Chapter 3:

DNA structure and Replication

TB Ch. 12 p. 287

Sep 26-1:21 PM

The race to discover DNA

How did we come to discover that all of our genetic information comes from DNA?

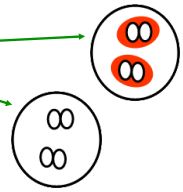
Frederick Griffith's work Summary: Figure 12-2, p. 288

Griffith was a bacteriologist studying pneumonia.

He discovered two types of colonies:

smooth colonies

rough colonies



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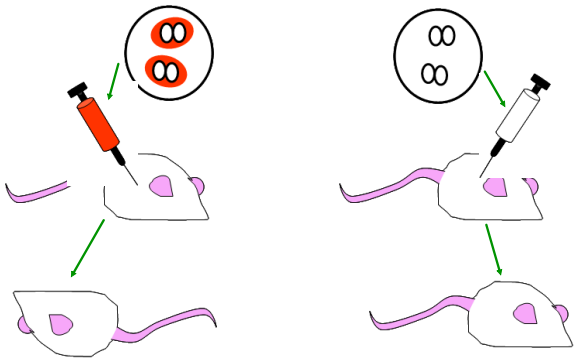
He injected mice with the colonies and discovered that mice injected with the smooth colonies developed pneumonia and died.

Those injected with rough colonies survived.



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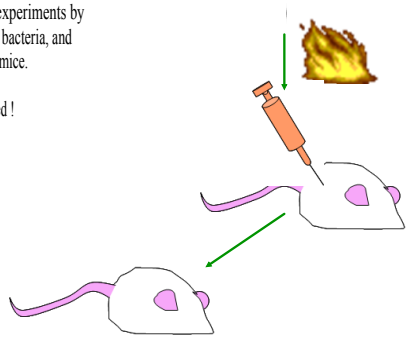
Griffith's conclusion: The smooth bacterial colonies cause the disease.
Do they carry a poison?

He continued his experiments by heating the smooth bacteria, and injecting them into mice.

In this case, they lived !



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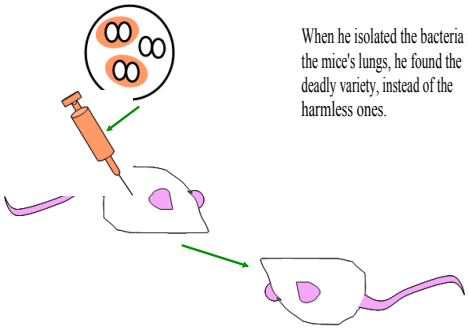
Next, he mixed the heat-killed, disease causing bacteria with the harmless colony and injected the mixture into more mice.

To his surprise, the mice developed pneumonia and died.



When he isolated the bacteria in the mice's lungs, he found the deadly variety, instead of the harmless ones.

Sep 26-1:50 PM

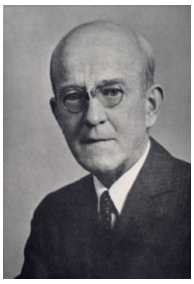
His conclusions?

The bacteria must have ***transformed*** itself into the deadly variety.

He called the process ***transformation*** and hypothesized that some factor got transferred from the heat-killed bacteria to the harmless ones and permanently changed them.

Sep 26-1:57 PM

In 1944, Griffith's experiments were repeated by a group of scientists led by Canadian biologist, Oswald Avery.

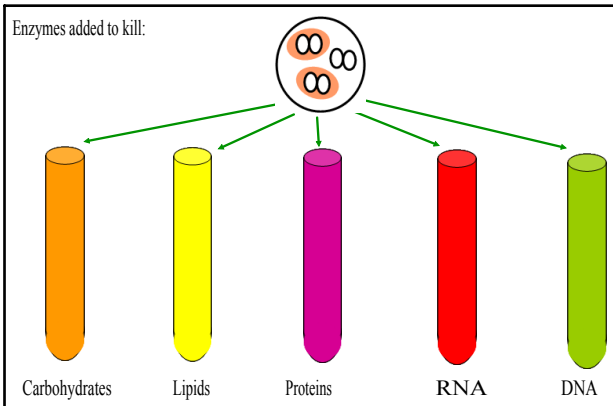


Oswald Avery

The created a mixture of the heat-killed bacteria, along with the non-lethal rough colonies, but added enzymes that destroyed key factors to identify which one was responsible for the transformation.

Sep 26-2:00 PM

Enzymes added to kill:



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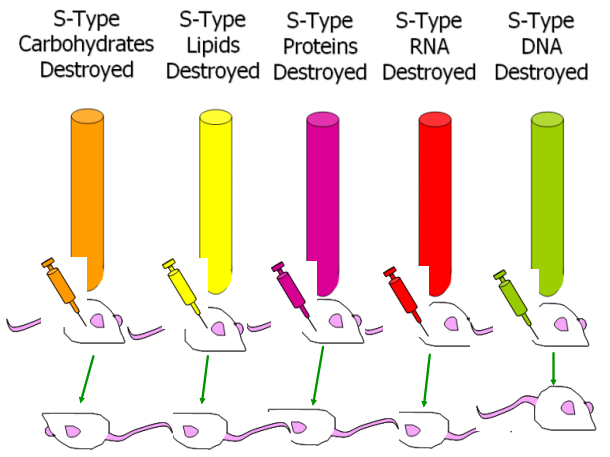

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Conclusions: DNA is the transforming factor!

