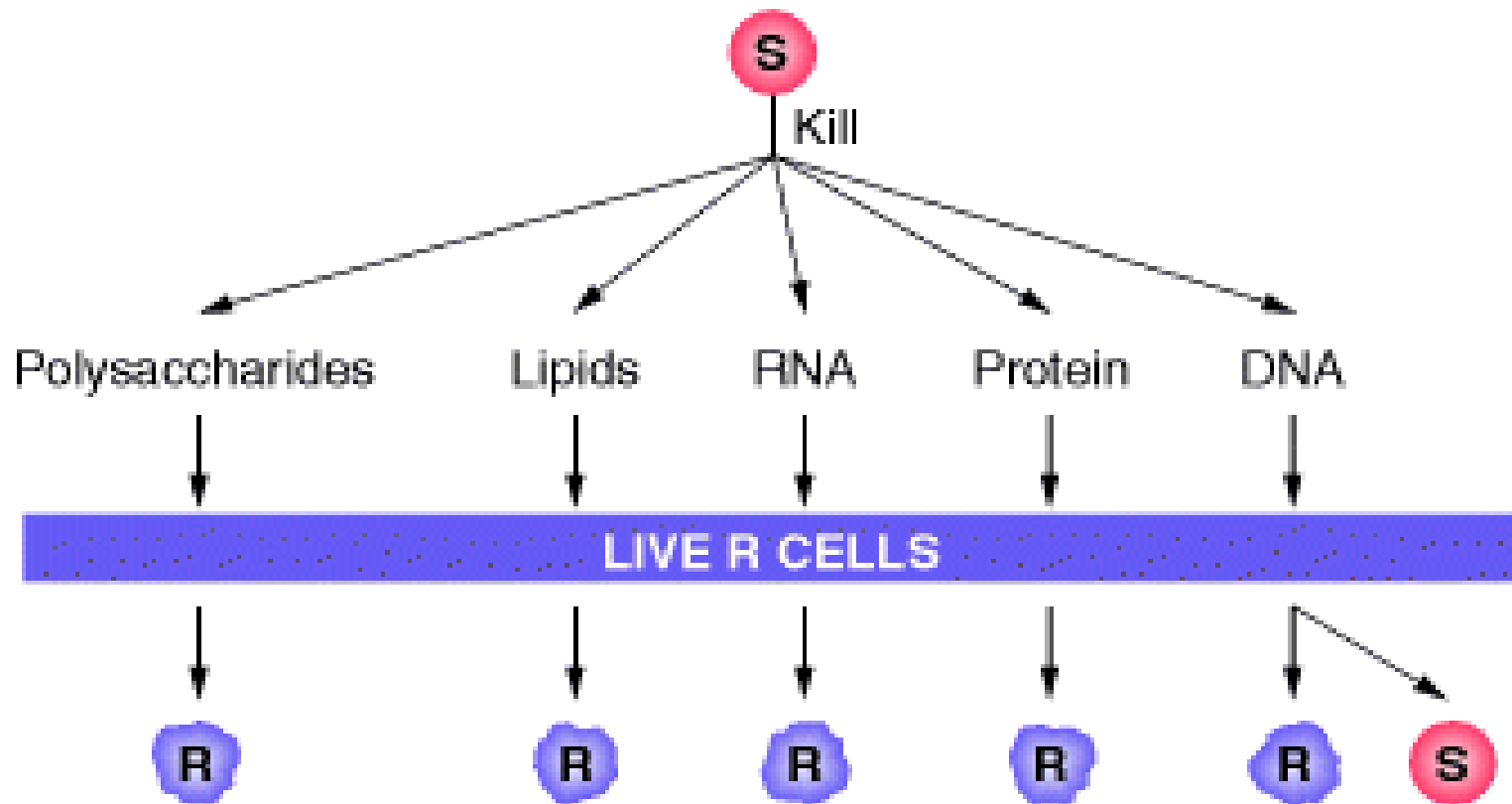
5. The chromosomes were found to consist of DNA

# The discovery of DNA as genetic

- One of the first study that ultimately led to the identification of DNA as genetic material was done by Frederick Griffith involving the bacterium *Streptococcus pneumoniae* in 1928.
- This bacterium, which causes pneumonia in humans, is normally lethal in mice.
- Griffith used two strains that are distinguishable by the appearance of their colonies when grown in laboratory cultures. In one strain, a normal virulent type, the cells are enclosed in a polysaccharide capsule, giving colonies a smooth appearance; this strain is labelled S. In the other strain, a mutant nonvirulent type that is not lethal, the polysaccharide coat is absent, giving colonies a rough appearance; this strain is called R.<sup>2</sup>

- Griffith injected mice with living R type bacteria. The mice were not affected and after a while the bacteria disappeared from the animal's blood stream.
- He also injected mice with living S type bacteria. The mice died, and S type bacteria could be isolated from their blood.
- Griffith killed some virulent cells by boiling them and injected the heat-killed cells into mice. The mice survived, showing that the carcasses of the cells do not cause death.
- However, mice injected with a mixture of heat-killed virulent cells and live nonvirulent cells did die. Live cells could be recovered from the dead mice; these cells gave smooth colonies and were virulent on subsequent injection. Somehow, the cell debris of the boiled S cells had converted the live R cells into live S cells. The process is called [transformation](#).

