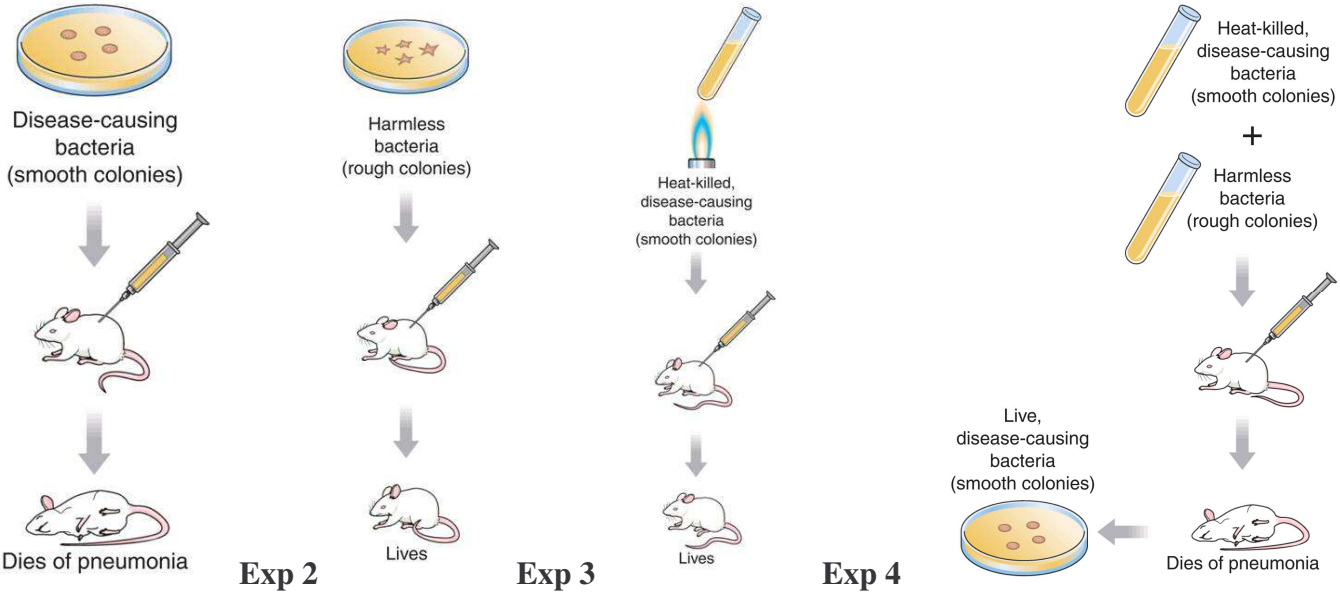
12–1 DNA

Griffith and Transformation

In 1928, British scientist Fredrick Griffith was trying to learn how certain types of bacteria caused pneumonia. He isolated two different strains of pneumonia bacteria from mice and grew them in his lab.
Griffith made two observations:
(1) The disease-causing strain of bacteria grew into smooth colonies on culture plates.
(2) The harmless strain grew into colonies with rough edges.

Griffith's Experiments

Griffith set up four individual experiments.



Experiment 1: Mice were injected with the disease-causing strain of bacteria. The mice developed pneumonia and died.
Experiment 2: Mice were injected with the harmless strain of bacteria. These mice didn't get sick.
Experiment 3: Griffith heated the disease-causing bacteria. He then injected the heat-killed bacteria into the mice. The mice survived.
Experiment 4: Griffith mixed his heat-killed, disease-causing bacteria with live, harmless bacteria and injected the mixture into the mice. The mice developed pneumonia and died.

Griffith concluded that the heat-killed bacteria passed their disease-causing ability to the harmless strain.

Transformation

Griffith called this process **transformation** because one strain of bacteria (the harmless strain) had changed permanently into another (the disease-causing strain).
Griffith hypothesized that a factor must contain information that could change harmless bacteria into disease-causing ones.