Scientists, however, are hard to convince. The experiments done so far did nothing to prove that genetic information was stored in DNA.

In 1952, Alfred Hershey and Martha Chase set out to prove it.

Sep 26-2:11 PM

Hershey and Chase studied bacteriophages (viruses that attack bacteria).

A bacteriophage is a simple organism made of a protein coat and DNA core.

When it infects a bacteria, it injects it's genetic material into the bacteria, which serves as a free replicator.

The genetic matierial will eventually break out of the bacterium, killing it in the process.

The question here was: Which part of the bacteriophage is the genetic material? The DNA, or the protein coat?

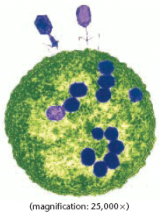
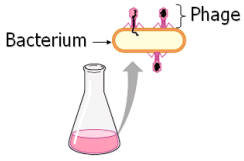


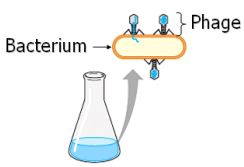
Figure 12-3, p. 289

Sep 26-2:22 PM

Hershey and Chase designed an experiment in which they grew colonies of bacteriophages and infected bacteria.

In one colony, the protein coat was labeled with radioactive Sulfur-35.

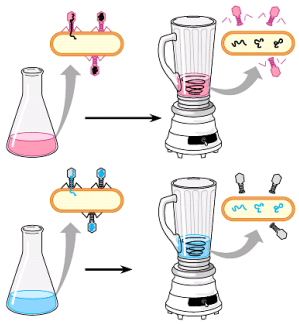




In the other colony, the DNA was labeled with Phosphorus-32.

Sep 26-2:29 PM

The bacterial colonies were separted from the viruses by agitating the mixture in a blender.



In the second colony, the bacterial DNA was found to be radioactive and labeled with phosphorus-32.

Scientists now knew that DNA carried a cell's genetic information, but there were still important details to discover:

How does DNA store genetic information?

How does it replicate itself?

Sep 26-2:33 PM

The race to understand DNA picks up the pace:

Until this point, only a few things were known about DNA:

- DNA is made up of long chains of small molecules called ***nucleotides***.

- Each nucleotide is made up of 3 components:
  1) Deoxyribose (a 5-carbon sugar compound)
  2) A phosphate group
  3) A nitrogen-containing base

Sep 26-2:35 PM

There are four types of nucleotides:

Adenine Guanine — Two-ringed purines

Thymine Cytosine — One-ringed pyrimidines

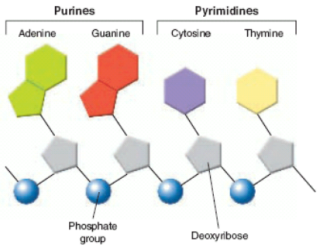


figure 12-5, p. 291

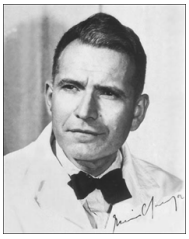
Sep 26-2:47 PM

The backbone of DNA is formed by the sugars and phosphate groups of the nucleotides. The nitrogen bases stick out to the side.

The nucleotides can be arranged in any order and can form an infinite number of combinations.

At this point in history, scientists are baffled about how such a molecule can be responsible for passing on genetic information from one generation to the next.

Sep 26-2:50 PM



Erwin Chagraff

Erwin Chagraff ran an experiment and discovered that the quantities of adenine [A] were always equal to the quantities of thymine [T]. Quantities of cytosine [C] were also equal to those of guanine [G].

Chagraff's Rule

[A] = [T]

[C] = [G]

DNA samples from all organisms seemed to obey this rule.

Sep 26-2:34 PM

Watson and Crick's Contributions

James Watson and Francis Crick were trying to understand the structure of DNA by building cardboard and wire models.

Work done previously by Rosalind Franklin helped them understand that 2 DNA strands were coiled around one another.

This led them to create a model in which DNA was a double-helix (two strands coiled around one another), much like a twisted ladder.

This helped explain Chagraff's Rule:

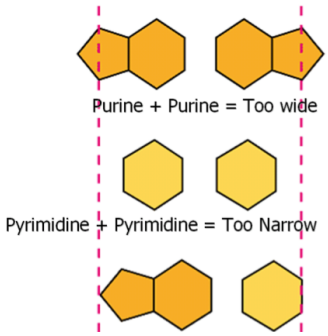
[A] is always attached to [T]

[G] is always attached to [C]

} Therefore, they always exist quantities.

Sep 26-3:05 PM

Why would these nucleotides always exist in equal quantities?



Purine + Pyrimidine = perfect fit

This is known as *base pairing*.

This model also helped scientists understand how DNA replicates.

Sep 26-2:59 PM