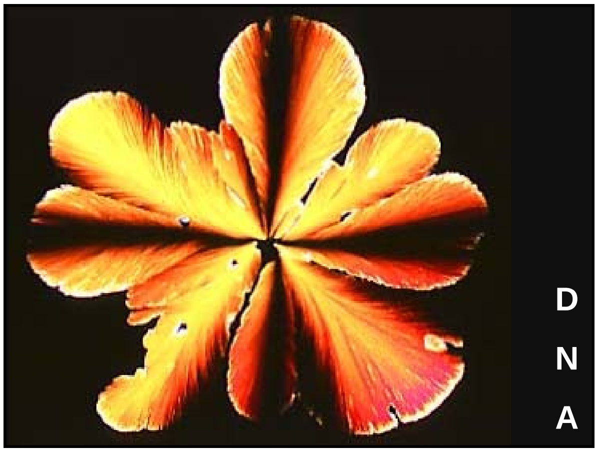


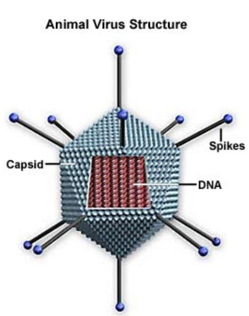
Deoxyribonucleic Acid

How do cells know what to do in your body?

How can DNA determine what you will look like?

Why does DNA testing prove you committed a crime or that you're not my baby's daddy?

Viruses are NOT Organisms

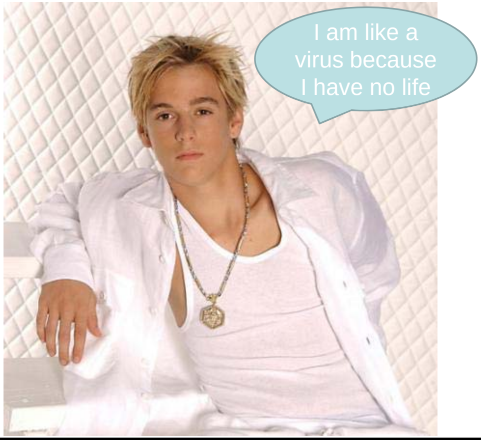


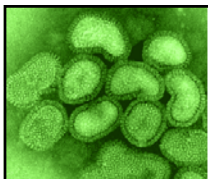
No cytoplasm
No organelles
No life

Viruses are not plants, animals, or bacteria, but they are the quintessential parasites of the living kingdoms. Although they may seem like living organisms because of their prodigious reproductive abilities, viruses are not living organisms in the strict sense of the word.

Without a host cell, viruses cannot carry out their life-sustaining functions or reproduce. They cannot synthesize proteins, because they lack ribosomes and must use the ribosomes of their host cells to translate viral messenger RNA into viral proteins.

Viruses cannot generate or store energy in the form of adenosine triphosphate (ATP), but have to derive their energy, and all other metabolic functions, from the host cell. They also parasitize the cell for basic building materials, such as amino acids, nucleotides, and lipids (fats).





TEM of Influenza virus.

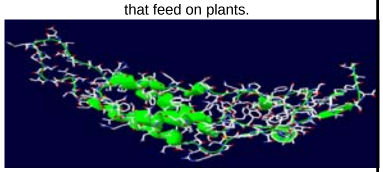
The Orthomyxoviridae are a family of RNA viruses which, so far as is known, infect mainly vertebrates.

It includes those viruses which cause influenza.

In 1995 the CDC ranked the flu as the 6th leading cause of death in the US following heart disease, cancer, stroke, accidents, and pulmonary disease

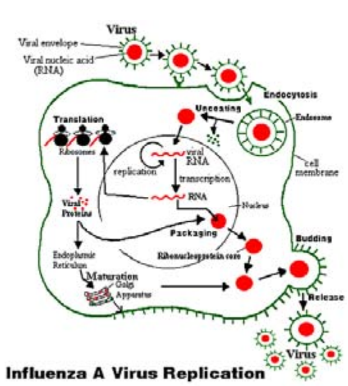
All viruses contain nucleic acids, either DNA or RNA (but not both), and a protein coat, which surrounds the nucleic acids. Some viruses are also enclosed by an envelope of slippery fat and protein molecules.

Viruses are generally classified by the organisms they infect, animals, plants, or bacteria. Since viruses cannot penetrate plant cell walls, virtually all plant viruses are transmitted by insects or other organisms that feed on plants.