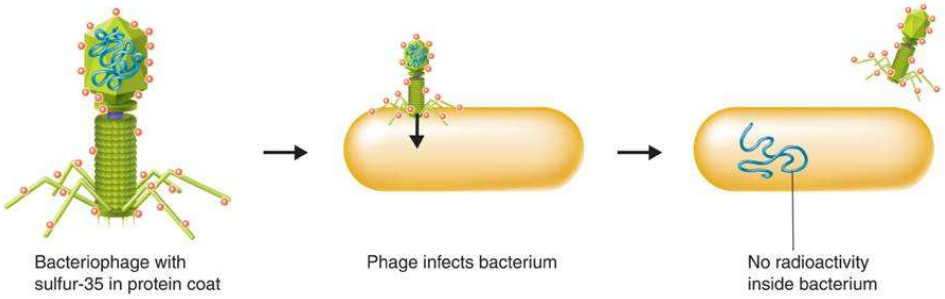
Avery and DNA

Oswald Avery repeated Griffith's work to determine which molecule was most important for transformation.
Avery and his colleagues made an extract from the heat-killed bacteria that they treated with enzymes.
The enzymes destroyed proteins, lipids, carbohydrates, and other molecules, including the nucleic acid RNA.
Transformation still occurred.
Avery and other scientists repeated the experiment using enzymes that would break down DNA.
When DNA was destroyed, transformation did not occur. Therefore, they concluded that DNA was the transforming factor.

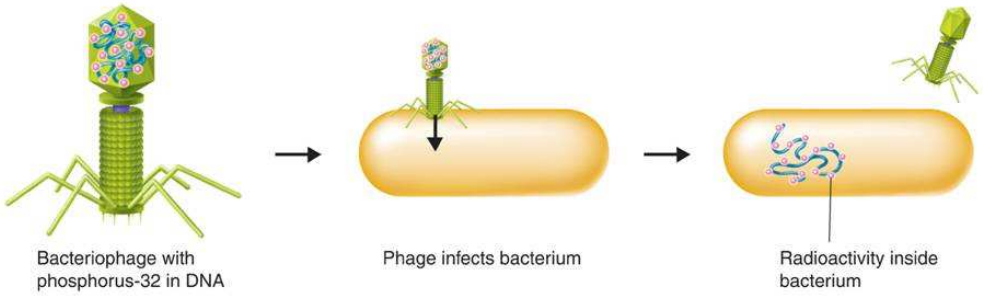
Avery and other scientists discovered that the nucleic acid DNA stores and transmits the genetic information from one generation of an organism to the next.

The Hershey-Chase Experiment
Alfred Hershey and Martha Chase studied viruses—nonliving particles smaller than a cell that can infect living organisms.

Bacteriophages
A virus that infects bacteria is known as a **bacteriophage.**
Bacteriophages are composed of a DNA or RNA core and a protein coat.
When a bacteriophage enters a bacterium, the virus attaches to the surface of the cell and injects its genetic information into it.
The viral genes produce many new bacteriophages, which eventually destroy the bacterium.
When the cell splits open, hundreds of new viruses burst out.
If Hershey and Chase could determine which part of the virus entered an infected cell, they would learn whether genes were made of protein or DNA.
They grew viruses in cultures containing radioactive isotopes of phosphorus-32 (32P) and sulfur-35 (35S).
If 35S was found in the bacteria, it would mean that the viruses' protein had been injected into the bacteria.



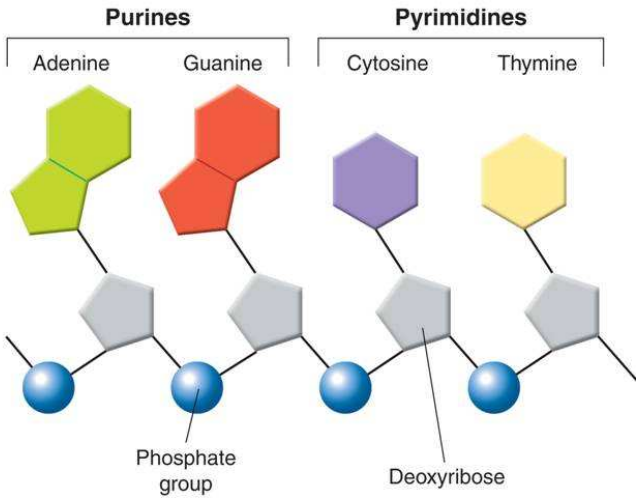
If 32P was found in the bacteria, then it was the DNA that had been injected.



