Hershey & Chase 1952

Home
Biol 4241
Luria-Delbruck 1943
Hershey-Chase 1952
Meselson-Stahl 1958
Garapin et al. 1978
McClintock 1953
King-Wilson 1975
Sanger et al. 1977
Jeffreys et al. 1985
Rothberg et al. 2011
Hamer et al. 1993

Background & Introduction

Paper Title: Independent functions of viral protein and nucleic acid in growth of bacteriophage

Alfred Hershey (1908-1997) and Martha Chase (1927-2003)

Series of experiments to determine the role of protein and DNA in bacteriophage

What is known at this point in time:

1848: Chromosomes discovered; exchanged during mitosis
Wilhelm Hofmeister: cell nuclei resolve into small, rod-like bodies during mitosis

1869: DNA isolated from cells
Friedrich Miescher: nuclei contain a phosphorous-rich molecule, "nuclein"

Early 20th century:
1902 Walter Sutton hypothesizes that chromosomes are hereditary units
Chromosomes carry **genes**; basic units of heredity
Genes are arranged linearly on chromosome
Chromosomes are made of both protein and DNA - didn't know which one carries **information**

Many thought proteins were better candidates; 20 amino acids vs 4 nucleic acids

Life is complicated, DNA is a relatively simple molecule

1928: Griffth's Expierment showed Genes were able to be transferred

1944: Avery, MacLeod and McCarthy: transformation only occurs when DNA was present, and occurs when proteins are removed

1952: Oversimplification of the Hershey and Chase experiment as portrayed in a textbook.

Methods:

Phage DNA and Protein can be detected using **radiolabelled isotopes:** P^{32} and S^{35}

Phosphorus containing **DNA** labelled with P^{32}

Sulfur containing **proteins** labelled with S^{35}

Preparation of radiolabelled phage

Results:

Lead up experiments

Experiments 1 and 2:
Ghosts are empty phage particles adsorbed to bacteria
Ghosts can be created by plasmolysis
Using radiolabelled isotopes, characteristics of phage DNA and protein can be observed (Table 1)
DNA is in the supernatant while protein stays in sediment (Table 2)

Experiments 3 and 4:

Adsorption of phage to a bacterium is followed by the release of **DNA** from the protein coat
Shown through the use of **DNase** on frozen, thawed, and fixed bacterial cells after infection (Table 3)
Followed by tests involving addition of phage to bacterial debris (Table 4)

Experiment 5:

The blender experiment indicates that protein does not enter into the cell, while DNA does (Figure 1)
Preformed by allowing phages to infect and using a blender to break capsids off of cells
Possible due to "precarious attachment" of phage to bacteria

Experiment 6:
If more time is allowed for infection and replication of the phage it has no effect on the amount of S^{35} sedimented (Table 6)
Showing that there is little S^{35}going into phage progeny.
Did a similar experiment with P^{32} and about 30% of it was in phage progeny
S^{35} was only 1% in phage progeny.

Experiment 8:

Fixing the DNA into the phage with formaldehyde affects the replication of phage (Table 8)
Much lower plaque titer (1000 fold decrease)

Conclusions

Hershey & Chase conclude:

Adsorbed phage inserts DNA **into the cell**, sulfur containing protein **remains outside**

Phage adsorb to membrane fragments and release DNA into solution

Phage progeny contained parental P^{32} and little to no parental S^{35}

Sulfur containing protein has no intracellular function, DNA appears to have **"some function"**

"We have shown that when a particle of bacteriophage T2 attaches to a bacterial cell, most of the phage DNA enters the cell, and a residue containing at least 80 per cent of the sulfur-containing protein of the phage remains at the cell surface."

The results of these experiments convinced a number of people that DNA was the molecule of heredity, including Watson and Crick.

This paper was therefore pivotol, resulting in a race to discover the structure and function of DNA

Steve Carr (instructor: scarr@mun.ca) *** Linda Lait (TA: ll1583@mun.ca)
Dept of Biology, Memorial University of Newfoundland, St John's NL A1B3X9