The Tobacco mosaic virus (TMV) is an RNA virus that infects plants, especially tobacco and other members of the family Solanaceae, showing mottling and discoloration on the leaves.

TMV was the among the first viruses to be discovered (1892).



The influenza virus is a class of viruses containing RNA as its hereditary material.

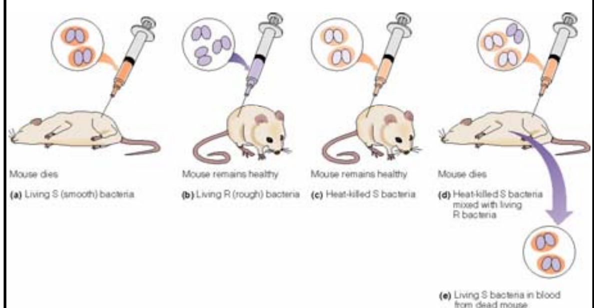
It replicates by entering a host cell and using this cell's resources to produce hundreds of copies of the viral RNA.

The virus attaches to the outside of the host cell and its RNA enters into the cell. The viral genes are transcribed and translated by the cell's enzymes and ribosomes. In this way, the virus takes over the cell's productivity.

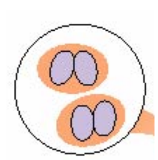
Now, instead of producing only new cellular material, the cell produces hundreds of new virus particles. The new virus particles are eventually released from the cell and drift off, to land on a host cell of their own to pirate.

In 1928 Frederick Griffith conducted one of the first experiments suggesting that bacteria are capable of transferring genetic information, otherwise known as the “transforming principle”, which was later discovered to be DNA.

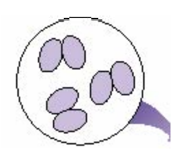
Griffith's experiment on transformation of Pneumococcus



Griffith used two strains of Pneumococcus (which infects mice), a S (smooth) and a R (rough) strain. The S strain covers itself with a polysaccharide capsule that protects it from the host's immune system, resulting in the death of the host, while the R strain doesn't have that protective capsule and is defeated by the host's immune system.



In his experiment, bacteria from the S strain were killed by heat, and their remains were added to R strain bacteria. It turned out that the formerly harmless R strain now was able to kill its host. It had been transformed into the lethal S strain, obviously by a transforming principle that was somehow part of the dead S strain bacteria.



But What Causes Transformation?

- Protein? – More subunits (20 amino acids)
  - More likely because it is found throughout the cell's cytoplasm.
  - Cells are constantly making proteins
  - Without the protein coat the bacteria is harmless
- DNA? – Fewer subunits (4 nucleotides)
  - Only found in the nucleus
  - Considered a boring molecule.

What Causes Transformation?

Today, we know that the DNA of the S strain bacteria had survived the heating process, and was taken up by the R strain bacteria.

The S strain DNA contains the genes that form the protective polysaccharide capsule.

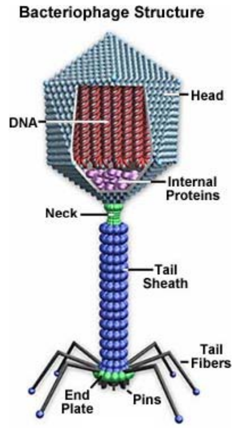
Equipped with this gene, the former R strain bacteria were now protected from the host's immune system and could kill it.

The first bacterial viruses were discovered in 1917 by scientists working independently in London and Paris.

The French scientist, Felix d'Herelle, was studying the feces of patients who had recovered from a bacterial dysentery (diarrhea). This somewhat unpleasant work led him to the discovery of an organism capable of killing bacteria.

He coined the term "bacteriophage," meaning eater of bacteria, to describe his discovery. d'Herelle was hopeful that this discovery would be useful in fighting disease.

The study of a Bacteriophages turned out to be crucial in establishing the identity of DNA as the genetic material of all living things.



Meet the Bacteriophage

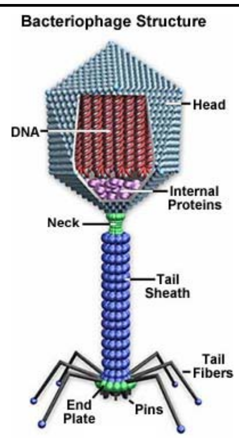
Certain bacterial viruses, such as the T4 bacteriophage, have evolved an elaborate process of infection.

The virus has a "tail" or landing section which it attaches to the bacterium surface by means of proteinaceous (meaning made of protein) "pins."

The tail contracts and the tail plug penetrates the cell wall and underlying membrane, injecting the viral nucleic acids into the cell.