Nearly all the radioactivity in the bacteria was from phosphorus (32P).
Hershey and Chase concluded that the genetic material of the bacteriophage was DNA, not protein.

The Components and Structure of DNA
DNA is made up of **nucleotides**.
A nucleotide is a monomer of nucleic acids made up of a five-carbon sugar called deoxyribose, a phosphate group, and a nitrogenous base.
There are four kinds of bases in in DNA:

- adenine
- guanine
- cytosine
- thymine

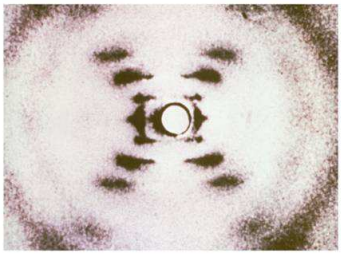


The backbone of a DNA chain is formed by sugar and phosphate groups of each nucleotide.
The nucleotides can be joined together in any order.

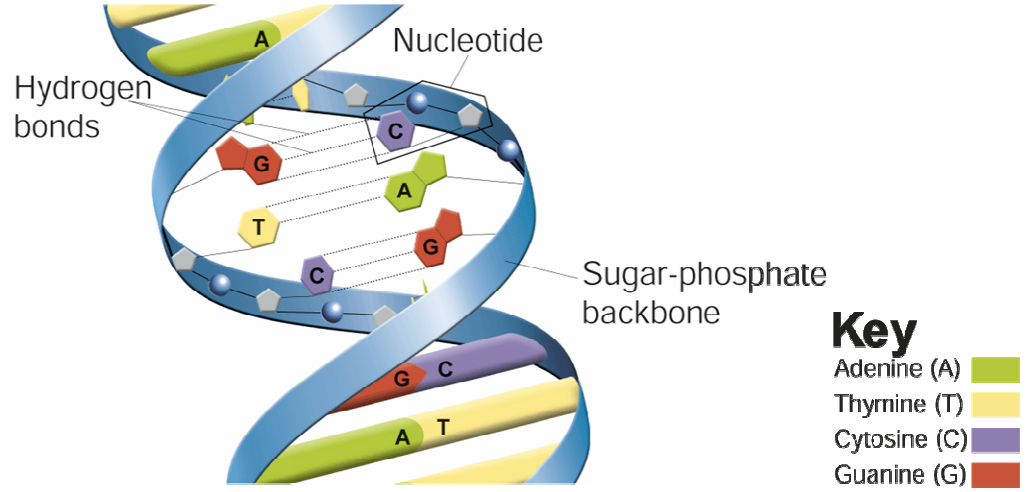
Chargaff's Rules
Erwin Chargaff discovered that:

- The percentages of guanine [G] and cytosine [C] bases are almost equal in any sample of DNA.
- The percentages of adenine [A] and thymine [T] bases are almost equal in any sample of DNA.

X-Ray Evidence
Rosalind Franklin used X-ray diffraction to get information about the structure of DNA. She aimed an X-ray beam at concentrated DNA samples and recorded the scattering pattern of the X-rays on film.



The Double Helix
Using clues from Franklin's pattern, James Watson and Francis Crick built a model that explained how DNA carried information and could be copied.
Watson and Crick's model of DNA was a double helix, in which two strands were wound around each other.



Watson and Crick discovered that hydrogen bonds can form only between certain base pairs—adenine and thymine, and guanine and cytosine.
This principle is called **base pairing**.