

**DNA
The Genetic Material**



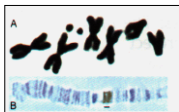
Scientific History

- The march to understanding that DNA is the genetic material
 - T.H. Morgan (1908)
 - Frederick Griffith (1928)
 - Avery, McCarty & MacLeod (1944)
 - Erwin Chargaff (1947)
 - Hershey & Chase (1952)
 - Watson & Crick (1953)
 - Meselson & Stahl (1958)

1908 | 1933

Chromosomes related to phenotype

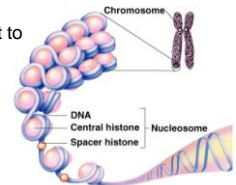
- T.H. Morgan's Experiment
 - working with *Drosophila*
 - associated phenotype with specific chromosome
 - white-eyed male had specific X chromosome



1908 | 1933

Genes are on chromosomes

- Morgan's conclusions
 - genes are on chromosomes
 - but is it the protein or the DNA of the chromosomes that are the genes?
 - initially proteins were thought to be genetic material... Why?



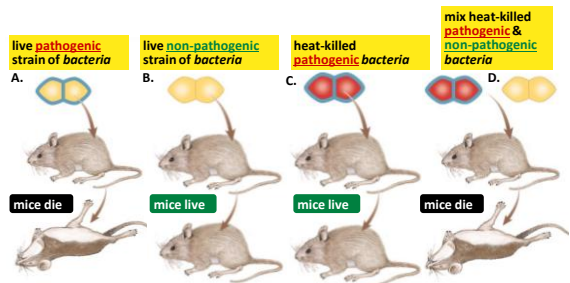
1928

The "Transforming Principle"

- Frederick Griffith's Experiment
 - *Streptococcus pneumoniae* bacteria
 - was working to find cure for pneumonia
 - harmless live bacteria ("rough") mixed with heat-killed pathogenic bacteria ("smooth") causes fatal disease in mice
 - a substance passed from dead bacteria to live bacteria to change their phenotype
 - "Transforming Principle"



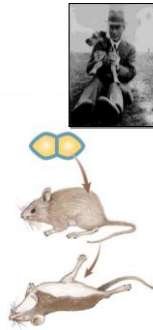
The "Transforming Principle"



Transformation = change in phenotype something in heat-killed bacteria could still transmit disease-causing properties

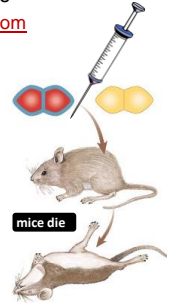
The "Transforming Principle" 1928

- Frederick Griffith's Conclusions
 - a substance passed from dead bacteria to live bacteria to change their phenotype, which he called the "Transforming Principle"



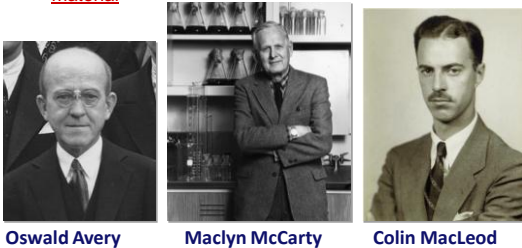
DNA is the "Transforming Principle" 1944

- Avery, McCarty & MacLeod's Experiments
 - purified both DNA & proteins separately from *Streptococcus pneumoniae* bacteria
 - which will transform non-pathogenic bacteria?
 - injected protein into bacteria
 - no effect
 - injected DNA into bacteria
 - transformed harmless bacteria into virulent bacteria



Avery, McCarty & MacLeod 1944 | ???!

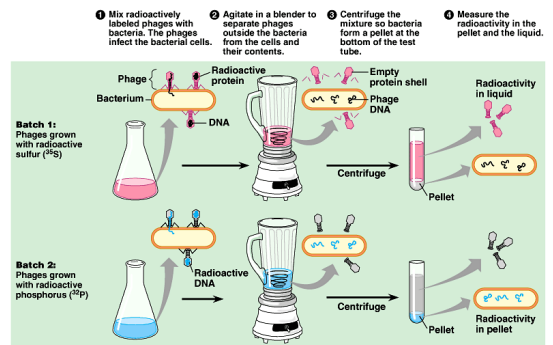
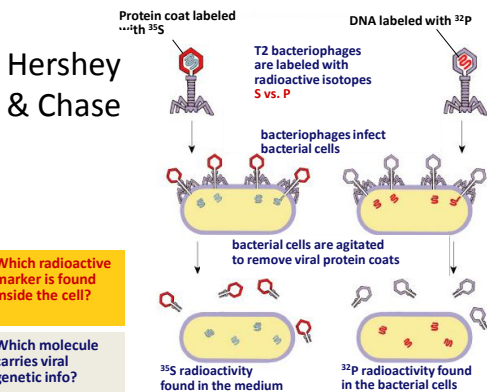
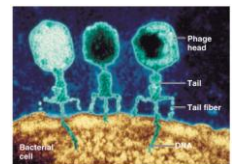
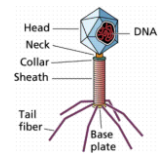
- Conclusion
 - first experimental evidence that DNA was the genetic material