After the viral nucleic acids are in the cell they takeover the nucleus and begin telling the ribosomes of the host cell to make copies of the bacteriophage's proteins instead of the ones belonging to the host cell.

Eventually the cell becomes so full of bacteriophages that it bursts open allowing them to infect more cells.



In 1952, American biologists Alfred Hershey and Martha Chase set out to determine what composed the genetic material of a bacteriophage.

They knew that a bacterial virus was an extremely simple organism, composed only of protein and DNA.

The protein makes up the exterior of the virus, and the DNA is contained within it.

When a bacterium is infected by a bacteriophage, the bacterium's internal machinery falls under the control of the virus, which uses the bacterium to produce more viruses.

What Hershey and Chase wanted to know was: Which substance directed this takeover - DNA or protein?

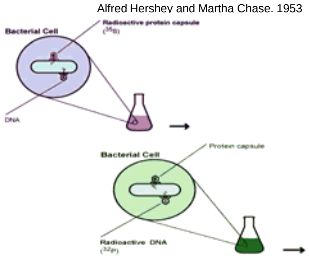
Hershey and Chase added bacteriophage to cultures containing either radioactive sulfur or radioactive phosphorus.

The bacteriophages grown in the cultures with radioactive sulfur picked it up and incorporated it into their protein.

The bacterial viruses grown in the culture with radioactive phosphorus picked that up, incorporating a little of it into the protein, but most of it into their DNA.

Hershey and Chase now had two types of bacteriophages: one with a radioactive external protein coat, the other with highly radioactive DNA. They were ready to begin their experiment.

Alfred Hershey and Martha Chase. 1953



Each of the two types of radioactive bacteriophage was added to a separate culture of bacteria.

The bacteriophages were allowed to infect the bacteria, then the cultures were whirled in a kitchen blender, the spinning blades caused any part of the bacteriophages that hadn't got inside the bacteria to fall off the cell.

Next the cultures were spun in a centrifuge, which separates materials suspended in liquid according to their weights.

The heavier bacterial cells fell to the bottom and formed a pellet, the lighter bacteriophages and loose phage parts remained in the liquid.

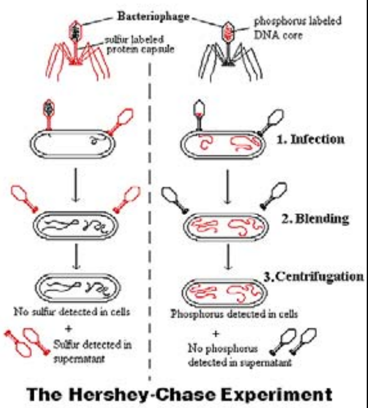
Where was the radioactivity now?

It depended on which radioactive element you looked for.

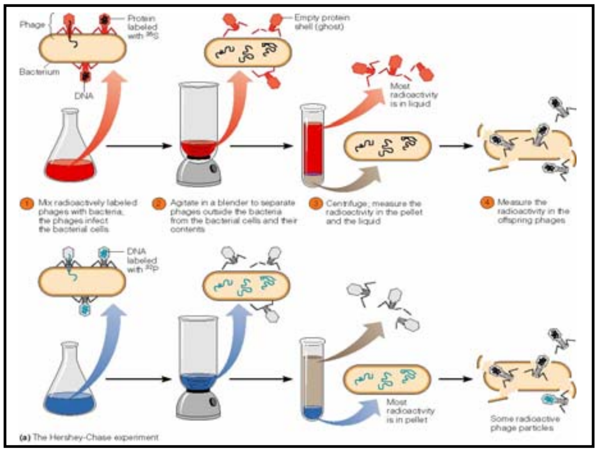
In the cultures infected by bacteriophages with radioactive sulfur (with labeled protein), most of the radioactivity was in the liquid with the phages.

In the cultures infected by bacteriophages with radioactive phosphorus (with most of the label in their DNA), most of the radioactivity was in the pellet of infected bacteria.

The radioactive protein hadn't entered the bacterial cells, but the DNA had.



The final proof that DNA, not protein, was the genetic material was provided by the offspring of the phosphorus-labeled bacteriophages.



The final proof that DNA, not protein, was the genetic material was provided by the offspring of the phosphorus-labeled bacteriophages.

They had radioactive DNA, passed down from their parents, but no radioactive protein.

These experiments convinced the scientific community that DNA alone was the material of heredity, and inspired Watson and Crick to begin their efforts to discover its structure.