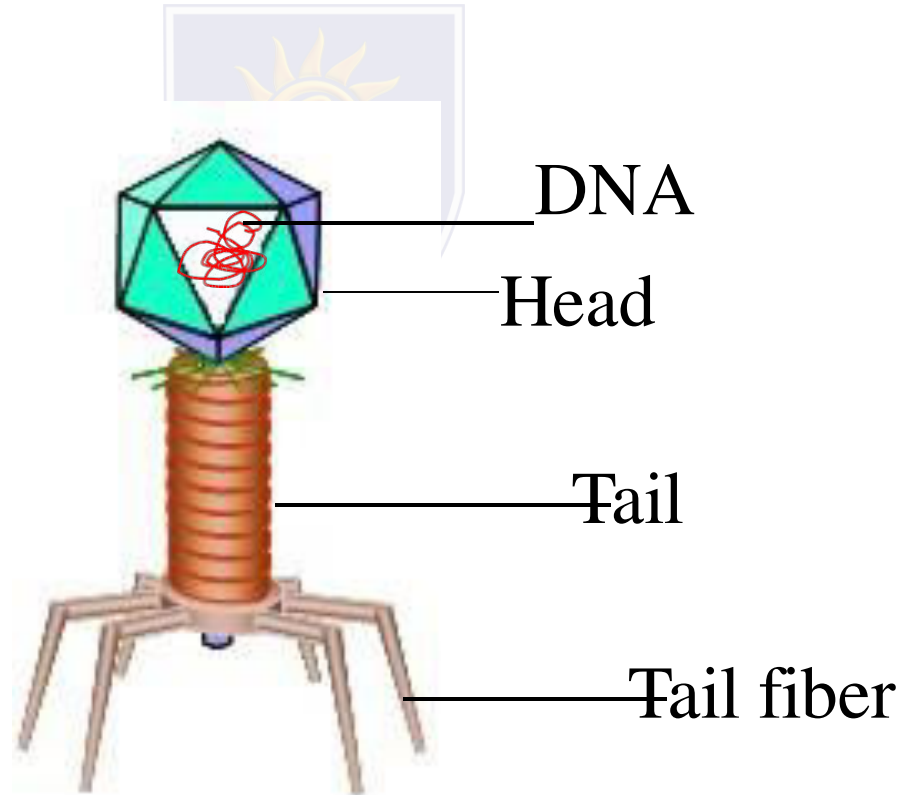
- In 1944, Oswald Avery, C. M. MacLeod, and M. McCarty separated the classes of molecules found in the debris of the dead S cells and tested them for transforming ability, one at a time. These tests showed that the polysaccharides themselves do not transform the rough cells.
- In screening the different groups, it was found that only one class of molecules, DNA, induced the transformation of R cells. DNA is the agent that determines the polysaccharide character and hence the pathogenic character. It seemed that providing R cells with S DNA was equivalent to providing these cells with S genes.
- The demonstration that DNA is the transforming principle was the first demonstration that genes are composed of DNA.



# Hershey-Chase experiment

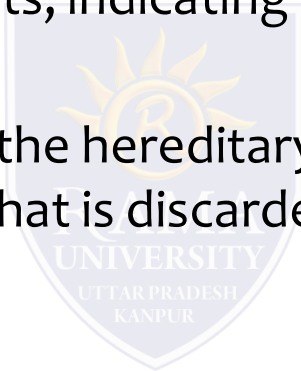
- In 1952 Alfred Hershey and Martha Chase used bacteriophage (virus) T<sub>2</sub> to show that DNA is the genetic material. Most of the phage structure is protein, with DNA contained inside the protein sheath of its “head.”
- They reasoned that phage infection must entail the introduction (injection) into the bacterium of the specific information that dictates viral reproduction.
- Hershey and Chase incorporated the radioisotope of phosphorus (<sup>32</sup>P) into phage DNA and that of sulfur (<sup>35</sup>S) into the proteins of a separate phage culture. P is not found in proteins but is an integral part of DNA; S is present in proteins but never in DNA.

# Bacteriophage





- When the  $^{32}\text{P}$ -labelled phages were used, most of the radioactivity ended up inside the bacterial cells, indicating that the phage DNA entered the cells.  $^{32}\text{P}$  can also be recovered from phage progeny.
- When the  $^{35}\text{S}$ -labelled phages were used, most of the radioactive material ended up in the phage ghosts, indicating that the phage protein never entered the bacterial cell.
- They concluded that DNA is the hereditary material; the phage proteins are mere structural packaging that is discarded after delivering the



The Hershey-Chase experiment, which demonstrated that the genetic material of phage is DNA, not protein.