Oswald Avery Maclyn McCarty Colin MacLeod

Confirmation of DNA 1952 | 1969 Hershey

- Hershey & Chase's Experiment
 - grew bacteriophage viruses in 2 media, radioactively labeled with either:
 - ³⁵S in their proteins
 - ³²P in their DNA
 - infected bacteria with labeled phages



Blender experiment Conclusions

- Radioactive phage & bacteria in blender
 - ³⁵S phage
 - radioactive proteins stayed in supernatant
 - therefore **viral protein did NOT enter bacteria**
 - ³²P phage
 - radioactive DNA stayed in pellet
 - therefore **viral DNA did enter bacteria**
- **Confirmed DNA is "transforming factor"**

Taaa-Daaa/

1952 | 1969
Hershey

Hershey & Chase



Martha Chase Alfred Hershey

Chargaff's Conclusions

1947

- **DNA composition:**
 - **varies from species to species**
 - **all 4 bases not in equal quantity**
 - **bases present in characteristic ratio, where A=T, C=G**
 - humans:
 - A = 30.9%
 - T = 29.4%
 - G = 19.9%
 - C = 19.8%



Erwin Chargaff

Structure of DNA

1953 | 1962

- **Watson & Crick's Conclusions**
 - **developed double helix model of DNA**
 - other leading scientists working on question:
 - Rosalind Franklin
 - Maurice Wilkins
 - Linus Pauling



Franklin

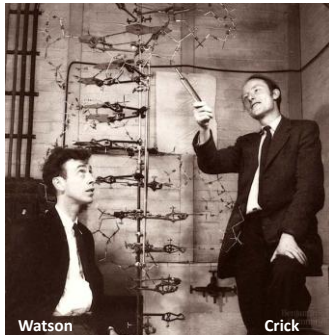


Wilkins



Pauling

Watson and Crick

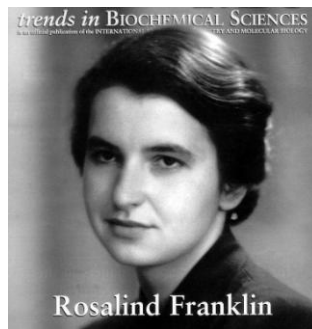


Watson

Crick



Rosalind Franklin (1920-1958)

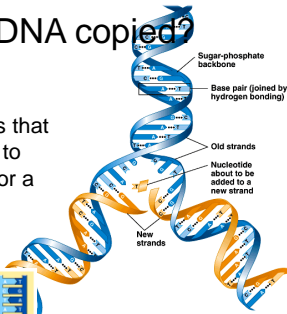


Rosalind Franklin



But how is DNA copied?

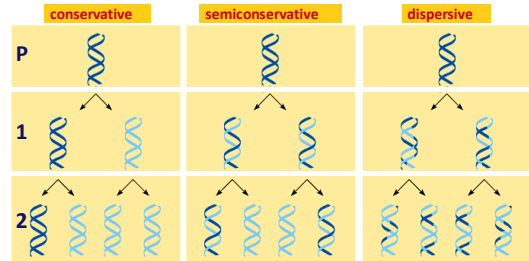
- Replication of DNA
 - base pairing suggests that it will allow each side to serve as a **template** for a new strand



"It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material." — Watson & Crick

Models of DNA Replication

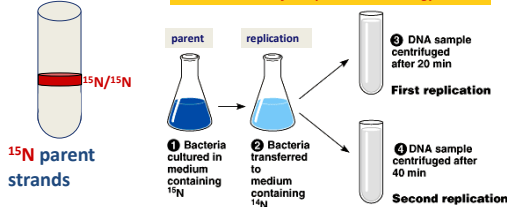
- Alternative models
 - become experimental predictions



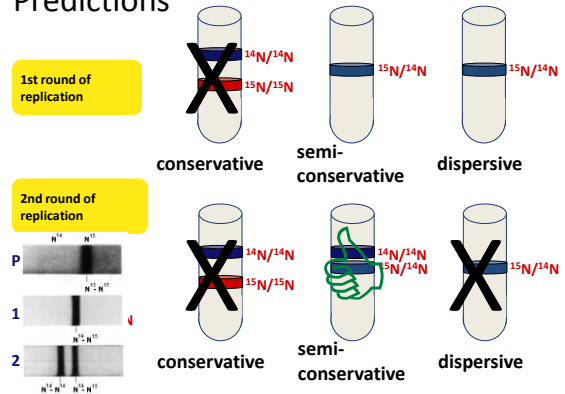
Semiconservative replication 1958

- Meselson & Stahl's Experiment
 - label "parent" nucleotides in DNA strands with heavy nitrogen = ^{15}N
 - label new nucleotides with lighter isotope = ^{14}N

"The Most Beautiful Experiment in Biology"



Predictions



Meselson & Stahl

- Conclusions
 - DNA replication is semi-conservative



Scientific History

- March to understanding that DNA is the genetic material
 - T.H. Morgan (1908)
 - genes are on chromosomes
 - Frederick Griffith (1928)
 - a transforming factor can change phenotype
 - Avery, McCarty & MacLeod (1944)
 - transforming factor is DNA
 - Erwin Chargaff (1947)
 - Chargaff rules: A = T, C = G
 - Hershey & Chase (1952)
 - confirmation that DNA is genetic material
 - Watson & Crick (1953)
 - determined double helix structure of DNA
 - Meselson & Stahl (1958)
 - semi-conservative replication